Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan

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PURPOSE

The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance program run as part of the World Bank's Energy, Mining and Telecommunications Department. ESMAP provides advice to governments on sustainable energy development. Established with the support of UNDP and bilateral official donors in 1983, it focuses on the role of energy in the development process with the objective of contributing to poverty alleviation, improving living conditions and preserving the environment in developing countries and transition economies. ESMAP centers its interventions on three priority areas: sector reform and restructuring; access to modern energy for the poorest; and promotion of sustainable energy practices.

GOVERNANCE AND OPERATIONS

ESMAP is governed by a Consultative Group (ESMAP CG) composed of representatives of the UNDP and World Bank, other donors, and development experts from regions benefiting from ESMAP's assistance. The ESMAP CG is chaired by a World Bank Vice President, and advised by a Technical Advisory Group (TAG) of four independent energy experts that reviews the Programme's strategic agenda, its work plan, and its achievements. ESMAP relies on a cadre of engineers, energy planners, and economists from the World Bank to conduct its activities under the guidance of the Manager of ESMAP, responsible for administering the Programme.

FUNDING

ESMAP is a cooperative effort supported over the years by the World Bank, the UNDP and other United Nations agencies, the European Union, the Organization of American States (OAS), the Latin American Energy Organization (OLADE), and public and private donors from countries including Australia, Belgium, Canada, Denmark, Germany, Finland, France, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, the United Kingdom, and the United States of America.

FURTHER INFORMATION

An up-to-date listing of completed ESMAP projects is appended to this report. For further information, a copy of the ESMAP Annual Report, or copies of project reports, contact:

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ESMAP Management"

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Preface

In early 1998 Francisco Viray, then Secretary of Energy of the Government of the Philippines, formally requested that the World Bank conduct an objective and comprehensive external review of the Philippines' non-conventional energy development program, including technology choices, short- and long-term objectives, institutional coordination and other implementation issues. Viray asked that the review identify near-term opportunities for investment in new and renewable energy (NRE), particularly for its use in bringing energy to remote villages. ESMAP resources were subsequently obtained for this purpose in mid-1998, and in October 1998 a mission was fielded to discuss next steps with the new DOE secretary, Mario V. Tiaoqui. Secretary Tiaoqui reaffirmed DOE's strong interest in the assistance, emphasizing the urgency of his government's electrification program for some 5,000 off-grid *barangays* (villages) under the presidentially mandated Energy Resources for the Alleviation of Poverty (ERAP) program.

ESMAP subsequently forged an alliance with two other agencies with ongoing technical assistance programs in the Philippines: the U.S. National Renewable Energy Laboratory (NREL) and Winrock International. This alliance led to (1) an exchange of expert information and analysis and (2) the joint conduct of a workshop on renewable energy in Cavite in June 1999. At this workshop, the initial findings and recommendations of ESMAP and its cooperators were discussed with officials and staff of DOE, the National Power Corporation, and the National Electrification Administration. The ESMAP team also helped EASEG staff prepare a Rural Power Sector Policy Note that could identify a potential Bank operation in rural electrification, which may include NRE in off-grid areas. The present report summarizes the final findings and recommendations of the ESMAP team, which consisted of Ernesto Terrado, Task Manager (EMTEG), Christopher Rovero (Winrock International), and Donald Hertzmark and Jerome Weingart (consultants). Where the report draws on the findings and analysis of NREL, Winrock International, and other collaborators, this is duly acknowledged.

Note: As of June 8, 2001, the legislature had passed and President Gloria Macapagal-Arroyo had signed into law Republic Act No. 9136, *An Act Ordaining Reforms in The Electric Power Industry, Amending for the Purpose Certain Laws and for Other Purposes.* This is known as the "Electric Power Industry Reform Act of 2001." The act opens the power sector to significant restructuring and privatization. Among the goals of the act are "to assure socially and environmentally compatible energy sources and infrastructure, and to promote the utilization of indigenous and new and renewable energy resources in power generation in order to reduce dependence on imported energy." Many of the recommendations made in this report were subsequently incorporated or reflected in the act. This report has not been thoroughly revised in light of passage of the act, and does contain discussion of proposed legislation that was incorporated into Act No. 9136.

Acknowledgments

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Christopher Rovero
Jerome Weingart
Donald Hertzmark

Abbreviations and Acronyms

ANEC	Associated Non-conventional Energy Center
ARMM	Autonomous Region of Muslim Mindanao
AusAid	Australian Agency for International Development
BOI	Board of Investments
BOS	balance of system
CEPALCO	Cagayan Electric Power and Light Company
CO2	carbon dioxide
DENR	Department of Environment and Natural Resources
DILG	Department of Interior and Local Government
DOE	Department of Energy
DBP	Development Bank of the Philippines
EIAB	Energy Industry Administration Bureau (DOE)
EO	Executive Order
ER	Energy Regulation
ERAP	Energy Resources for the Alleviation of Poverty program
ERB	Energy Regulatory Board
ERDC	Energy Research and Development Center
FINESSE	Financing Energy Services for Small-Scale End Users
GEF	Global Environment Facility
GENCO	power generation company
genset	generator set
GIS	Geographic Information System
GOP	Government of the Philippines
GSIS	(Philippine) Government Service Insurance System
GTZ	Gesellschaft für Technische Zusammenarbeit (Germany)
IFC	International Finance Corporation
IPP	independent power producer
LBP	Land Bank of the Philippines
LGU	local government unit
MMBFOE	million barrels of fuel oil equivalent
NEA	National Electrification Administration
NEDA	National Economic and Development Authority
NGO	nongovernmental organization
NOFFO	Non-Fossil Fuel Obligation
NO_x	nitrogen oxides
NPC	National Power Corporation
NRE	new and renewable energy
NREL	U.S. National Renewable Energy Laboratory
OECD	Organisation for Economic Co-operation and Development
O Ilaw	"Oh Light" Rural Electrification Program
O&M	operation and maintenance
PEI	Preferred Energy Inc.
PCIERD	Philippine Council for Industry and Energy Research and Development

PNB	Philippines National Bank
PNOC	Philippine National Oil Company
PPA	power purchase agreement
PSGF	private sector generating facility
PV	photovoltaic
RA	Republic Act
R&D	research and development
REC	rural electric cooperative
REPP	Renewable Energy Power Program
SHS	solar home system
SIBAT	Sibol ng Agham at Teknolohiya
SO2	sulfur dioxide
SPUG	Strategic Power Utilities Group
SSS	(Philippine) Social Security System
TWG	technical working group
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
VAT	value added tax
WTP	willingness to pay

Units of Measure

AC	alternating current
DC	direct current
GWe	gigawatt (electric)
km	kilometer
kW	kilowatt
kWe	kilowatt (electric)
KWh	kilowatt-hour
m	meter
m/s	meters per second
mt	metric ton
MW	megawatt
MWe	megawatt (electric)
MWh	megawatt-hour
MWp	megawatt-peak
TWh	terawatt-hour
W	watt
We	watt (electric)

Executive Summary

1. The broad economic reforms that began in the mid-1980s have profoundly changed the Philippines energy sector. With its oil refining and coal mining operations privatized and petroleum product prices deregulated, the country is now poised to carry out sweeping reforms of the power sector, including the restructuring and privatization of the National Power Corporation (NPC) and the rationalization of the distribution sector. As articulated in the new energy plan for 1999–2008 (DOE 1999), the key sector objectives remain security of energy supply, affordable energy prices, and an energy infrastructure compatible with broader social and environmental objectives. For commercial energy, the plan projects a decline in imported energy supplies from about 80 percent of total requirements in 1999 to 68 percent in 2008. The Plan includes accelerated commercial application of new and renewable energy (NRE) technologies, increasing their contribution from about 70 million barrels of fuel oil equivalent (MMBFOE) in 1999 to 91 MMBFOE in 2008.

2. The projected contributions for electricity supply from NRE technologies comprise both large-scale grid-connected applications, some of which are still commercially undeveloped, and small-scale off-grid applications that are already economic today. In the near and medium terms, the projected contributions are relatively small but can have significant economic, social, and environmental benefits, especially those that improve energy access for people in the countryside. Despite the rapid pace of electrification nationally, about 25 percent of the country's 72 million people remain unserved, almost all of them in rural areas. The Philippines comprises some 7,000 islands spread over 300,000 square kilometers. For cost and technical reasons (e.g., distance from the main network), many rural communities will not be connected to the grid in the foreseeable future, if at all. Small-scale renewable energy systems may be the only practical option for providing basic electricity services to such communities.

The Need for a New Public/Private Initiative

3. Although numerous large and small NRE projects have been carried out in the Philippines over the last two decades by both the public and private sectors (see Chapter 1), true commercialization has proved elusive. The projects have typically been "one-off," donor-driven, of subcritical mass, and lacking the financial or technical resources for sustained operation and maintenance. A large part of the problem is exogenous, and thus beyond the control of local planners: only recently have some NRE technologies of interest to the Philippines compiled adequate track records and achieved sufficiently significant reductions in cost to be of interest to investors.

4. The NRE development program in the Philippines has been hindered by the lack of a policy framework that (1) articulates the contribution that renewable energy can realistically make in the short and long terms, (2) provides adequate incentives to the private sector for participation, and (3) supports effective institutional arrangements for carrying out a coherent national program. The purpose of this report is to help the government of the Philippines (GOP) identify key policy gaps and to suggest specific strategies to address them. These policies and strategies require an effective understanding of the technical nature and economic potential for the country of the technologies of interest. Therefore the report also advises on which technologies make practical sense in the immediate, medium, and long terms.

5. The report deliberately emphasizes the discussions on near-term economic investments in NRE and an action plan to hasten their implementation, particularly NRE applications in off-grid electrification. This emphasis is dictated by DOE's urgent need to carry out a presidentially-mandated program to energize 10,000 unelectrified *barangays* (villages) nationwide by 2004. However, some suggestions are also made on what the government's position and strategy should be as regards its support for longer-term, larger-scale NRE technologies.

Practical Near-Term Technology Choices

6. Table 1 indicates potentially important renewable energy options that are commercially available for backbone grid connection, distributed minigrid applications, and dispersed freestanding uses. Chapter 2 and the annexes provide more detailed discussions of the technical characteristics and current costs of these technologies.

7. For some renewable energy technologies there is virtually no in-country experience even though the technologies are fully commercial elsewhere and appear to be highly relevant to the Philippines. Examples include large-scale wind electric power plants, small wind turbines, and wind/diesel hybrid power units. Rapidly evolving and commercially available technologies of special relevance to off-grid communities include small (less than 500 kWe) bioelectric systems and hybrid power-generation units running on a combination of solar, wind, and fossil fuel energy. There are other technologies relevant to the renewable energy resource base in the Philippines, but the development of commercial equipment has not yet been achieved internationally, especially for marine energy conversion systems that mobilize marine currents, waves, and ocean thermal gradients. For these still-speculative technologies, the report discusses recent technical developments and suggests practical ways for the GOP to keep abreast of international developments, such as hosting international precommercial trials in Philippine waters.

Applications for Off-Grid Communities

8. Effective and lasting poverty reduction is nearly impossible to achieve in rural areas without broad-based economic growth—that is, growth based on generating jobs in efficient and labor-intensive commercial activities and supported by sufficient development of the local infrastructure in general and the energy infrastructure in particular. Even small amounts of electricity, applied strategically, can promote economic activities in isolated areas. The availability of affordable electric lighting for households also contributes to the quality of life in unelectrified areas.

Table 1: Renewable Energy Options for the Philippines (Electricity and Cogeneration)

Classification and Scale	*Technologies*	*Primary Applications*	*Commercial Status*
Large-scale (> 10 MWe)	Wind electric power generation (wind farms)	Bulk power generation (10–100 MWe)	Fully commercial, with evolution in efficiency, reliability, and cost-effectiveness
	Biomass-based power generation and cogeneration	Cogeneration, with capacity of 10–30 MWe	Fully commercial, but each plant is engineered to reflect unique; legal and regulatory impediments
	Mini-hydro power (up to 50 MWe)		Fully commercial, cost and performance highly site-specific
	Geothermal energy conversion	Base-load power	Well established in Philippines; policy issues limit expansion
Medium-Scale (1–10 MWe)	Small windpower plants	Intermittent generation, connected to local and regional minigrids	No experience yet in Philippines, significant potential likely
	Wind/diesel hybrid power units	Fully dispatchable power, with majority component from wind energy	Commercially available, configured and engineered for specific sites and applications
	Biomass-based power generation and cogeneration	Agro-industrial applications, private power	Commercially available, configured and engineered for specific sites and applications
	Mini-geothermal	Base-load power	Commercially available, at the lower end of the range of typical installations.
Small-Scale (up to 1 MWe)	Wind electric		
	Photovoltaic		
	PV/wind/diesel hybrid		
	Bioenergy including biomass/diesel fuel hybrids	Local minigrid power generation	Commercially available at 100-, 250-, and 400-kWe biomass/diesel-fueled gensets
	Micro-geothermal		
Distributed Small-Scale (< 1 MWe)	Wind electric	Residential, community, and productive activities. Water supply, lighting, refrigeration, ice making, telecom	Fully commercial (100 We to 10 kWe)
	Photovoltaic		Fully commercial packaged systems
	PV/wind/fossil hybrids		Commercially available, packaged or custom engineered

9. In communities where households are widely dispersed and household energy use is low (typically less than 1 kWh per day), NRE technologies such as photovoltaics (PV) or small PV/wind hybrid power units are often less expensive than either grid extension or village A/C minigrids. Where households in the community are geographically more concentrated, small-scale hydropower and bioenergy systems often can compete effectively with fossil fuel options in powering local minigrids. Although rural inhabitants of the Philippines may prefer to have grid electricity at low prices, the current choice for close to 5,000 barangays is either (1) no electricity or (2) basic *pre-grid* electricity services that are not supplied by a central grid. Locally powered A/C minigrids can delivery electricity of very high quality and reliability, but they are limited by the maximum power generation capabilities of the local electricity sources (e.g., micro-hydro power units). By contrast, central (or "backbone") power grids can deliver power at virtually any level to local communities. This power limitation of isolated minigrids only becomes an issue if the isolated communities' demand for electric power exceeds the capability of the local minigrids.

10. Philippine market reforms have been quite effective in reducing costs and extending coverage of electricity supply. However, in other countries that have fully privatized their power sector, the impact on social programs for improving the access of dispersed rural populations to electricity and modern fuels has been invariably negative. New strategies that involve public/private sector partnerships and deployment mechanisms featuring decentralized technologies may be the only way for the GOP to pursue social equity and poverty reduction goals in a privatized energy sector. These concepts are discussed more specifically in Chapter 4.

Grid-Connected Applications

11. A number of large-scale grid-connected technologies have recently emerged into full commercial use internationally. Perhaps the most prominent and most promising for the Philippines is wind electric power generation, now with more than 15,000 MWe of installed capacity worldwide, most of it financed commercially.

12. Recent comprehensive wind-mapping data for the Philippines show that wind electric power has the potential to make a significant contribution to the country's power supply. Because wind turbines are modular (typically 0.2 to 2 MWe each), wind power is very adaptable to fast, unpredictable growth in power demand. Wind power is particularly advantageous for small islands compared with the prohibitive costs of expanding national grids and full reliance on imported fuels for diesel generator sets (gensets).

13. As with more developed geothermal energy, the Philippines' new energy plan recognizes local commercial exploitation of large-scale indigenous and renewable energy resources as a way to increase energy self-sufficiency and diversify the energy mix. Chapter 2 discusses the latest information on current and projected technology performance and costs of major NRE technologies of interest to the Philippines.

14. For much of the coming decade there appears to be no need for additional generation capacity for the NPC backbone grid beyond the projects that are under construction or in the pipeline. The Asian economic situation has resulted in lower mid-term growth projections for the Philippines economy. Yet there are important reasons why the Philippines should now encourage the development of wind resources for grid-connected power generation. One reason is the long lead time required for preparatory work. It will take the better part of a decade for the Philippines to have an active wind electric power development program underway and about 500

MWe of wind generation capacity in place. Several years of non-construction preparation are required for wind plant site identification, characterization, and ranking, and for detailed wind resource measurements (typically, two years of detailed data are required as part of the preinvestment activities). Developers, investors, and the government will all want a few years of experience with the initial wind plants before significantly expanding construction activities. *If wind electric power is to emerge as a significant, clean option for indigenous power generation in the coming decade, development must begin now.*

Near-Term Investment Opportunities

15. To give energy planners a "ball-park" (approximate) idea of the physical, financial and implementation requirements of these types of projects, this report outlines two important near-term NRE investment opportunities. These opportunities are in (1) off-grid electrification and (2) grid-connected wind electric power development. Although based on recent data and cost information available for the specific technologies and proposed local sites, the analyses presented are highly conceptual in nature and not intended for use in making immediate investment decisions.

Off-Grid Electrification

16. The near-term entry point for practical NRE applications on a significant scale is in off-grid electrification because most of the technologies involved are often already the least-cost options on a life-cycle basis. The conceptual project targets, as an example, 700 off-grid barangays in Region II (Cagayan Valley), Region VIII (Eastern Visayas), and Region IX (Western Mindanao). These regions have the largest number of off-grid barangays outside the Autonomous Region of Muslim Mindanao (ARMM). At the end of the conceptual (i.e., hypothetical) project, about 50 percent of the off-grid markets in these regions would have been served.

17. The market in each barangay will comprise (1) households for lighting; (2) public service centers, with one school and one health clinic per barangay; and (3) economically productive applications. The project would cover 126,000 households (at 100-percent market penetration), 1,400 public service centers, and 700 productive applications. It was assumed that 25 percent of the households will be connected to local centralized power systems and that 75 percent will have individual SHS units of 50W each. For costing the microgrids, it was assumed that one-half are powered by pure diesel gensets, 40 percent by centralized PV, 20 percent by micro-hydro, and 5 percent by wind power/hybrids. Each microgrid will have a capacity of about 30 kWe. For simplicity, the individual systems were assumed to be all 50-W solar home systems (SHSs). In a real project, the market for other system capacities should be investigated. The project would be carried out in three phases over five years, with the second and third phases overlapping. Each succeeding phase covers more barangays than in the previous phase, as the costs decline.

18. The analysis shows a required investment of about $90 million[1] for the modest-sized conceptual project. Given the magnitude of this financial requirement, the implementation plan must be based on principles of cost recovery and maximum contribution from the private sector, through companies that specialize in providing off-grid electrification services. The three

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1 All dollar amounts are current U.S. dollars.

basic implementation approaches now employed in similar projects elsewhere include (1) dealer sales of equipment, with consumer financing; (2) leasing of equipment to rural users by dealers and/or leasing companies; and (3) "fee-for-service" approaches by rural energy service companies (RESCOs). To attract private sector participation in off-grid projects, the government must develop an appropriate policy and regulatory framework that (1) will permit RESCOs to enter unserved franchise areas of rural electric cooperatives (RECs) and (2) allow charging of tariffs that reflect the true cost of service in such areas. These issues are discussed in more detail in Chapter 4.

Grid-Connected Wind Electric Power Development

19. An illustrative project description for a 50-MWe wind electric power project is presented in Chapter 4 and summarized in Chapter 5. The objective of such a modest but commercial-scale pilot project would be to catalyze local commercial development. A consultant study, on which the conceptual project is based, considered 16 potential project sites, through review of available wind data and site visits. The study concludes that Subec and Pagali in Ilocos Norte are both very good candidates for a commercial-scale wind plant. A likely scenario would involve construction at both sites (which are close to each other) since neither appears to be capable of supporting 50 MWe.

20. It is estimated that the 50-MWe wind farm could be built for an installed cost of about $1,000 per kWe (approximately $50 million capital investment), and that the turbines would operate with an average annual capacity factor of about 30 percent. Some 67 turbines, each with a capacity of 700 kW, would be employed.

21. Because such a project would be carried out by independent power producers, the consultant report suggests some specific incentives (see Chapter 5) to attract private industry, including the provision of long-term power purchase contracts, accelerated depreciation schemes, and investment/production tax credits. Although the World Bank and the GOP do not necessarily endorse all of these fiscal recommendations, they do illustrate the kinds of concerns that the private sector has regarding this area of investment. One recommended action clearly worth pursuing is to examine the potential for matching wind projects with pumped storage hydro projects, to address the intermittency issue of the resource.

The Role of Renewables in a Restructured Environment

22. The impact on renewables of the impending restructuring of the power sector is mainly on large grid-connected NRE technologies, such as wind power, that are not yet in the system. Some of the potential impacts are negative. In a pool[2] system, which is one of the likely forms of the restructured sector, generators are paid only for specific services such as energy, capacity, spinning reserve, black start, and reactive power. Energy prices are based strictly on the marginal cost of energy at a given hour. Capacity payments are normally based on some combination of plant availability, reliability, and a chosen method of calculating periodic capacity cost for the system. Stand-alone renewable electricity plants will generally receive only energy payments as stand-alone units. Normally, NRE plants cannot provide adequate availability to receive capacity payments under typical pool arrangements.

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[2] A more complete discussion of this approach appears in Annex 3.5.

23. In general, a power pool arrangement will not be able to give capacity credit to a renewable plant if its availability is below a specified level, usually 85–90 percent.[3] Because without capacity payments it will be difficult to finance wind farms, a means must be devised to obtain capacity payments for the renewable plant. One approach is to promote hybrids rather than stand-alone renewables plants. Under the future pool rules a power generation company (GENCO), which may include renewable generating plants ("virtual hybrid" configuration),[4] could be responsible for providing capacity from its portfolio of generating assets and not from any specified individual plant. This gives the GENCO an incentive to acquire power plants with very low variable costs, such as renewable generators, that are "reasonably" available and reliable, especially if they can help meet peak period demands. A GENCO could find this approach economically attractive because, over the life of the investment, the lower operating costs of the NRE facility could offset the capital costs of both the NRE and the conventional plant firming up the NRE resource.

24. The chief benefits of this approach for the country are that (1) older oil-fired plants can be retired more quickly without affecting system reliability and (2) the GENCO using the NRE plants may be able to obtain carbon offset payments from the Global Environment Facility (GEF) or other sources as a corporate entity, thereby maximizing the incentive to invest in renewable energy.[5] A similar approach integrating dispersed biomass plants into generating companies would enable a GENCO to supply not only active power and energy, but also such auxiliary services as reactive power throughout the grid. Thus the proposed reorganization of the country's electricity system, coupled with planned plant retirements, could in fact create an environment for increased use of renewables-based electricity.

25. Nevertheless, developers of renewable energy generation projects such as windfarms will require long-term power purchase agreements (PPAs) at favorable rates before they will be willing to commit to and invest in a project. This will certainly be the case for a new market, such as the Philippines, where no company will have the locally established infrastructure (e.g., trained local staff), sunk costs, and experience base to enable them to operate on a less risky basis. One possible problem stemming from the restructuring is that it is not apparent whether there will be a government-related entity (e.g., NPC-residual, other) that will be in a position to issue PPA(s) with favorable power purchase rates for wind generation, and possibly serve to channel external resources (such as GEF grants) for renewable generation incentives. It is recommended that this issue be examined closely by the DOE and efforts made to introduce appropriate provisions to the proposed Omnibus Bill.[6]

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3 The *availability* factor (the ability of the plant to produce when called) is often confused with the *capacity* factor. Plants with low capacity factors (for example, combustion turbines operated just a few hundred hours annually) will receive capacity payments because they are highly available to the system when called (usually more than 95 percent). On the other hand, a NRE plant with a high capacity factor, such as a mini-hydro plant that generates 60–70 percent of the hours of the year, might not be sufficiently available to receive a capacity payment.

4 A *virtual hybrid* is a GENCO with traditional and renewable energy capacity.

5 The transactions costs required to obtain such payments are likely to go beyond the resources of a small NRE generator, whereas a larger company is more likely to have the wherewithal to navigate the application process.

6 The NRE bill referred to in this document is superseded by the recently passed bill discussed in Annex 1.1.

Recommended Policy Initiatives

Near-Term Initiatives

26. Promoting NRE on a significant scale will require private sector investment; this in turn will require a supportive policy and regulatory environment. There is considerable potential for both grid-connected and (especially) off-grid energy supplies from NRE, but only if the risks and rewards of such investments can be made compatible by appropriate government policies. The main report recommends actions that can be taken now along with rationales for each one. Recommendations include the following:

- Revise accreditation requirements for renewable energy projects. This will remove significant obstacles to local private sector investment in NRE.
- Revise the definition of *renewable energy technologies* used by NPC regarding the limitations on hybrid power systems. This will permit the use of a range of hybrid power generation approaches in which renewable energy–dominated power generation will be made reliable and dispatchable through integration of fossil fuel backup equipment.
- Complete the revision of Executive Order (EO) 462. This will remove a major obstacle to large-scale investment by both in-country and international investors and developers.
- Exercise full DOE powers under the Mini-Hydro Law. The DOE is empowered to be the sole agency charged to carry out policies, rules, and regulations. This will facilitate mini-hydro development.
- Consider special favorable treatment of renewable energy generation—for example, permitting distribution utilities to own renewable generation plants up to a certain percentage of their load, providing generation incentives, and allowing for a limited number of new private power agreements (PPAs) for renewable installations.

27. The following recommended initiatives involve primarily off-grid renewable energy applications, and reflect the goals of the DOE's O Ilaw rural electrification program:

- Open the electrification of small and isolated grids to the private sector. In-country and international companies are prepared to invest in providing electricity services in off-grid regions provided that they can be allowed to do this on a profitable fee-for-service basis.
- Address key regulatory issues. It will be essential to allow market-based tariffs for wireless electricity services, and to permit private rural energy service companies to enter unserved REC franchise areas.
- Promote and facilitate co-investments for social and economic development. The Department of Energy should support the energy component of programs and initiatives that build rural community infrastructure (potable water, health, education, telecommunications, public lighting, etc.) and initiatives that develop and expand economically productive activities. This initiative should include

coordination with other government agencies responsible for these non-energy sectors.

- Establish national standards for renewable energy equipment. For large-scale use of NRE to be sustainable in off-grid areas, uniform and enforceable standards must exist for equipment design, installation, and performance. The DOE should expand its efforts in this area and make use of the work of international organizations already developing such standards for Europe, North America, and Japan.
- Expand availability of information needed by the private sector. The DOE, on its own and through contracts to others, has developed substantial information related to the market for renewable energy products and services. However, this information is not easily accessible by the private sector. It is recommended that DOE make this information more readily available to the private sector, and expand the information available. This can substantially reduce the time and expense required by companies to make informed NRE investment decisions. Useful actions by DOE would be to (1) further characterize and document renewable energy resources, (2) support socio-economic market characterization and documentation, and (3) support the determination of the willingness and ability to pay for modern energy services (especially through new survey instruments recently developed with DOE). Detailed market characterization is the most important preparatory task for off-grid electrification projects. It is the principal basis of project design and the determinant of whether a convincing case can be made for private sector investment.

Recommendations for SPUG's Future Mission and Activities

28. The NPC's Strategic Power Utilities Group (SPUG) is a major player in the electrification of isolated areas (minigrids and individual systems) and apparently will continue to be so in the future. To be consistent with the principles stressed above on maximizing private sector participation, the following changes are recommended in the mission and operation of SPUG:

- Give SPUG the mission to expand electrification on a least-cost, maximum-sustainability basis (both technical and financial), using SPUG funding as a lever for other sources of funding rather than, not as the sole source.
- Divest NPC and SPUG of design and implementation roles to the extent practicable, and change the role of SPUG to one focused on programming, planning and funding.
- Implement the SPUG mission, including isolated grids, through private firms, especially Rural Energy Service Companies (RESCOs), making use of competitive bidding for rights to build and operate systems.
- Allow private RESCOs to bid on SPUG franchise areas on the basis of subsidy minimization, subject to certain service standards.

- Permit RESCOs to charge prices that will recover all variable costs plus the non-subsidized investment costs and encourage experimentation with different levels of service to recover costs. This consideration needs to be reflected in the proposed Electricity Industry Reform Act.
- For areas where RESCOs are not interested in operating, offer subsidy packages to NGOs and communities to encourage project development.
- Coordinate expansion activities with the National Electrification Administration (NEA) and the RECs so that the tenure of the RESCOs is long enough to recover investments.

29. Other recommendations are as follows:

- Standardize the unit sizes for PV around several widely available sizes.
- Encourage bilateral donors to contribute to the electrification program overall rather than to small, unconnected pieces; and make effective coordination of project design and implementation efforts among NRE donors a much higher priority.
- Adopt standards for performance, efficiency, and reliability that will enable consumers and RESCOs to compare different vendors and even different technologies.
- Change the specifications of hybrid (NRE-fuel) systems such that common technically feasible and financially viable designs can meet the requirements for various government incentive programs.
- Encourage continuity of daily service, rather than peak period lighting, as a design goal to increase the productive uses of electricity.

Policy Considerations for the Long Term

30. Internationally, various large-scale grid-connected NRE technologies for power generation are gradually emerging as important long-term options for developing countries such as the Philippines. An important way in which the commercialization of these technologies is being accelerated is through special policy support. An example is the United Kingdom's Non-Fossil Fuel Obligation (NOFFO) initiative, which succeeded in significantly reducing the cost of wind energy and significantly expanding installed capacity in that country. Other examples include (1) the Electricity Feed Law in Germany and Spain and (2) the Systems Benefit Charges and Renewable Portfolio Standards (RPS) now being tried in some parts of the United States (see Annexes). All of these approaches involve some form of mandating increased production of renewable electricity from the power system, with the higher cost being financed by subsidies from various sources and schemes. The financial cost of such initiatives is high and it is not surprising that these programs are all limited to the industrialized countries for now.

31. For the Philippines and other developing countries, it may be possible to conduct similar initiatives to create initial markets for large-scale renewables for power through a new program called the World Bank/GEF Strategic Partnership for Renewable Energy. Under this program, GEF grant support for renewable energy in client countries is being shifted from single

projects to long-term (more than, say, 10 years) development programs that enable market development to occur in progressive phases. It is conceivable, for example, that the Philippines could adopt a "localized" version of the NOFFO or the RPS to accelerate market development of wind power with the incremental cost of development financed by the Strategic Partnership. The Philippines, in fact, is one of four initial countries being considered for participation in this global program, which is budgeted at about $150 million annually. It is recommended that the GOP actively pursue this possibility with the World Bank/GEF.

Note: The present report was completed in April 2000. Since then a number of events have taken place that directly or indirectly affect the recommended plan of action discussed in Chapter 5. Annex 1.1 provides an update of the situation as of June 2000.

Organization of this Report

32. The first chapter of this report briefly lays out the social, environmental, and economic justifications for developing NRE resources against the backdrop of privatization and reform of the energy sector. It reviews the experience with NRE from the 1970s to the present, highlighting some important lessons learned from both successful and failed initiatives.

33. The second chapter reviews the commercial status and current and expected costs internationally of NRE technologies of potential usefulness to the Philippines. It distinguishes between immediate and long-term potential, small- and large-scale systems, and rural and urban applications. Because electricity is one of the most important outputs of NRE systems, the chapter reviews the status of several off-grid and grid-connected technologies. On the basis of this review, the chapter makes a more realistic estimate of the medium- to long-term contribution of the various NRE technologies to the energy mix. It concludes with a recommended position of DOE as regards the priority to be accorded to these technologies.

34. The third chapter examines how existing and impending (proposed in the Omnibus Bill) policies, legislation, incentives, procedures and institutional arrangements affect, positively or negatively, the commercialization of NRE in the Philippines. Because *commercialization* implies a maximized role of the private sector, much of the discussion revolves around the effectiveness (or lack thereof) of various incentives and regulatory mechanisms directed at NRE development. The impact of such incentives on NRE technologies of immediate usefulness, such as mini-hydro and PV systems, is framed within the context of how rural electrification of off-grid areas (where NRE technologies are likely to be more competitive) can encourage the private sector to assume investment and implementation risks. For the medium and long terms, the chapter discusses the possible role of large-scale, grid-connected NRE systems (such as windfarms) in a restructured power sector where generators are organized in a pool system.[7]

35. The fourth chapter outlines near-term investment possibilities in off-grid electrification and large-scale wind power. The off-grid electrification project considers a slice of the rural electrification program, estimates the physical and financial requirements, and outlines possible technology deployment mechanisms that maximize the role of private players and minimize public subsidies. The windfarm project considers a representative location in the Ilocos

[7] This chapter benefited substantially from contributions by Paul Galen, U.S. National Renewable Energy Laboratory (NREL). Mr. Galen is the task leader for the Policy Task in NREL's renewable energy study for the Philippines, supported by USAID.

Region, where wind regime data and site information are sufficient to enable the estimation of physical, financial, and implementation needs. The objective is to give local energy planners and decision makers a more concrete idea of the magnitude of financial and other requirements as well as options for implementation.

36. The final chapter outlines some specific actions that need to be taken to pursue the priority investments identified. These actions include the rectification of certain policies and incentives and the carrying out of specific preparatory work, such as the conduct of systematic market characterization surveys of *barangays* included in the ERAP program and more detailed wind measurements in candidate sites. The chapter then reviews the different multilateral and bilateral assistance mechanisms that could usefully be exploited in the development of environmentally friendly NRE projects.

1

Introduction

Social and Strategic Justifications for Developing Renewable Energy

1.1 The broad economic reforms that began in the mid-1980s have profoundly changed the Philippines energy sector.[8] Now, with oil refining and coal mining operations privatized and petroleum product prices deregulated, the country is poised to carry out sweeping sector reforms that include the restructuring and privatization of the National Power Corporation (NPC) and the rationalization of the distribution sector. As articulated in the new energy plan for 1999–2008 (DOE 1999), the central sector objectives remain a secure energy supply, affordable energy prices, and energy infrastructures that are compatible with broader social and environmental objectives. For commercial energy, the plan projects a decline in imported energy supplies from about 80 percent of total requirements in 1999 to 68 percent in 2008.

1.2 Among the strategies the plan advances to improve the contribution of domestic supplies is accelerated commercialization of new and renewable energy (NRE) technologies,[9] increasing their contribution from about 70 MMBFOE in 1999 to 91 MMBFOE in 2008.

1.3 The projected increase in absolute terms is not substantial. However, even incremental increases in NRE for certain applications can have significant economic, social, and environmental benefits, especially those applications that help improve access to energy by people in the countryside. For example, despite the rapid pace of electrification nationally, some 25 percent of households of the country's population of 72 million remain unserved, almost all of them in rural areas. The Philippines comprises about 7,000 islands spread over 300,000 square kilometers. For cost and technical reasons (distance from the main network, for example), many rural communities will not be connected to the grid in the foreseeable future, if at all.

1.4 In communities where households are widely dispersed and energy end use is low (typically less than 1 kWh per day), NRE technologies such as photovoltaic (PV) or PV/wind

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[8] Since the present report was completed in April 2000, a number of events have taken place that directly or indirectly affect the recommended plan of action discussed in Chapter 5. Annex 1.1 provides an update of the situation as of June 2000.

[9] The term *new and renewable energy (NRE)* as used in this report refers to energy from solar; wind; biomass; mini, micro and small hydropower; and small or low-temperature geothermal applications. Renewable large-scale geothermal and large hydropower plants are excluded because they are already the subjects of conventional programs; in fact, the Philippines is a world leader in both technologies.

hybrids are often less expensive means of providing basic electricity services than either extending the grid or installing a village minigrid. Where households in the community are more concentrated, small-scale hydropower and bioenergy systems can compete effectively with fossil fuel options. Thus, purely on a cost basis, in these communities renewables can be an important component of the rural energy supply mix. Furthermore, certain characteristics of NRE systems make them the preferred energy supply option for other off-grid functions, such as electricity for decentralized/distributed community facilities and productive uses (e.g., small-scale irrigation, drying of crops). The annualized cost of NRE service in such areas is often comparable with or lower than fossil fuel alternatives. Rural inhabitants of the Philippines may prefer grid electricity at low prices, but the choice now for close to 5,000 *barangays* (villages) is either no electricity or electricity services that are not connected to the central grid.

1.5 Market reforms have been quite effective in reducing electrification costs and extending coverage. However, in other countries that have fully privatized their power sectors, the impact on social programs for improving the access of dispersed rural populations to electricity and modern fuels has invariably been negative. New strategies that involve public/private sector partnerships and deployment mechanisms featuring decentralized technologies may be the only way for the Philippines to pursue social equity and poverty reduction goals in a privatized energy sector. These concepts will be discussed more specifically in Chapter 4.

1.6 Aside from small-scale applications for off-grid areas, a number of NRE technologies suitable for grid supply have recently reached commercial status internationally and may become economic electricity-generation options for the Philippines in the near-to-medium term. Perhaps the most prominent is wind electric power generation (i.e., wind power), with more than 10,000 MWe of installed capacity worldwide, most of it financed commercially.

1.7 According to recent wind mapping data for the Philippines,[10] more than 10,000 km^2 of windy land areas are estimated to have good-to-excellent wind resource potential. Using the conservative assumption of about 7 MW per km^2, these areas could support more than 70,000 MW of potential installed capacity. Considering only areas of good-to-excellent wind resource, there are 47 provinces in the Philippines with at least 500 MW of wind potential and 25 provinces with at least 1,000 MW of wind potential. Wind energy is pollution-free, emitting no CO_2 or local pollutants such as NO_X or SO_2. Because wind turbines are relatively small (typically 0.2 to 2 MWe each, with economically viable wind farms at 20 to 200+ MWe), wind power is very adaptable to fast, unpredictable growth in power demand. Construction time is also short compared with fossil fuel and large hydro alternatives. Wind power is particularly advantageous for small islands compared with the prohibitive costs of expanding national grids and reliance on imported diesel fuels for diesel gensets (generator sets). Finally, the use of renewable energy enhances the national energy security position of the Philippines by using indigenous energy rather than imported fuels.

1.8 As with more-developed geothermal energy, the new energy plan recognizes local commercial exploitation of large-scale indigenous and renewable energy resources as a way to increase energy self-sufficiency and to diversify the energy mix. Chapter 2 reviews the current

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10 The assessment was a joint effort of the U.S. National Renewable Energy Laboratory (NREL), The Philippine Council for Industry and Energy Research and Development (PCIERD), Winrock International, The Philippine National Oil Company (PNOC), and the National Power Corporation (NPC).

and projected technology performance and costs of major NRE technologies of interest to the Philippines.

Experience with Renewable Energy in the Philippines

Beginnings of the Program

1.9 The first official attempt to carry out a program for renewable energy development was made in 1977 with the promulgation of Presidential Decree 1068. The decree created the Non-Conventional Energy Development Program for research, development, and demonstration of NRE technologies, to be administered by the Ministry of Energy (now the Department of Energy, or DOE). The first five years of the program were devoted more to building capacity than to commercializing NRE technology. Mirroring the general experience of other countries at that time, including industrialized countries with large programs, true commercialization proved difficult to achieve because of the immaturity and high cost of most NRE technologies compared with conventional alternatives.

1.10 Shortly thereafter, extensive and heavily subsidized attempts to commercialize dendrothermal power,[11] biomass gasifiers, and small hydro were launched by agencies other than the Ministry of Energy, but all were unsuccessful and were later abandoned. Although the reasons for failure were many, it was primarily a matter of trying "to do too much too soon." There was inadequate knowledge of the markets, overestimation of technology readiness, and little or no buy-in by the private sector.

Recent Experience

1.11 In the 1990s the most significant Philippine government initiative to commercialize NRE was the creation in 1993 of the Renewable Energy Power Program (REPP). REPP was designed to provide up to P750 million in financing for private power projects using solar, wind, biomass, and small hydro resources with a capacity of between 200 kWe and 25 MWe. To administer the program, a DOE Task Force was created consisting of representatives from the DOE, the NPC, the National Electrification Administration (NEA), the Philippine National Oil Corporation's Energy Research and Development Centre (PNOC-ERDC), and the Philippine Council for Industry and Energy Research and Development (PCIERD). The source of funds would be the Government Service Insurance System (GSIS) and Social Security System (SSS); The Philippines National Bank (PNB), Land Bank of the Philippines (LBP), and Development Bank of the Philippines (DBP) were the conduit banks that would lend to project proponents. The DOE would guarantee the purchase of power generated by REPP projects. Expectations were high that the REPP would indeed be the showcase program that would attract private investments in NRE power generation.

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[11] A dendrothermal power system consists of a wood-burning power plant and a dedicated plantation of short-rotation tree species. About 2,000 hectares planted with a tree species such as *Leucaena leucocephala* is needed to sustain a 3-MW power plant.

1.12 Unfortunately, the REPP encountered various difficulties and delays and was never successfully launched. Evaluations of the program[12] have identified several barriers in the appraisal and contractual process; these will be discussed in more detail in Chapter 3.

Other Activities

1.13 Several ongoing public- and private-sector NRE activities tend to be one-off types initiated because donor grant financing was available for specific projects or because of individual initiative. Most notable in the latter case is the extensive use of biogas systems at the livestock farms of Liberty Flour Mills. Since the 1970s Maya Farms has been biodigesting the wastes from some 60,000 hogs and cattle, using the methane produced for process heat and electricity. On a smaller scale, about 500 other biogas systems are being used nationwide in private hog and poultry farms. This use of NRE was clearly a practical and economic choice for the farm owners, who felt no need to wait for government assistance or incentives. In contrast, although some commercial establishments use solar water heaters, their economics depends strongly on the price of electricity, fuel oil, or gas; most are not yet competitive.

1.14 Ongoing bilaterally-funded NRE projects include the NEA's "pre-grid electrification" project, launched in 1991 with grant financing from the German GTZ.[13] The project installs individual solar home systems (SHSs) in remote households nationwide. Implemented by the rural electric cooperatives (RECs) under the auspices of the NEA, the project has to date installed about 2,000 units.

1.15 The Australian AID (AusAid) is providing to the Philippines Municipal Solar Infrastructure Project almost $30 million[14] to finance the installation of about 1,000 packaged PV systems in 390 barangays in the Visayas and Mindanao to supply power to public service centers and other community applications. The project is being executed by the Department of Interior and Local Government (DILG).

1.16 Although they clearly benefit populations in specific sites, the key question for these and similar donor-funded projects is whether the deployment mechanisms used will permit sufficient cost recovery to enable expansion of the project to other areas. Participating communities have made commitments to pay the full operation and maintenance costs for the installations, but no capital recovery is required. Consequently, replication of this program will require new financing for the capital costs for equipment and installation.

1.17 The Development Bank of the Philippines (DBP) through its Window III facility has financed a few renewable energy projects. Window III is a concessional lending facility for socially desirable projects that are too risky for traditional banking facilities. It is funded out of DBP profits. Though many types of NRE projects could meet the loan criteria, so far the applications have been few. The UNDP project "Financing Energy Services for Small-Scale End Users" (FINESSE) is now providing technical assistance to the DBP to revitalize the Window III program for renewable energy by improving the capability of DBP staff to identify and appraise NRE projects and by helping develop a solid project pipeline.

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12 See, for example, *Proceedings of the Sectoral Workshop-Conference on New and Renewable Energy Systems*, April 10-11, Subic, Zambales.

13 *Gesellschaft für Technische Zusammenarbeit.*

14 All dollar amounts are in current U.S. dollars.

The Need for a New Initiative

1.18 Although both the public and private sectors have carried out numerous large and small NRE projects over the last two decades, true commercialization has proved elusive. The projects have been "one-off"; donor-driven; of subcritical mass; often implemented using low-cost and inferior equipment; and lacking in the financial or technical resources for sustained operation, maintenance, and repair. A large part of the problem is exogenous and thus beyond the control of local planners: only recently have some NRE technologies of interest to the Philippines compiled adequate track records and achieved significant enough reductions in cost to be of interest to investors.

1.19 The NRE development program in the Philippines has also been hindered by the lack of a policy framework that (1) articulates the contribution that renewable energy can realistically make in the immediate and long terms, (2) provides incentives sufficient to attract private sector participation, and (3) supports effective institutional arrangements for carrying out a coherent national program. The purpose of this report is to help the government of the Philippines (GOP) identify key policy gaps and suggest specific strategies to address them. It addresses priorities for near-term economic investment in NRE and recommends an action plan to hasten that investment. NRE applications in off-grid electrification are emphasized as a quick entry point to commercialization, taking advantage of the opportunity provided by a presidentially mandated program to energize some 10,000 unelectrified barangays nationwide by 2004.

2

Choosing Renewable Energy Technologies: Practical Options for the Coming Decade

2.1 This chapter selectively explores the potential for mobilizing solar, wind, biomass, small hydro, and marine energy resources in the Philippines. It draws in part on the renewable energy technical assistance project[15] of the U.S. National Renewable Energy Laboratory (NREL) for the Philippines. The Bank ESMAP team is collaborating with NREL and other organizations in this work.

2.2 This report is not meant to be yet another technical and economic review of renewables; the Philippines DOE has extensive experience with commercially available renewable energy technologies and has kept abreast of emerging ones. Instead, the emphasis here will be on providing the latest information on technical advances, cost trends, and deployment strategies for technologies of relevance to the Philippines.[16]

2.3 The principal purpose is to help the government set priorities for renewable energy development; thus, this is information for decisionmaking, not a technical tutorial. For each technology of potentially strategic significance there is a set of issues that needs to be addressed if large-scale sustainable use of these technologies is to become a reality.

2.4 The depth of discussion varies with the Philippines' experience with the technology. Where there is extensive experience with these technologies in the Philippines (e.g., SHSs, small hydropower), the discussion is concise and focuses on issues related to the challenge of significant scale-up in their use. For some technologies in which the Philippines is a world leader, including large geothermal power and large hydropower development, there is virtually no discussion of technologies or costs; these are well understood by in-country experts in the public and private sectors. For small hydropower applications the resource is well known, with many sites characterized. Development of these sites has been inhibited not by lack of information but by the unfavorable investment environment.

2.5 For some technologies there is little or no in-country experience, although the technology is fully or partially commercial elsewhere and highly relevant to the Philippines. Examples include large-scale wind electric power technology, small wind turbines, and

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15 National Renewable Energy Laboratory (NREL) project "Technical Assistance on Renewable Energy—Philippines," supported by the U.S. Agency for International Development/Manila.

16 See Annex 1.1 for an update on the status of wind electric power technology as of June 2001.

wind/diesel hybrid power units. For these options the technical and policy requirements for attracting private sector investment in power plant development and sustained operation are discussed in detail.

2.6 There are other technologies relevant to the renewable energy resource base in the Philippines that are not yet commercialized, especially marine energy conversion systems. Here the discussion is of recent technical developments and practical courses of action for the government, such as hosting international precommercial trials in Philippine waters.

2.7 There is also discussion of rapidly evolving technologies of special relevance to off-grid communities; these include small (less than 500 kWe) bioelectric systems and PV/wind/fossil-fuel hybrid power generation units.

Classifications of Renewable Energy Options

2.8 As shown in Table 2.1, power generation and thermal-energy production technologies based on renewable energy vary widely in terms of both commercial and technological maturity. For the purposes of this report, these technologies have been classified on an electric and thermal power generation scale geared to applications in the Philippines (see Table 2.2):

1. Large-scale (more than 10 MWe) bulk power and cogeneration for grid-connected applications
2. Medium-scale (1–10 MWe) power generation and cogeneration
3. Small-scale (less than 1 MWe) applications for power generation, cogeneration, and thermal energy production
4. Freestanding applications for off-grid communities.

Table 2.1: Renewable Energy Technology Status in 1999

Commercially mature
Large geothermal
Hydropower (all sizes)
Commercially proven and rapidly evolving
Large wind-electric power (100–600 kWe units) in wind farms (typically 20–200 MWe)
Small-scale wind electric units (0.3–20 kWe)
Bioenergy plants (cogeneration, power generation)
Photovoltaic power systems (all sizes)
Commercially available but not fully proven
Minigeothermal power (500 kWe to several MWe)
Small-scale biomass power (50 kWe to 500 MWe)
PV/wind/diesel hybrid power systems (10 kWe to 5+ MWe)
Emerging and speculative renewable energy technologies
Wave energy to electricity (50 kWe to several MWe)
Ocean thermal energy conversion (OTEC) (5 MWe to 100 MWe+)
Ocean current energy conversion (100 kWe to multi-MWe)
Tidal current energy conversion

Table 2.2: Renewable Energy Options for the Philippines (Electricity and Cogeneration)

Classification and Scale	*Technologies*	*Primary Applications*	*Commercial Status*
Large-scale grid-connected > 10 MWe	Wind electric power generation (wind farms)	Bulk power generation (10–100 MWe)	Fully commercial, with evolution in efficiency, reliability, and cost-effectiveness
	Biomass-based power generation and cogeneration	Cogeneration, with capacity of 10–30 MWe	Fully commercial, but each plant is engineered to respond to unique legal and regulatory impediments
	Mini-hydro power (up to 50 MWe)		Fully commercial; cost and performance highly site-specific
	Geothermal energy conversion	Base-load power	Well-established in Philippines; policy issues limit expansion
Medium-scale grid-connected (1–10 MWe)	Small windpower plants	Intermittent generation, connected to local and regional minigrids	No experience yet in Philippines; significant potential likely. Possible economy-of-scale issues
	Wind/diesel hybrid power units	Fully dispatchable power, with majority component from wind energy	Commercially available; configured and engineered for specific sites and applications
	Biomass-based power generation and cogeneration	Agro-industrial applications, private power	Commercially available; configured and engineered for specific sites and applications
	Mini-geothermal	Base-load power	Commercially available; at the lower end of the range of typical installations
Small-scale grid-connected (up to 1 MWe)	Wind-electric		
	Photovoltaic		Technically proven; not yet economically competitive
	PV/wind/diesel hybrid		
	Bioenergy including biomass/diesel fuel hybrids	Local minigrid power generation	Commercially available at 100-, 250-, and 400-kWe biomass/diesel-fueled gensets
	Micro-geothermal		
Distributed small-scale (off-grid) < 1 MWe	Wind-electric	Residential, community, and productive activities: water supply, lighting, refrigeration, ice making, telecom	Fully commercial (100 We to 10 kWe); often competitive
	Photovoltaic		Fully commercial packaged systems
	PV/wind/fossil hybrids		Commercially available, packaged or custom engineered

2.9 Non-electric applications of renewable energy provide heat for water and space heating, industrial process heat, and agro-industrial uses (e.g., crop drying, food processing). This chapter also presents recommendations for a DOE position on renewable energy technology options.

2.10 The off-grid applications for both distributed and decentralized uses discussed have the potential for transforming the conditions of life in unelectrified communities—provided the energy supplied is coupled with income-generating activities and supports priority community services (e.g., potable water, health services, education, telecommunications, and telephony).

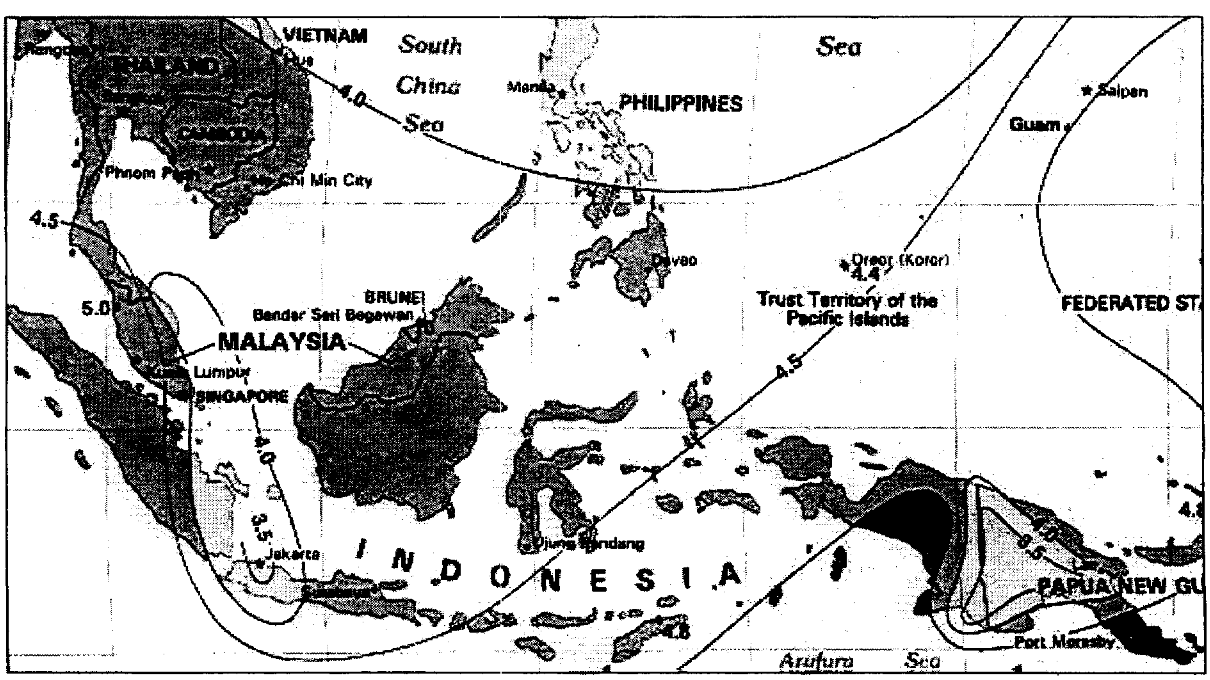
Renewable Energy Resources in the Philippines

2.11 This section discusses the nature, extent, and magnitude of renewable energy resources in the country, and their potential contribution to power generation. These resources include solar radiation, wind energy, mini-hydropower, biomass residues, and marine energy (ocean thermal energy, wave energy, and ocean currents).

Solar Radiation

2.12 The annual average incoming solar radiation (insolation) for the Philippines is in the range of 4 to 5 kWh/m^2 per day, with significant geographic (microclimatic) and seasonal variations (see Figure 2.1). On average the country has abundant sunlight and there is relatively little variation from month to month compared with countries in more extreme latitudes, including the United States and much of Europe. Roughly one-half the sunlight at the ground in much of the Philippines is diffuse radiation. In arid desert environments the diffuse component may be as low as 20 percent; in the humid tropics and subtropical regions of Asia atmospheric water vapor increases the scattering of direct solar radiation. This is an important consideration in choice of solar technologies, because those that depend on the focusing of direct beam sunlight (e.g., solar thermal electric systems) will not perform nearly as well in the tropics as in arid, sunny regions. Solar thermal flat-plate systems for water heating and PV arrays respond equally well to diffuse and direct (focusable) sunlight.

Figure 2.1: Annual Average Solar Energy in the Asia/Pacific Region (kWh/m^2 per day)



Limitations of Available Data

2.13 There is no electronic database of insolation measurements for the Philippines, and no central collection of written data. Experience teaches that solar resources are more than adequate for operation of PV systems and flat-plate solar thermal systems. Their financial performance depends less on the understanding of available solar radiation than on the costs and financing associated with the delivery and support of solar equipment and solar-based energy services. However, because there are significant geographic and seasonal variations in available sunlight, any significant investment in solar energy conversion systems should be preceded by insolation mapping for any proposed site. In this regard, an insolation map of the Philippines would be a useful adjunct to such investment initiatives (e.g., large-scale SHS projects). With support from USAID, NREL is now collaborating with Philippine institutions to establish a national solar resource database.[17]

Wind

2.14 Until recently, very little was known about the country's wind resources—or "resource," in technical terms. A quantitative atlas titled *Wind Energy Resource Atlas of the Philippines* was completed early this year under a joint United States/Philippine collaboration; this section draws directly on the text of the atlas.[18] An effort of unprecedented scope, the atlas has revealed an extensive wind resource whose size had been largely unsuspected. If only 5 percent of the regions with very good wind resource are suitable for commercial power generation, this could permit development of at least 5,000 MWe of capacity for commercial wind farms.

2.15 The maps in the atlas were created using a program developed at NREL based on the Geographic Information System (GIS). The mapping program, which combines high-resolution terrain data with formatted meteorological data, highlights areas with favorable wind resource where wind energy projects are likely to be feasible for both utility grid and rural power applications. The entire Philippines archipelago was mapped. An example (a wind resource map for Northern Luzon) is included in this summary report to give a sense of the extent and distribution of the nation's wind resource (see Figure 2.2); the full atlas should be consulted for a detailed review.

2.16 The wind resource over the Philippines, which varies considerably, depends strongly on latitude, topography or elevation, and proximity to the coastline. On an annual basis, the wind resource is best in the islands of Batanes Province north of Luzon; the north and northwest coast of Luzon; the northeast and east coasts of Luzon and Samar; the southeast coast of Mindanao; and the straits between Mindoro and Luzon, Mindoro and Panay, and Panay and Negros (see Figure 2.2). Windpower density ranges from 500–600 W/m^2 along the northwest Luzon coast to 250–350 W/m^2 between Mindoro and Panay, 250–300 W/m^2 along the eastern

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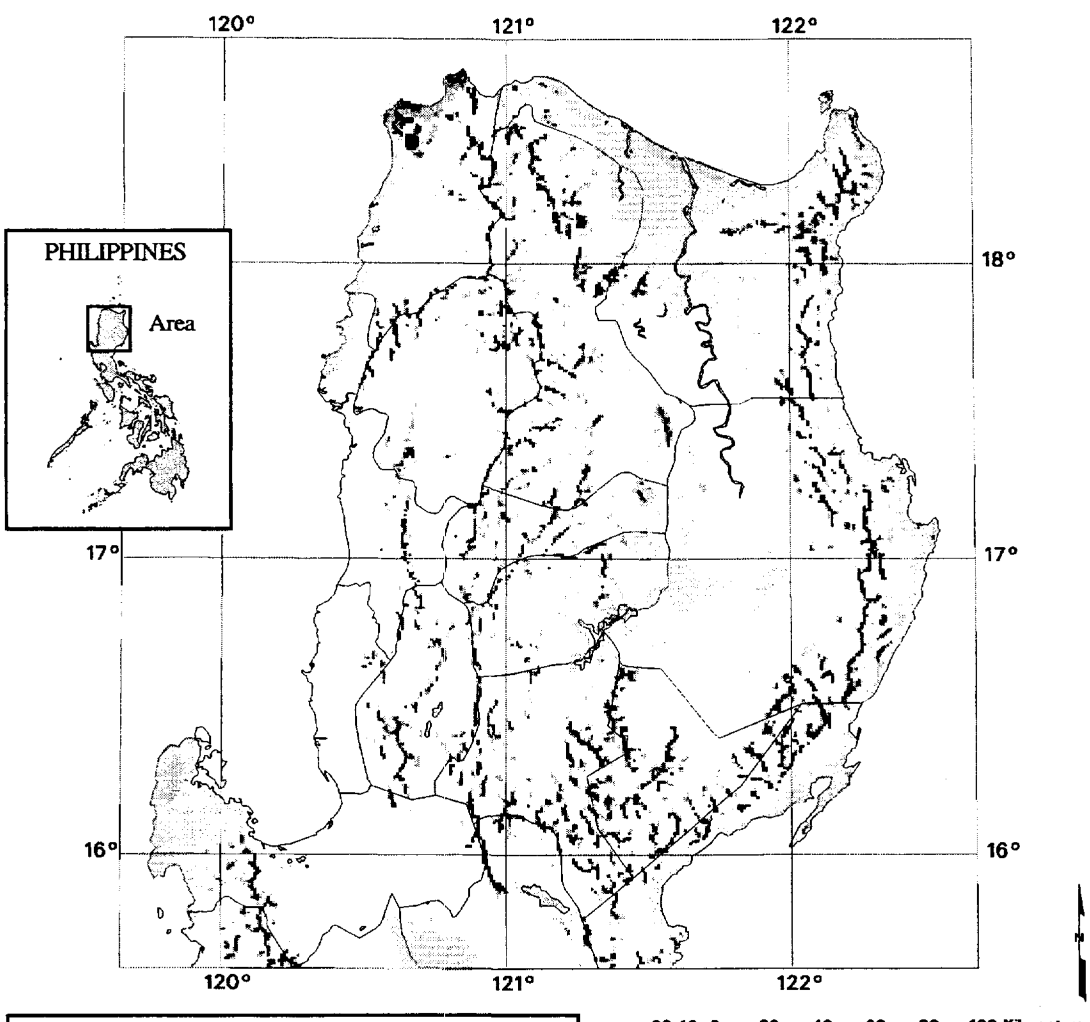
17 The task will incorporate Philippine solar data into a Geographic Information System (GIS) using the calculations of monthly average global horizontal solar resources developed from NREL's Climatological Solar Radiation (CSR) Model.

18 The PCIERD, PNOC, United States Department of Energy (USDOE), and USAID sponsored a project in collaboration with Winrock International to accelerate the large-scale use of wind energy technologies in the Philippines by creating an atlas of wind energy resources. The Philippines NPC supported the project by contributing wind-monitoring data collected at 14 prospective wind energy sites and by providing other technical assistance. NREL was the primary analytical author of the report.

coast of Luzon and the northern coast of Samar, and less than 100 W/m^2 off the southwest coast of Mindanao.

Figure 2.2: Wind Energy Resource Potential in Central Luzon (Taken from the NREL *Wind Atlas of the Philippines*)



Wind Power Classification

Resource Potential: Utility	Resource Potential: Rural	Wind Power Density at 30 m W/m2	Wind Speed[a] at 30 m m/s
Marginal	Moderate	100 - 200	4.4 - 5.6
Moderate	Good	200 - 300	5.6 - 6.4
Good	Excellent	300 - 400	6.4 - 7.0
Excellent		400 - 600	7.0 - 8.0
		600 - 800	8.0 - 8.8
		800 - 1200	8.8 - 10.1

[a] Wind speeds are based on a Weibull k value of 2.0

The wind resource classification is specific for both utility scale and rural applications and applies to areas with low surface roughness.

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2.17 The wind maps show many areas of good-to-excellent wind resource for utility-scale applications and excellent wind resource for village power applications, particularly in the northern and central regions. The best wind resource is found in several regions: the Batanes and Babuyan islands north of Luzon; the northwest tip of Luzon (Ilocos Norte); the higher interior terrain of Luzon, Mindoro, Samar, Leyte, Panay, Negros, Cebu, Palawan, eastern Mindanao, and adjacent islands; well-exposed east-facing coastal locations from northern Luzon southward to Samar; and the wind corridors between Luzon and Mindoro (including Lubang Island), and between Mindoro and Panay (including the Semirara Islands and extending to the Cuyo Islands).

2.18 More than 10,000 km^2 of windy land areas have been estimated to have good-to-excellent wind resource potential. Using the conservative assumption of about 7 MW per km^2, these areas could support more than 70,000 MW of potential installed capacity. Considering only areas of good-to-excellent wind resource, there are 47 provinces in the Philippines with at least 500 MW of wind potential and 25 provinces with at least 1,000 MW of wind potential. Additional studies are required to more accurately assess the wind electric potential, considering factors such as the existing transmission grid and the accessibility of the windy area.

2.19 The wind maps show numerous additional areas of moderate resource for utility-scale applications or good resource for village power applications. If these additional areas are considered, the estimated total windy land area increases to more than 25,000 km^2. Using conservative assumptions of about 7 MW per km^2, this land could support more than 170,000 MW of potential installed capacity. There are 51 provinces with at least 1,000 MW of wind potential and 64 provinces with at least 500 MW of wind potential (in reality, the total installed wind electric power generation capacity will not exceed circa 15 percent of total capacity of the grid to which it is connected).

2.20 There is a pronounced change in the wind resource depending on the season: the resource is best in the winter during the northeast monsoon and worst in the summer during the southwest monsoon. Throughout most of the Philippines the highest levels of wind resource occur from November through February and the lowest from April to September. However, there are some regional differences. For example, the period from October through February has the highest wind resource levels in the northern Philippines; in much of the central and southern Philippines this period is November through March. Two areas, the southeastern Mindanao coast and the western coast of Palawan, have relatively good wind resource from June through September during the southwest monsoon.

Wind Resource Monitoring Requirements

2.21 The wind resource maps and other characteristics information are essential for identifying prospective areas for wind energy applications. However, very limited data of sufficient quality were available to validate the estimates. Therefore, *it is strongly recommended that wind measurement programs be conducted in sites under consideration for future projects, to validate resource estimates and refine wind maps and assessment methods.*

2.22 There are few if any sites in the Philippines with sufficient wind resource data to permit a full feasibility study. The new Philippines *Wind Atlas* permits the next step of site identification to proceed. This step would identify sites in areas of economically exploitable wind resources that meet other site criteria. Project developers typically obtain contingent rights to a site and install anemometers to measure hourly mean wind speed, maximum wind speed (gusts), turbulence, wind shear, wind direction, and other meteorological factors. Such data must typically be collected for at least a year before a full technical and financial assessment of a wind plant investment can be conducted. Without such data, outside financing of a wind plant is unlikely. Given that the Philippines is in the Pacific typhoon belt, data on the frequency and distribution of extreme winds at and near the proposed site will also be necessary.

Small, Mini-, and Micro-Hydropower

2.23 By the end of 1996 the Philippines had 45 mini-hydro[19] plants with an aggregate installed capacity of 77.6 MWe; 17 plants had capacity ranging from 1.5 to 8 MWe. An additional 110 MWe potential has been identified for 60 specific project sites. The target for 2008 is the full development of those resources, with an installed mini-hydro capacity of 197 MWe. Small hydropower is projected to grow from 61 MWe in 1999 to 168 MWe in 1008. Obstacles to this expansion are largely procedural and institutional rather than technical; these were identified and characterized in the Winrock report (Weingart and others 1998) on barriers to accelerated and expanded use of grid-connected renewable energy power systems in the Philippines.

2.24 A few countries such as Nepal have promoted extensive development of micro-hydro resources to provide off-grid electricity services for economically productive activities. A similar scale of implementation appears possible in the Philippines. Preliminary assessments suggest that the Philippines has a significant and well-distributed micro-hydro resource with the potential to electrify many off-grid communities. Only about 60 micro-hydro facilities are operating in the country. The NGO Sibol ng Agham at Teknolohiya (SIBAT), with support from Winrock International and Preferred Energy Inc. (PEI), has identified and conducted feasibility studies for the development of eight community-based micro-hydro power generation units.

2.25 As part of the USAID-supported project, NREL is collaborating with Philippines institutions in assessing micro-hydro potential in the country to help the government create policies that can attract public and private investment. The assessment results will be incorporated into a GIS framework. Information on the location of non-electrified barangays, existing transmission and distribution lines, and access roads is essential to guiding potential private investment in micro-hydro technologies.

2.26 This project will significantly enhance in-country capacity for micro-hydro resource assessment, and will produce a national micro-hydro resource atlas by late 1999. The atlas will be designed to guide the DOE in implementing projects and attracting further investment in micro-hydro projects. As with the wind resource atlas, the micro-hydro atlas will allow for more accurate quantification of the total MW potential in the Philippines and an estimate of the number of barangays that can be electrified using this technology. The DOE and NREL will present the atlas to senior government officials and industry representatives through a series of briefings or seminars.

Biomass Residues

2.27 The Philippines produces sugarcane (24 million tons/year), coconut (12 million tons/year), rice (11 million tons/year), and wood products, all of which in turn produce biomass residues suitable for and to some extent used for power generation and cogeneration (Weingart and others 1998). Wood and wood waste are the largest source of fuel for home cooking for 61

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[19] *Micro-hydro plants* are defined as installations with nameplate generation capacities below 100 kWe.

percent of the total population and 84 percent of the rural population. The USAID-funded NREL project plans to update biomass resources data and assess potential bioenergy applications in the Philippines.

2.28 Biomass residues are not a strategically important resource in terms of national electricity production needs. However, they can be locally important in some parts of the Philippines, especially in areas not served or poorly served by the grid. Their value lies in their general availability and in the need for their environmentally acceptable disposal or conversion. However, changing patterns of agricultural production and the encroachment of development and urbanization on farmlands, especially in Luzon, may result in declining availability of biomass residues in the coming decade.

2.29 The Philippines produced about 10.5 million metric tons of rice in 1995, according to the Philippines Bureau of Agricultural Statistics. Rice hulls are approximately 20 percent of the production by weight, or 2.1 million metric tons. Assuming a combustion and conversion efficiency of 0.9 MWh per metric ton, the maximum production of electricity from rice hull conversion, *if all rice hulls were used for this purpose*, would be 1.9 TWh per year. Assuming a 70 percent capacity factor for the rice hull-fired power plants, this corresponds to an installed power generation capacity of 309 MWe. (See Table 2.3).

2.30 The Sugar Millers Association of the Philippines has surveyed all of its member mills. Table 2.4 summarizes the production of sugar cane bagasse in 1993, and estimates the potential for electricity production and installed generating capacity if all bagasse were used for this purpose. The total potential is about 1.4 TWh/year, with an associated installed power generation capacity of 233 MWe.

2.31 However, the *practical* upper limit of biomass fuel availability is likely to be much lower than these implied upper limits. Not all residues are available as fuel. Some have other uses, including fertilizer, binders, and road-building materials. However, when a new biomass-based power plant is built, additional fuel often becomes available, as people perceive a use for something that was previously thrown away.

2.32 The variability of the fuel supply also depends on the decisions of farmers about what crops to grow. These decisions are only partly conditioned on the sale of residues to a power plant. Weather, the level of economic development in the region, and the state of the world market for specific crops all play a significant role.

Ocean Thermal Energy, Marine Currents, and Wave Energy Resources

2.33 Around the Philippines the difference in temperature between the warm ocean surface and colder seawater at 300 to 700 meters depth is 15 to 25 degrees Celsius. This temperature gradient can be used to power a marine heat engine on a continuous (base load) basis. This ocean thermal energy resource has been studied extensively, and more than a dozen sites have been characterized (Uehara and others 1998) in ongoing measurement and research activities. These are among the best potential ocean thermal energy conversion sites in the world, and ocean thermal energy conversion (OTEC) power plants in the range of 25 MWe to 75 MWe and beyond are considered technically feasible.

Table 2.3: Rice Hull Production and Power Generation Potential in the Philippines (1995 data)

Province	*Production mt/year*	*Rice Hulls mt/year**	*MWh/year Potential***	*Capacity MWe****
Northern Mindanao	685,269	137,054	123,348	20.1
Southern Mindanao	684,388	136,878	123,190	20.1
Central Mindanao	752,426	150,485	135,437	22.1
ARMM	327,187	65,437	58,894	9.6
Bicol	598,618	119,724	107,751	17.6
Western Visayas	1,291,275	258,255	232,430	37.9
Central Visayas	230,759	46,152	41,537	6.8
Eastern Visayas	446,057	89,211	80,290	13.1
Western Mindanao	345,489	69,098	62,188	10.1
Car	193,221	38,644	34,780	5.7
Ilocos	886,517	177,303	159,573	26.0
Cagayan Valley	1,349,258	269,852	242,866	39.6
Central Luzon	1,757,425	351,485	316,337	51.6
Southern Tagalog	992,760	198,552	178,697	29.1
Total	**10,540,649**	**2,108,130**	**1,897,318**	**309.4**

Source: Bureau of Agricultural Statistics.
* Rice hulls taken as 20 percent of rice production, by weight
** 0.9 MWh per mt of rice hulls combusted (BioTen process)
*** Capacity factor assumed = 0.7.
ARMM: Autonomous Region of Muslim Mindanao.

Table 2.4: Bagasse Production (1993) and Power Generation Potential in the Philippines

Province	*Production mt/year*	*Fiber mt/year**	*MWh/year Potential***	*Capacity MWe****
Luzon	1,242,067	558,930	503,037	82.0
Eastern Visayas	314,270	62,854	56,569	9.2
Panay	429,224	85,845	77,260	12.6
Negros	3,831,055	766,211	689,590	112.5
Mindanao	574,127	114,825	103,343	16.9
Total	**6,390,743**	**1,588,665**	**1,429,799**	**233.2**

Source: Philippine Sugar Millers Association.
* Fiber = 45 percent of bagasse production by weight
** 0.9 MWh per mt of sugar cane bagasse combusted (BioTen process)
*** Capacity factor assumed = 0.7.

2.34 Ocean currents, including tidal currents, are a potential source of baseload power for off-grid communities throughout the archipelago. However, according to information from NPC, little is known quantitatively about marine currents around the Philippines. The technology to harness such currents has been demonstrated in the United Kingdom with a 15-kWe prototype turbine (similar to a wind turbine but designed for the fluid characteristics of water), and commercialization is underway by a consortium of European companies. As discussed below, an assessment of marine-current potential for Philippines is needed before this technology can be of direct use.

2.35 There appears to have been little quantitative assessment of wave energy potential for the Philippines. However, demonstrations of wave energy conversion plants at the 1-MWe scale in Japan suggest the possibility for near-shore installations where the backbone grid cannot reach. NREL will assess the commercial potential for wave energy conversion systems as part of its report to the Philippine government.

2.36 Although the extent of these types of marine energy resources in the Philippines is very large, the technologies for harnessing them and converting into electricity are still in the precommercial technical demonstration phase despite several decades of research and development, primarily in Japan, the United States, and Europe. Practical precommercial and commercial demonstration plants will require several hundred million dollars. *Philippine government support of research and development on these speculative technologies is not recommended at this time.* At the most, its participation in such efforts should be limited to providing to selected developers expedited access to suitable sites.

Commercial Status of Renewable Energy Technologies for Power Generation

2.37 This section addresses (1) power generation for off-grid applications and (2) large-scale grid-connected power applications.

Power Generation for Off-Grid Applications

2.38 There is a growing menu of commercial products designed to provide reliable high-quality electricity in challenging off-grid environments. These include the familiar PV and small wind electric units as well as the less-familiar PV/diesel, wind/diesel, and PV/wind/diesel hybrid power generation units. The characteristics and commercial availability for some of the more important options for off-grid applications are summarized in Table 2.5.

Photovoltaics

2.39 The cost of photovoltaic (solar-cell) panels has declined dramatically in the last two decades, even as similarly dramatic improvements have been made in quality, reliability, and efficiency. The PV industry now has annual shipments worldwide of more than 135 MWp (see Annex 2.1). In the Philippines, despite almost two decades of experience with PV technologies, the PV industry remains essentially a boutique operation serving niche markets. The few companies engaged in PV equipment supply, installation, and service usually act as side businesses of much larger enterprises or via cross-subsidies from those enterprises. This is reflected in DOE statistics: 2,750 households have been served by new PV solar home system (SHS) installations since 1992—1,323 in Luzon, 504 in Visayas, and 327 in Mindanao. The total installed PV module generating capacity for these installations is 140 kWp.

Table 2.5: Renewable Energy Technologies for Off-grid and Mini-grid Applications

Technology	*Philippines Experience*	*Experience Worldwide*	*Commercial status*
Photovoltaics	Extensive	Extensive	Fully commercial
Small wind electric	Almost none	Extensive	Commercial and evolving rapidly
PV/diesel hybrids	Almost none	Extensive, especially for telecommunications	Commercial, evolving
Wind/diesel hybrids	Almost none	Significant, not yet extensive	Commercial, evolving
Small modular biopower units (10 kWe to 100+ kWe)	*These are under commercial development, for introduction early in the coming decade.*		
Small bioenergy packaged units (<0.5 MWe)	None	Some	Limited; commercialization underway
Bioenergy > 0.5 MWe	Some	Extensive	Commercial, site-engineered
Micro-hydro electric	About 60 installations	Enormous (e.g., China, Nepal, Vietnam)	Fully commercial, with locally manufactured equipment and innovative products emerging

2.40 SHS installations typically cost the local equivalent of $10 to $20 per peak watt. At an average of $15/Wp, this corresponds to $2.2 million in aggregate equipment sales (including the costs of transport, installation, and the value of after-sales service contracts). Average annual gross revenues for SHS are low: $300,000 for the entire industry. During the same period 33 battery-charging stations (serving an average of 10 households each) were installed, with a total generating capacity of 5 kWp. Some PV industry leaders estimate the total number of PV systems in the Philippines at around 5,000.

2.41 The target of the NEA, which has responsibility for the RECs, is to support an average of 1,600 PV installations annually between 1998 and 2015 (for a total of about 30,000 systems). *To provide PV-based energy services for the coming decade to communities and households for which these systems could make an important and affordable contribution will require a 100-fold scaleup from present plans.* This is not a technology issue; rather, it reflects the difficulties of serving the country's widely dispersed unelectrified rural communities in a profitable and sustainable manner.

2.42 PV has seemed to many to be the almost perfect technology for providing basic pre-grid electrification for rural communities throughout the Philippines to serve the more than 5,000 unelectrified barangays outside the reach of conventional power grids. This vision has energized many Philippine government programs, NGO initiatives, and private businesses to serve what is hoped to be a quickly growing and robust market. However, realizing the vision of providing sustainable widespread electricity services with PV systems has proven painfully elusive virtually everywhere it has been tried—not just in the Philippines. After two decades of PV-related initiatives there are perhaps 5,000 PV solar home systems in the country, one-half of them the product of subsidized government programs and bilateral donor assistance initiatives. Yet the potential market for such systems is several million installations.

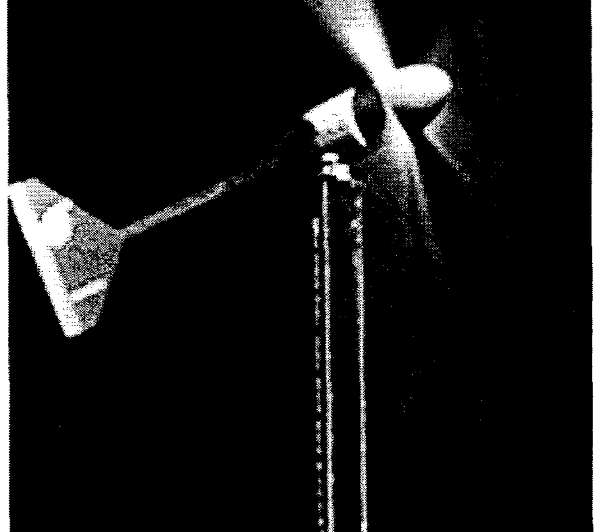
2.43 PV equipment and systems components are now widely available, and the best of the hardware is highly reliable. The technology *per se* is no longer the constraint in providing high-value electricity services to off-grid communities, although the cost of electricity from PV systems—typically US$1 to US$2 per kWh—remains a constraint in terms of supporting economically productive activities. The limitation in the Philippines is the lack of an infrastructure to deliver, install, maintain, and service the systems on a scale that can make a difference within a decade to the majority of barangays lacking electricity services today. Because the government has neither the financial resources nor the capacity to deliver renewable-energy-based services to off-grid customers on a significant scale, the private sector must be the dominant source of equipment, expertise, and financing.

2.44 Mitigating the risks for the private sector as it enters a new and largely untested market will require a new public-private partnership, in which the initial market entry costs and risks are shared. A prototype program for large-scale investment in off-grid PV systems is described in Chapter 4. Many of the services that PV can support (e.g., community water supply and purification, rural telecommunications, public lighting, basic power needs for health clinics, schools, government offices, community centers) are for public goods that are typically cofinanced by government and local communities. Just as community water supplies are increasingly operated by private companies through competitive bids—with financing by local government units (LGUs) using funds provided in part by the national government—a public/private partnership to supply electricity services for community needs can also be implemented.

Small Wind-Electric Power Units

2.45 Current commercial small wind turbines have rated outputs ranging from a few hundred watts to tens of kilowatts. There are several dozen manufacturers, primarily in North America and Europe, with several commercial producers in Asia, but there has been little experience with these machines in the Philippines; by contrast, there are several hundred thousand small wind turbines in use in China, the largest market for this technology.

Figure 2.3: Bergey 10-kWe Excel Wind Turbine

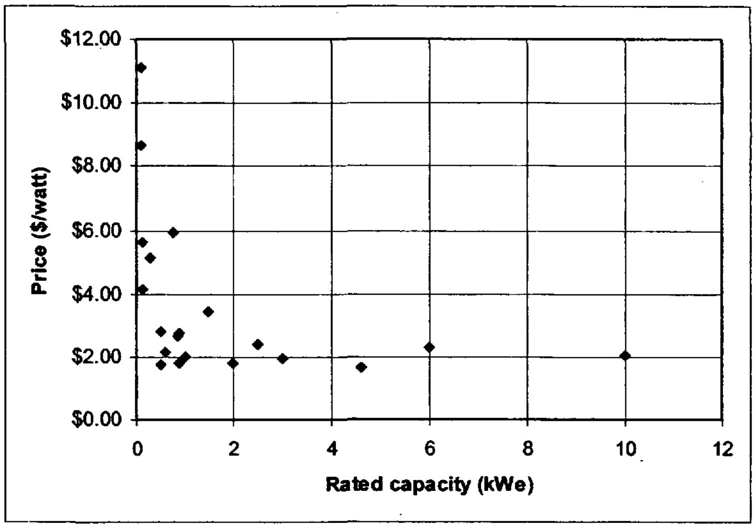


2.46 The turbine shown in Figure 2.3 is the Excel, a 10-kWe unit made by Bergey Windpower Company; one of these is on test in Batanes. Wind conditions in many rural areas in the Philippines are sufficient (an annual average wind speed greater than 4.5 m/s) to justify using such technologies for pumping for the community water supply and small-scale irrigation and for AC power (when integrated in hybrid power units). This model, which survived a direct hit by Hurricane Hugo, is suitable for the extreme wind conditions encountered in the

Philippines. Units with ratings ranging from 0.5 to 1 kWe retail for $2–3 per watt. As is typical of the best modern small wind turbines, it has only three moving parts and is designed to operate for several years between routine maintenance checks.

2.47 Units in the range of 1 to 20 kWe cost about $2 per watt; most are configured to tie into the utility grid. Figure 2.4 shows current prices ($ per rated watt of output) for small wind turbines available from the United States, Europe, and Australia. For wind turbines with rated peak capacity in the range of 1 to 10 kWe, the typical wholesale price is approximately $2,000 per kilowatt. The rated capacity refers to the maximum output of the turbine; wind speeds for rated output vary somewhat among turbines. The capital component of the levelized cost of electricity is $0.09/kWh for $2,000/kilowatt, a 25 percent annual capacity factor, and a 10-percent fixed charge.

Figure 2.4: Current Prices for Small Wind Electric Power Units (FOB Supplier)

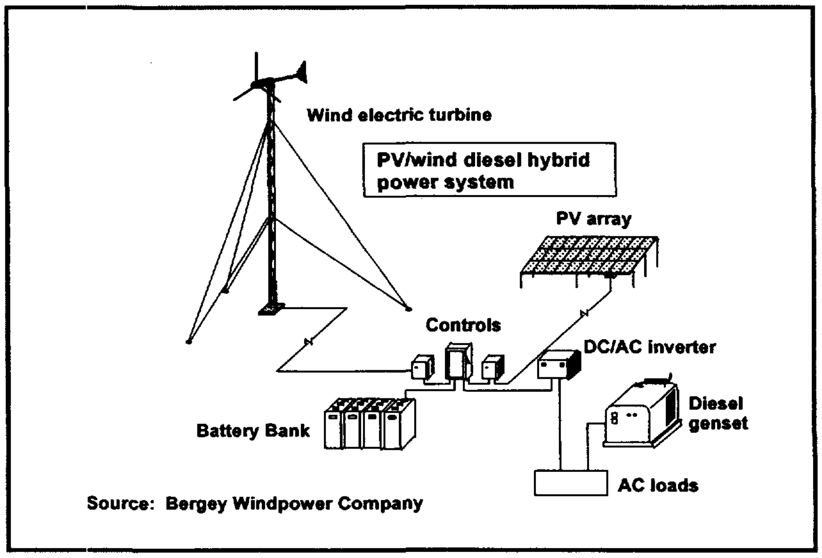


PV/Wind/Diesel Hybrid Power Generation

2.48 By integrating PV and/or wind electric generation units with bidirectional modular inverters, batteries, and advanced solid state control units, it is possible to generate reliable high-quality, 24-hour power at annualized costs equivalent to the costs of part-time (evening) power from freestanding diesel gensets. Two-thirds or more of the electricity is produced by the PV or wind energy components, with the rest provided by diesel gensets that may operate only a few thousand hours annually. Typical installations for village power applications provide from 50 kWh per day to 1 MWh per day.

2.49 Figures 2.5 and 2.6 show a commercial prototype PV/wind/diesel hybrid power system that supplies electricity on a 24-hour basis (800 kWh daily) to a hospital and other community facilities in Nambouwalu, Fiji.

Figure 2.5: Commercial Prototype PV/Wind/Diesel Hybrid Power System Developed in Fiji



Source: Bergey Windpower Company

It was developed by the Pacific International Center for High Technology Research (PICHTR) in collaboration with the government of Fiji. The UNDP and the Global Environment Facility (GEF) are jointly supporting a new follow-on initiative to use hybrid power technologies to supply full-time power to off-grid communities in Fiji.

Figure 2.6: Fiji PV/wind/Diesel Hybrid Power Plant

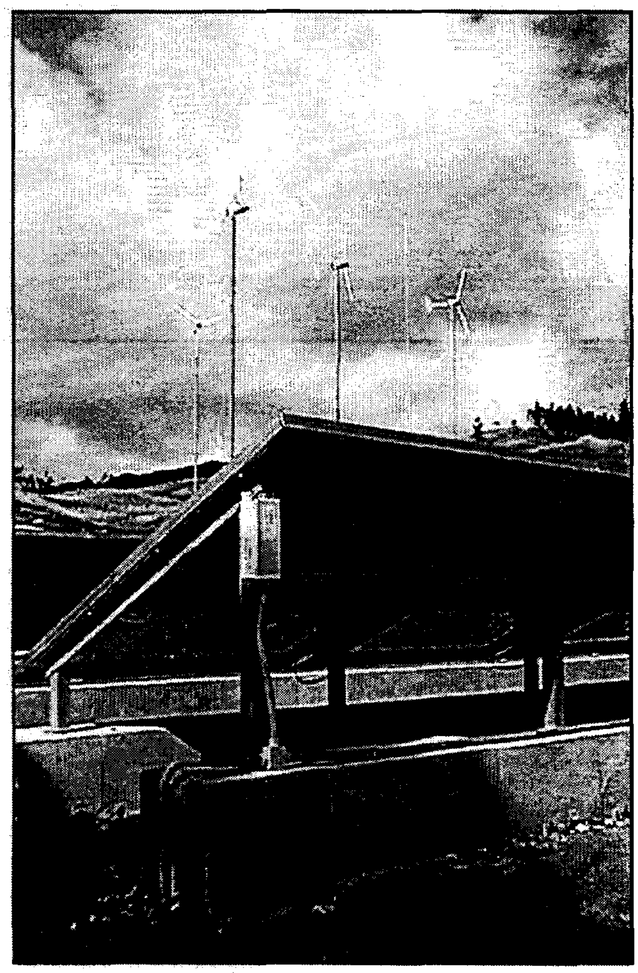


Photo courtesy of the Pacific International Center for High Technology Research (PICHTR).

2.50 Hybrids similar in scale and operation to that in Fiji could be employed in the Philippines. The Fiji system combines eight 10-KWe wind turbines and a 40-kWp PV array with two diesel gensets (100 kVA each), batteries, and inverters and controls. The system powers a 140-volt AC minigrid for the hospital and community facilities.

Small, Modular Biopower Systems

2.51 Small, modular biopower systems have the potential to supply electric power not only to many of the unelectrified barangays but also to those that are underserved. The potential exists wherever large amounts of biomass are available for fuel, such as in communities that produce coffee, coconut, and rice or have forest product industries. Small biomass systems also have a great potential market in distributed applications. These applications consist of power generation attached to the transmission and distribution grid close to where the consumer uses electricity. Some consumer-owned units would be connected to the grid on the customer side of the meter.

2.52 The Philippines had several years of experience with small gasifier systems in the late 1970s. Powered by biomass fuels, these systems were used for small-scale irrigation and transport. Overall, the experience was negative: operating and maintaining the small gasifier systems proved too difficult under normal conditions. The conclusion was that if there were other alternatives, the biomass gasifier system would be the last choice.

2.53 In the last decade, however, significant advances in technology have resulted from continued development work by various agencies, among them the USDOE, NREL, and Shell Renewables. A private U.S. company, BG Technologies,[20] advertises a line of biomass power units rated at 100–400 kWe. Commercial systems with rated capacities ranging from tens of kilowatts to several megawatts may be ready for commercial deployment within five years. Because the potential market in the Philippines for this technology is large, the Philippines

[20] See www.bgtechnologies.net for further technical and cost information.

should keep abreast of commercial developments and field-test suitable systems as soon as available.

2.54 *Note/update: A 12.5 kWe small modular biopower (SMB) generator operating from coconut shells is installed in Alaminos barangay in Aklan Province. Developed by Community Power Corporation (United States), it has passed all technical acceptance tests, and will be used to power the RESCO minigrid at Aklan that is now being powered by a PV/propane hybrid power unit.*

Large-Scale Grid-Connected Power Applications

2.55 Only two large-scale grid-connected technologies are discussed in this section: wind electric power and grid-interactive photovoltaic power. The first represents a fully commercial renewable energy technology that has great relevance to the Philippines in the near-term. The other has been proved technically but needs further cost reductions to become practical. It is the subject of a proposed demonstration project of the International Finance Corporation (IFC) with GEF and the Cagayan Electric Power and Light Company (CEPALCO). There are, of course, other technologies in this large-scale category, such as mini-hydro and geothermal power, but their characteristics are already well known in the Philippines.

Wind Electric Power

2.56 Wind electric power is now a mature technology (see Figure 2.7). During the first half of 1999 installed grid-connected wind electric generation capacity worldwide had reached 10,000 MWe. By early 2000, this expanded to 13,000 MWe. By the end of 2002 capacity is expected to grow to more than 20,000 MWe, with 3,000 MWe in Asia alone (primarily India and China).[21] Annex 2.2 shows installed capacity by country and lists current major turbine makers.

Figure 2.7: Wind Electric Power Is Now a Mature Technology

2.57 The Philippines has significant wind energy resources that can be commercially exploited using current technology. The potential is at least several thousand MWe and could be as much as 10,000 MWe, although the grid's capacity to accept wind electric power will limit the practical level to about 15–20 percent of total spinning reserve. In combination with large hydropower plants, wind electric power generation could contribute a significant amount of energy in backbone

[21] European renewable energy institutions, as quoted in *Renewable ENERGY World*, May 1999, p. 135.

grid-connected applications without degrading grid performance or stability. Wind/diesel hybrid power units in regional and community minigrids are also potentially important cost-competitive options for some regions.

2.58 Although several private companies are now conducting wind resource measurements, few have expressed serious interest in developing a commercial grid-connected wind project. The principal reasons include (1) perceived financial risks and insufficient government incentives for private windpower projects and (2) equipment risks posed by the frequency of major typhoons in prospective sites. In addition, there are still technical issues to be addressed related to the grid's capacity to accept intermittent power from a wind plant.

The Challenge of Typhoons

2.59 Major storms, including typhoons, hit the Philippines each year, with the eastern areas of the country often incurring higher wind damage than others. Ilocos Norte, one of the regions being considered for wind energy projects, appears protected from the most extreme typhoons, as do other areas along the western coast and some inland provinces. A full feasibility study must (1) examine data on extreme winds and (2) calculate the probability of winds in excess of 200 km/hour at specific turbine sites within the 20- to 30-year lifespan of the project.

2.60 Large modern wind turbines are designed to survive extreme winds. "Class 1" turbines are built to withstand gusts of up to 70 meters/second (252 kilometers per hour), with some turbine designs capable of surviving gusts of up to 90 meters/second (324 kilometers per hour). Tilt-down towers can protect turbines in the path of an extreme storm. These can be used for turbines as large as 300 kWe but are not practical for the larger turbines that have better technical and financial performance. The safety and survivability of these towers in extreme winds is unknown.

2.61 Permanent towers appear feasible for sites reasonably well sheltered from extreme winds. Turbines mounted on rigid towers can be protected by feathering the blades, locking or tying down the rotor, and strengthening the yaw braking mechanism. If 600-800-kWe turbines are technically feasible in this wind regime, there should be no strong incentive to consider only tilt-down towers. Advantages and disadvantages of alternative tower designs are discussed in the consultant report (Rackstraw 1999).

Current Environment for Private Investment in Wind Plants in the Philippines

2.62 Overall, the current policy environment for private investment in windpower plants in the country is not attractive. Although there are general investment incentives that are favorable (e.g., tax holidays for first-of-a-kind "pioneer" projects), prospective wind-project developers would have serious concerns with existing foreign-ownership restrictions and potentially onerous revenue-sharing requirements.

2.63 Developers face the following major risks:

1. Currency fluctuations.
2. Regulatory risk in the future restructured power sector.
3. Treatment of existing independent power producer (IPP) contracts with NPC after privatization, deregulation, and restructuring.

4. NPC's policy of "equal misery": if the grid goes down as a result of a typhoon or other "force majeure," NPC would not have to pay for power, even if available, until the grid is restored.

5. Treatment of wind energy projects, as well as solar and marine energy technology projects, under the production-sharing provisions of Executive Order (EO) 462. A major issue is the possible requirement for sharing revenues with the government for ocean, solar, and wind projects. Current government policies leave this issue "to be negotiated"; the concern is that the 60/40 revenue split for geothermal energy will be applied (i.e., 60 percent of revenues to go to the Philippine government).

6. The requirement that 60 percent of the equity be held by Philippine firms.

7. Typhoons, which raise equipment risks.

Incentives Needed from the Viewpoint of the Wind Industry

2.64 NREL recently commissioned a consultant study (Rackstraw 1999) to conceptualize a near-term windpower project in the Philippines and to identify key implementation barriers. Some of the study's technical and policy recommendations (especially 1 through 4 in the list below) may be inconsistent with current or impending laws and regulations governing the power sector in the Philippines. They are listed here, however, to illustrate the type of concerns members of the international windpower industry raise when they are invited to act as IPPs—i.e., to build, own, and operate windpower plants in a country. The consultant recommendations are as follows:

1. Provide long-term power purchase contracts (up to 20 years) to encourage private sector investment.

2. Denominate wind energy contract payments (power tariffs) in hard currency.

3. Formalize treatment of wind energy as a "must-run, must-take" form of energy.

4. Create front-loaded power-tariff structures for wind projects (higher prices in the early years).

5. Waive duties, VAT, and other taxes on imported wind equipment for all wind projects regardless of whether the projects are first-of-a-kind.

6. Waive the requirements of EO 462 for wind plants.

7. Eliminate or reduce the requirement limiting foreign ownership to 40 percent, or furnish other contractual mechanisms to encourage foreign investment (e.g., service contracts).

8. Establish production and/or investment tax credits to accelerate wind project development.

9. Establish accelerated depreciation schemes.

10. Build a government transmission line to handle substantial wind capacity in key resource areas.

11. Examine the potential for matching wind with pumped-storage hydro projects to increase the productivity of the hydro projects.
12. Analyze load flows to explore the impact of adding different levels of wind energy to the grid system at various points. (This analysis is relevant for Luzon and for islands where system stability may be an issue.)
13. Assess the potential for smaller distributed wind projects on the grid throughout the country.
14. Continue to analyze wind resources to reduce the risks associated with wind project development.

Creating an Initial Market for Wind Power in the Philippines

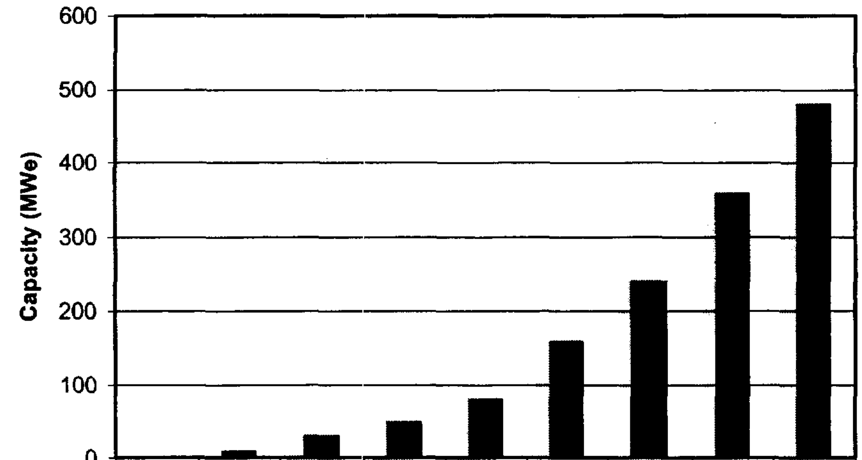
2.65 The government of the Philippines, in concert with the private sector and the financial community, can stimulate commercial wind farm development through policy initiatives and financial incentives. The array of possible incentives is very large, and the government should explore several: no single initiative is likely to be sufficient to attract the scale of private investment needed if wind electric power is to become a significant source of electricity over the next 10 to 20 years. Policy initiatives have stimulated ongoing commercial development of large wind electric power plants in Denmark, Germany, India, and the United States. The United States has promulgated many incentives at both state and federal levels. Recent reports from the U.S. Energy Information Administration (EIA) discuss incentives used in the United States and elsewhere (Guey-Lee 1998, U.S. EIA December 1998); these incentives are summarized in Annex 2.3. *It is recommended that the DOE, in concert with other appropriate government agencies, carefully review, assess, and compare these incentives and their impacts, both negative and positive, in the countries where they have been implemented and determine the potential for adopting similar initiatives in the Philippines.*

A Possible Development Scenario for Wind Electric Power

2.66 Annex 2.4 presents a scenario for developing commercial wind electric power plants over the period 2000–2008. In this scenario 480 MWe of wind electric generation capacity is in place by the end of 2008 (see Figure 2.8), representing roughly half a billion[22] dollars of investment. In the following 10 to 15 years there could be an additional 2–3 GWe of wind electric power in the Philippines, given the economic justification.

[22] For this report, a billion is 1,000 million.

Figure 2.8: Total Grid-Connected Wind Generation (Scenario for the Philippines, 2000–2008)



	2000	2001	2002	2003	2004	2005	2006	2007	2008
MWe	0	10	30	50	80	160	240	360	480

Year

Grid-Interactive PV Systems

2.67 Grid-interactive PV applications are not yet used in the Philippines, although they have been demonstrated to be technically practical in Europe and the United States. They include (1) the use of bulk PV power for repowering and grid stability support for small power distribution grids and (2) building-integrated PV systems.

2.68 The grid-tied PV market has some potential advantages over dispersed rural applications because the individual procurements (1) are in the range of hundreds of kilowatts to several megawatts range and (2) have relatively minor logistic and service requirements compared with large numbers of very small (50–100 Wp) installations for household and community uses. The Philippine urban building industry is quite similar to that of the OECD countries, where many international (OECD) firms are engaged in urban building projects, ranging from turn-key installations to joint ventures with local firms. Consequently, building-integrated PV applications could also be a practical future option for the Philippines.

2.69 Power quality correction and rural power grid support are the reasons for an emerging grid-connected market for large PV installations. The two markets have received little attention in the Philippines compared with rural household and community applications. The grid-interactive PV market could be very important in the next 5–10 years if the costs of installed systems decline as anticipated from $7–10 per watt down to $3–4 per watt.

2.70 For building-integrated applications the current costs for PV systems range from $5 to $7 per Wp. In both cases (buildings and grid support), roughly 50 percent of this installed cost (price) is embedded in the cost of the PV modules, and the remainder is in the balance-of-system (BOS) costs. Grid-tied PV systems will be economically attractive when the entire system installed price is at or below $3/Wp.

2.71 The IFC, with grant financing from the GEF, is collaborating with CEPALCO to cofinance and demonstrate a 1-MWp PV system[23] tied to the CEPALCO grid in conjunction with a recently commissioned 7-MWe hydropower facility on the CEPALCO power system. The idea is to demonstrate the effectiveness of grid-connected PV plants in conjunction with a hydro plant in addressing distribution system capacity issues. The joint PV/hydro resource would effectively provide firm generating capacity and help postpone the need for additional substations in the CEPALCO distribution system for up to three years.

Projected Contributions of Renewable-Energy–Based Power Generation for Grid-Connected Applications (1999–2008)

Projections for Electricity Demand and Supply, 1999–2008

2.72 According to its draft energy plan (DOE 1999),[24] the DOE expects electricity demand in the Philippines to more than double over the coming decade, with peak demand growing from 7.4 GWe in 1998 to 16.2 GWe in 2008. The average rate of growth in peak electricity demand nationally from 1999 through 2008 is just over 9 percent annually, with growth somewhat lower in Luzon and somewhat higher in Mindanao and the Visayas (see Tables 2.6 and 2.7).

Table 2.6: Projected Electricity Demand in the Philippines (GWh per year)

Year	*Luzon*	*Visayas*	*Mindanao*	*Total*
1999	32,564	4,501	5,945	43,010
2004	48,465	7,450	10,196	66,111
2008	68,367	10,908	14,626	93,901

Table 2.7: Projected Peak Power Demand, 1999–2008 (GWe per year)

Year	*Luzon*	*Visayas*	*Mindanao*	*Total*
1999	5,536	877	1,002	7,415
2004	8,262	1,409	1,750	11,421
2008	11,655	2,033	2,511	16,199

2.73 The DOE has also projected the installed national generation capacity through 2008, based on power generation projects under construction, in preparation, and planned for the coming decade.

2.74 To provide generation capacity and spinning reserve sufficient to cover the projected peak demand and annual average consumption, the government expects installed generating capacity to grow from 11.6 GWe in 1998 to 21.9 GWe in 2008, an annual average rate of growth of 6.5 percent per year. This is the *net* increase; it includes the retirement of 2,533

23 IFC Project Brief: *Philippines—CEPALCO Distributed Generation PV Power Plant* (Project No. 502486).

24 The power development program is summarized in the section "Sectoral Programs and Physical Targets—Power Development Program," pp. 70–80.

MWe of oil-based plants and 55 MWe of local coal-fired capacity. New capacity of 12.9 GWe will be added between 1999 and 2008, with natural gas from the Camago-Malampaya offshore gas fields firing 3.74 GWe of new thermal capacity. (See Table 2.8.)

Table 2.8: Peak Demand (MWe), Peak Generating Capacity (MWe), Spinning Reserve Margin (SRM), and Projected Capacity Savings at Reduced SRM

Year	*Capacity*	*Peak Demand*	*Spinning Res. Margin*	*Capacity at SRM = 0.15*	*Capacity Savings*	*Cost Savings @ $500/kWe*
1998	11,615	7,415	0.57	8,527	3,088	
2008	21,909	16,199	0.35	18,629	3,280	$ 1.64 billion

2.75 Plants fired by imported coal and natural gas dominate capacity additions. The draft energy plan shows a projected shortfall of 3,000 MWe of capacity, equivalent to 25 percent of all capacity additions during this period. This is characterized in the plan as "other fuel." If technically available and economically attractive energy efficiency and demand-side management practices are widely implemented, and growth in demand decreases from 9 percent/year to 7 percent/year, by 2008 the need for most of this unidentified new capacity could be averted even without the extremely large spinning reserve margin of 35 percent projected for 2008 (see Box 2.1).

2.76 A striking feature of this scenario is the projected reserve margin in 2008 of 35 percent (21.9 GWe / 16.2 GWe). The usual reserve margin in interconnected systems is between 15 and 20 percent. This suggests a reserve margin of between 2.43 GWe and 3.24 GWe, or a total capacity of between 18.63 GWe and 19.44 GWe. Under the conservative assumption of a $500/kWe ($0.5 billion/GWe), simply planning traditional capacity at the "rule-of-thumb" reserve margin rather than at 35 percent saves between *$1.6 billion and $1.2 billion* (the difference between 21.9 GWe and 18.63 GWe or 19.44 GWe times $0.5 billion/GWe).

Box 2.1: The Impact of Energy Efficiency and Peak Demand Management on NRE Contributions

The table below illustrates the important consequences of a reduction in the rate of growth in peak power demand through aggressive peak demand management and energy efficiency in all sectors—commercial, industrial, government, and residential. The difference in year 2008 peak demand between sustained growth at 9 percent/year and at 8 percent/year is 2,100 MWe. Reduction to 7 percent/year growth reduces new capacity needs by 3,300 MWe, equivalent to the entire capacity of gas-fired plants supplied by the Malapaya gas field. The cost of implementing measures to achieve this modest reduction in growth rate will be in the range of several hundred dollars per peak kilowatt avoided; offsetting this growth through new renewable energy plants will cost $1,000 or more per kilowatt of new generating capacity.

Projected Peak Electricity Demand for the Philippines, 2008

Growth rate (percent/year)	*Growth Factor Relative to Year 1999*	*Peak Demand in Year 2008 (MWe)*
2	1.20	8,862
3	1.30	9,675
4	1.42	10,554
5	1.55	11,503
6	1.69	12,527
7	1.84	13,632
8	2.00	14,823
9.07	*2.18*	*16,918**

* DOE projection.

Real GDP growth in the Philippines was 5.7 percent in 1996 and 5.2 percent in 1997, in spite of the broad Asian financial crisis. GDP, which shrank by 0.2 percent in 1998, is projected to grow by 2.7 percent in 1999 and 4.8 percent in 2000. The projected rate of growth in peak power demand reflects DOE assumptions of average growth in GDP of 5 percent/year (real) between 1999 and 2008. However, broad implementation of available technologies for energy and peak power management can decouple economic growth and power generation growth.

This situation is reminiscent of the experience of the state of California between 1970 and 1990. In California in the early 1970s peak power demand, growing at 7 percent per year, was officially projected to continue at that rate for two decades. Through state-wide implementation of mandated new energy performance standards, growth in demand for power generation fell rapidly to an average of 2 percent/year, while real economic growth continued at 5 percent/year. This suggests that a reduction in peak power demand growth from 9 percent/year to 7 percent/year or less over the coming decade is feasible in principle in the Philippines, and is consistent with real economic growth of 5 percent/year. Achieving sustained reduction in peak demand growth would permit the renewable energy plants coming on line (geothermal, hydro, wind, and biomass) to offset coal and petroleum imports for the power sector, rather than cover new demand for electricity supply.

The conclusion of this simple example is that energy efficiency and demand management significantly enhance the relative scale and value of renewable energy power generation options. While this report does not address the demand side of the energy sector, the single most important action needed to significantly enhance the role of renewables in the power sector would be for both government and private sector to moderate energy demand.

The Contribution of Renewable Energy to Bulk Power Generation

2.77 The DOE's draft energy plan anticipates that large geothermal, large hydropower, and industrial biomass cogeneration systems will make up the principal renewable energy contributions to bulk power generation in the Philippines over the coming decade and beyond (See Table 2.9). Geothermal capacity, at 1,934 MWe today, is projected to increase to 2,460 MWe by 2008—a net increase of 526 MWe. According to the DOE, known economically exploitable geothermal resources are nearly exhausted. For hydropower net expected growth is 1,714 MWe, from 2,311 MWe today to 4,025 MWe in 2008. The hydropower additions are projected to come from completion of 10 large and 14 mini-hydro projects, with aggregate capacities of 1,558 MWe and 100 MWe respectively.

Table 2.9: Projected Increase in Geothermal and Hydropower Capacity in 2004 and 2008 (MWe)

Year	*Geothermal*	*Hydro*	*Total*
1999	1,934	2,311	4,245
2004	2,010	3,022	5,032
2008	2,460	4,025	6,485
Increase	526	1,714	2,240

2.78 In addition, with the commercially significant wind resources newly identified in the country, wind electric power generation can make an important contribution. Investment opportunities on the order of $500 million for wind electric power plants appear feasible, with 500 MWe of wind electric capacity additions by 2008. A detailed scenario for wind electric power development is presented at the end of this section.

NRE Options in the Generation Mix

2.79 The DOE projects additions to new and renewable power generation, both grid-connected and off-grid, at 410 MWe through 1999–2008, roughly 3 percent of new grid-connected capacity (see Figure 2.9). The projections include 30 MWe of marine energy conversion facilities and 182 MWe of wind electric power (see Table 2.10). All this capacity is assumed to be connected to the unified national grid by the end of 2008. An alternative scenario in which there is no marine energy conversion, but wind electric power capacity of close to 500 MWe is added, is summarized below (see Table 2.11) and discussed further in Chapter 4.

Table 2.10: Grid-Connected New and Renewable Power Generation Systems, DOE Scenario (MWe)

	PV	*Wind*	*Micro Hydro*	*Ocean*	*Coconut*	*Rice*	*Bagasse*	*MSW*
1998–2004	7	2	2	0	5	40	0	0
2005–2008	12	180	6	30	6	55	5	60
Additions	19	182	8	30	11	95	5	60

Figure 2.9: Capacity Additions by Generation Type (1999–2008)

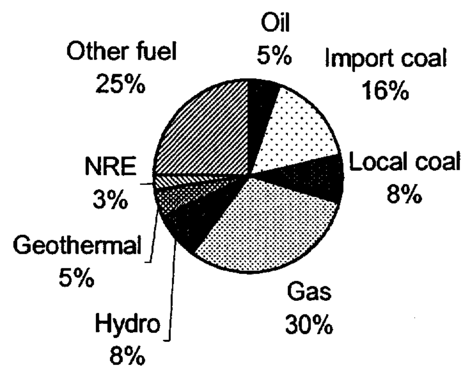


Table 2.11: Grid-Connected New and Renewable Power Generation Systems, Modified DOE Scenario (MWe)

	PV	*Wind*	*Micro Hydro*	*Ocean*	*Coconut*	*Rice*	*Bagasse*	*MSW*
1998–2004	7	**80**	2	0	5	40	0	0
2005–2008	12	**400**	6	0	6	55	5	60
Additions	19	**480**	8	0	11	95	5	60

Conclusion: Renewable Energy Technology Priorities

Off-Grid Technologies

2.80 For off-grid[25] communities and regions where grid extension is not feasible, freestanding energy systems, primarily small fossil-fired generators and renewable energy systems, are already economic options. The market is substantial. Of the 10,500 barangays included within the purview of the DOE's Energy Resources for the Alleviation of Poverty (ERAP) program, it is estimated that more than 5,700 barangays will not be connected to the backbone grid or larger island/isolated grids. Their energization will have to be achieved using a mix of renewable energy technologies, renewable/fossil fuel hybrid energy systems, and conventional fossil sources (primarily diesel power). The choice of specific technologies will depend on a case-by-case assessment of the least-cost preferred options.

[25] *Off-grid* does not imply the absence of power grids. Rather, it refers to regions that are connected neither to the national backbone grid nor to part of one of the larger island or other isolated grids served by SPUG-operated generation facilities. In many cases, in these unelectrified regions, it will make sense to utilize small generation plants (e.g., micro-hydro, diesel, hybrids) coupled with small distribution mini-grids serving one or several small communities. Local and regional minigrids are expected to proliferate in the off-grid region, with both conventional fuels and renewable energy resources mobilized to energize them. It should be noted that outside observers and reports often confuse the island and isolated grids served by the NPC/SPUG generation (which usually are associated with multi-megawatt peak demand levels) with smaller distribution mini-grids (which are typically associated with peak demand levels in the tens or hundreds of kilowatts).

Grid-Connected Technologies

2.81 Over the coming several decades, renewables can have potentially strategic importance in providing high-quality electricity and non-electric energy (cogeneration and clean fuels) using environmentally responsive technologies. Experience elsewhere suggests that a decade or more of effort is typically required to build up a significant national on-line inventory (about 1 GWe or more) of new generation options such as wind electric power plants. If the Philippines government wishes certain new and renewable energy technologies to make a significant contribution to the generation mix, it will need to begin supporting the initial projects in the near future. For example, in the case of wind electric generation, it took approximately a decade for the United States, Germany, Denmark, Spain, and the Netherlands to achieve significant progress; the same is likely for the Philippines.

2.82 **Wind energy:** The draft energy plan projects 145 MWe of wind electric power by 2008. The new wind resource atlas[26] for the country and the experience of other countries in harnessing wind energy for power generation suggest that there is scope for building about 500 MWe of grid-connected wind electric power over the next decade.

2.83 **Mini-hydropower:** Judging from data gathered at previously assessed sites, it will be feasible to build new mini-hydro plants generating several hundred megawatts—provided the government alters the current bid process and policy environment for the plants' development. The DOE's draft energy plan projects 110 MWe of mini-hydro capacity from 14 projects. In 1996 the DOE inventory of potential mini-hydro sites listed some 60 sites with approximate potential capacity of 112 MWe. Preliminary investigation and pre-feasibility studies have already been completed for each site. More than 1,000 MWe are potentially available from other sites identified by the NEA.

2.84 **Bioenergy:** There is scope for several hundred megawatts of power from biomass (cogeneration associated with agroindustries and the wood products industry) *provided several inhibiting procedures and policies are modified to facilitate private sector investment.* (See Box 2.2.) The draft energy plan assumes that only one bioenergy plant—the 40 MWe Bulacan cogeneration facilities—will come on line during that period.

Box 2.2: Biomass Residue Production Sharing System—
A Constraint on Private Development

RA 809 (1952) specifies a sharing of the products and byproducts of sugar cane, including sugar, molasses, mud cake, and bagasse: The planter gets 64 percent of these products and byproducts and the miller gets 36 percent. There is no purchase of the cane. The planter delivering his cane gets a receipt specifying his share of the products. Where there is no value for the surplus bagasse and mud press, the planter takes only the sugar and molasses and the mill is left with large volumes of bagasse. Currently some mills burn it to get rid of it. If the mill tried to develop the bagasse as a fuel resource, the planters could claim their share and the fuel would no longer be free. This is true of all investments in the mill. The cost is born by the miller but the benefit in added useable sugar from the cane is shared with the planters; that is, when revenues come in, the growers want their share. If the mill buys a new roller, the mill only receives 36 percent of the revenues associated with the improvement it brings. *This is a constraint on investment in bioenergy facilities.*

26 NREL (1999). See Chapter 2 for details.

3

Institutional and Policy Framework for Renewable Energy Technologies

Introduction

3.1 The government of the Philippines, in particular the DOE, has a strong interest in expanding the use of renewable energy technologies for grid-connected power generation (including cogeneration) and for off-grid rural applications. The DOE is especially interested in facilitating near-term use of renewable energy technologies as a significant part of the electricity supply mix for the more than 5,000 unelectrified and underelectrified communities for which grid electrification is considered to be economically impractical. Renewable energy resources and technologies are thus seen as an essential element in the government's poverty alleviation efforts through the DOE's ERAP program. In spite of the DOE's strong interest and support, however, the broad use of renewable energy technologies in both grid and off-grid applications faces a number of barriers that must be overcome, including institutional, policy, and legal barriers.[27]

3.2 Current institutional arrangements and policies severely limit opportunities for investment in both grid-connected and off-grid NRE technologies in the Philippines. Although some government programs and incentives facilitate the expansion of renewable energy applications, many others impede it, albeit unintentionally. As a result, NRE applications have not expanded as anticipated. Indeed, during the past decade both the domestic and the international private sectors have experienced enormous frustration in their attempts to develop renewable energy projects in the Philippines. The current array of laws, regulations, policies (official and unofficial), and procedures (formal and informal) has severely limited the flow of capital into the power sector for renewable energy projects. International investors and developers in hydropower and other renewable technologies are unlikely to initiate new projects until an Omnibus Energy Bill is passed or clear and attractive interim conditions are established under which their investments can proceed with acceptable risks. Opening new NRE markets in the Philippines will require policy modifications and new initiatives; these are particularly important and urgent for the potential market for off-grid and unelectrified communities.

3.3 This chapter discusses institutional and policy actions the government of the Philippines can take to foster the wider and more rapid adoption of renewable energy throughout the country. It identifies a number of existing problems, as well as a number of anticipated

[27] See Annex 1.1 for the status of relevant legislative and policy initiatives as of June 2001.

problems to do with restructuring, and recommends specific initiatives to facilitate significant investment in renewable energy for off-grid service and for grid-connected generation.

Energy Sector Jurisdiction

3.4 Renewable-energy-based power generation for grid-connected applications is subject to the jurisdiction of several Philippine government agencies, among them the DOE, several departments within the National Power Corporation (including its Strategic Power Utilities Group, or SPUG), PNOC, and the NEA, which has responsibility for the 119 rural electric cooperatives (RECs). Other interested agencies include the National Economic and Development Authority (NEDA), the Energy Regulatory Board (ERB), the Board of Investments (BOI), and the Department of Environment and Natural Resources (DENR).

Department of Energy

3.5 The DOE's mandate under the Department of Energy Act of 1992 is to "prepare, integrate, coordinate, supervise, and control all plans, programs, projects, and activities of the Government relative to energy exploration, development, utilization, distribution, and conservation."[28] The DOE, including its affiliated organizations,[29] is the largest purchaser, user, and regulator of renewable energy products and services. The legislative and regulatory framework governing renewable energy policies includes measures that both advance and retard the implementation of renewable energy technologies. The roles of key agencies are summarized below, together with a discussion of specific laws (Republic Acts, or RAs) and Executive Orders (EOs) that affect NRE development and application.

3.6 The DOE operates under the authority of RA 7638. Under its jurisdiction come energy sector institutions that produce and refine oil; generate, transmit, and distribute electricity; and sell both oil products and electricity. Other agencies that participate in the energy sector include the DILG and the Department of Agrarian Reform. In the fiscal area, the Bureau of Customs, the Board of Investment, and the Bureau of Internal Revenue all significantly affect NRE incentives.

3.7 The DOE's role will expand under power sector restructuring and privatization. The draft Electricity Industry Reform Act of 1999 (House version, 1 September 1999) provides for the following powers and functions of the DOE:

3.8 "In addition to its existing mandate, the DOE shall have the following powers and functions related to the implementation of this Act:

(a) Supervise the restructuring of the electricity industry;

(b) Formulate rules and regulations for the implementation of this Act which shall include, but are not limited to, the following:

i. Rules and guidelines for the generation and supply market to prevent undue concentration and market share;

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28 Republic Act or RA 7638 (Department of Energy Act of 1992).

29 The National Power Corporation (NPC), the Philippines National Oil Company (PNOC), and the National Electrification Administration (NEA).

ii. National Grid Code and Distribution Code setting the minimum range of acceptable technical specifications, performance standards and safety requirements for the operation of the grid and the distribution system;

iii. Rules and guidelines under which companies engaged in the generation, transmission, distribution of electricity shall offer and sell to the public ten percent (10%) of their of stocks not later than five (5) years from the effectivity of this Act: Provided, than the ten percent mentioned herein is deemed in compliance with existing laws;

iv. Rules and guidelines in the conduct of competitive procurement of power supply; and

v. Rules and guidelines in the administration of the EIRC pursuant to this Act;

(c) Administer the electricity industry reform charge (EIRC) as may be determined by the ERB;

(d) Facilitate and encourages reforms in the structure and operation of distribution utilities which result in greater efficiency and lower costs;

(e) Ensure the reliability, quality and security of supply of electric power;

(f) Facilitate and encourage reforms in the structure and operation of all industry participants which would result in greater efficiency and lower costs;

(g) In coordination with DOF, formulate and implement the privatization plan of NPC assets, in accordance with this Act;

(h) Encourage private sector investments in the power industry and in the development of indigenous energy resources for power generation;

(i) Evaluate the annual development plans of generation companies, transmission company, and distribution utilities to be integrated into the Philippine Energy Plan (PEP);

(j) Develop policies and procedures and, as appropriate, promote a system of energy development incentives to enable and encourage industry participants to provide adequate capacity to meet demand including, among others, reserve requirements;

(k) Undertake an information campaign to educate the public of their rights, privileges and responsibilities; and

(l) Impose fines and penalties for any breach of the rules which it administers pursuant to this Act."

Philippine National Oil Company

3.9 The Philippine National Oil Company (PNOC) plays a major role in renewable energy development—as it is usually defined—through its extensive activities in geothermal energy, a field in which it has helped to make the Philippines one of the leading players. The PNOC also maintains a major interest in NRE through its Energy Research and Development Center (ERDC). PNOC serves as one of the executing "arms" of the DOE, and on occasion handles special tasks for the DOE. It also appears that PNOC executives feel they have a broad implicit mandate or obligation to support development and exploitation of indigenous energy resources, including renewable energy. PNOC, as a parastatal company, can legally engage in ventures with private companies and in fact has done so in fossil energy exploration and production joint ventures. It thus appears that PNOC is one of the agents through which DOE could support renewable energy development and channel external (e.g., GEF) support for private renewable energy projects or ventures such as windfarms or RESCOs, including through possible joint venture participation in such enterprises.

National Power Corporation

3.10 In the electricity sector, the National Power Corporation (NPC) and an array of IPPs generate virtually all the grid-supplied power in the Philippines. NPC also owns and operates transmission assets and substations. Subtransmission and distribution are undertaken by 140 electric utility companies and cooperatives, both public and private. The missionary function of establishing and operating generation facilities to serve island and isolated grids is the responsibility of NPC's Strategic Power Utilities Group (SPUG).

3.11 Under the proposed Electricity Industry Reform Act (1999), NPC will be reorganized and most of its successor companies and components privatized. The implications of reorganization and privatization for renewable energy—for both off-grid rural development and backbone grid-tied electricity supply—are discussed later in this chapter. Under the proposed Act, SPUG will "where feasible, develop and implement a privatization plan for approval by the President of the Philippines. In the event that any party is willing to purchase any of its facilities and/or systems, SPUG shall publish its intention to sell." This opens the possibility for the private sector taking over some of the existing SPUG diesel generating facilities and expanding generation.

3.12 As stated in Chapter 2, NPC has suspended the REPP program initiated in 1996 to acquire as much as 300 MWe of capacity from renewable sources, up to 50 MW annually over a period of six years. Under the terms of this program, small (less than 10 MW) power plants could apply to sell electricity to the NPC at a rate negotiated in a PPA. The program was suspended for several reasons: most important, (1) NPC was understandably reluctant to acquire additional take-or-pay liabilities given the pending power sector restructuring and lack of need for new capacity; (2) the program's assumption of below-market financing from retirement funds conflicted with the fiduciary responsibilities of the fund managers; and (3) serious program design flaws (discussed in Chapter 2) deterred serious private sector interest.

3.13 The purchase of electricity from small plants was supposed to be the vehicle through which a market for small hydro could be created under the Mini-Hydro Act. This did not occur. Mini-hydro developers were deterred by unacceptably high transaction costs in the form of feasibility studies, long delays, and lack of confidentiality and site security. One problem is that the application of technical standards for NRE and mini-hydro projects appears to be derived directly from fossil fuel power generation projects. This means that peak period availability and other typical measures of reliability for fossil systems are applied to energy flow resources (wind, run-of-river hydro, solar energy) that cannot be so controlled. In addition, hydro and other renewable energy projects typically require far more site-specific investigation as part of the pre-investment process, and the developers were reluctant to make the investment in such studies if they would not be able to retain the information on a confidential proprietary basis. Only two mini-hydro projects have reached the point of accreditation and construction.

3.14 SPUG develops and operates small (1–10 MW) power generation systems for island grids and other geographically isolated grids; SPUG-generated power is generally sold to RECs, which distribute and resell the power to customers. SPUG has expressed interest in buying power from IPPs, and has encouraged IPPs to enter the power generation business using indigenous resources, whether fossil or renewable. IPP developers report that it has been difficult to obtain favorable PPAs from SPUG. One key issue appears to be whether IPPs selling to SPUG should have to sell for less than the subsidized price at which SPUG sells to RECs, or whether they should have to compete only with SPUG's generation costs. In the latter case, although a subsidy would remain, the IPP could result in a lower subsidy cost for the government. Under the proposed Electricity Industry Reform Act, SPUG would be retained.

National Economic and Development Authority (NEDA)

3.15 The National Economic and Development Authority (NEDA), as the government's central planning body, coordinates the development plans of all sectors. It becomes involved in independent power projects (renewable and non-renewable) if the government provides any guarantees or if the project contract is with NPC.

Energy Regulatory Board

3.16 The pricing of electricity and power generation fuels is the province of the Energy Regulatory Board (ERB), an independent entity. Under the proposed Omnibus Electricity Act, the ERB's role will probably be strengthened considerably as it takes on the role of referee among the various market participants. In particular, the ERB may be charged with enforcing the financial responsibility and loss-limitation provisions of current and proposed electricity law as it applies to distribution companies and RECs. Further, and perhaps more significantly, ERB will have an antitrust regulatory role if truly competitive wholesale and retail markets develop. Under the proposed Electricity Industry Reform Act, the ERB would also be responsible for key functions in the restructured industry. The ERB would be reorganized, as specified in the Act.

National Electrification Administration

3.17 The NEA supports the RECs through grants, loans, subsidies, and technical assistance. NEA's jurisdiction includes both community minigrid and dispersed (freestanding) applications of renewables for rural electricity supply. NEA has limited its renewable energy activities to providing low-interest loans for PV applications, subsidized by a grant from the German government. The NEA-supported PV activities were ground-breaking in certain respects, being among the first efforts to employ end-user financing and fee-for-service approaches. They have resulted in relatively little progress, however, with approximately 2,700 systems installed over an eight-year period. Although the program appears to have had a number of weaknesses, there does not appear to have been a concerted effort to identify problems and suggest remedial actions, and the role of the private sector appears to have been smaller than would have been ideal. GTZ has ended its support of this program.

Board of Investments

3.18 The Board of Investments (BOI) facilitates commercial investments in the Philippines and will help investors identify business opportunities. A number of investment incentives are available to firms engaged in what are described as Pioneer Industries (See Annex 3.1). For example, an IPP may register with the BOI to seek investment incentives. These incentives include a four-year income tax holiday, exemption from the VAT, exemption from duties on capital equipment, tax credits on locally manufactured equipment, ability to employ foreign nationals, additional tax incentives for labor expenses, tax credits for locally fabricated capital equipment and supplies, and additional deductions from taxable income for local labor. In addition, the BOI can grant a number of non-fiscal incentives for qualifying projects. These include the right to employ foreign nationals, simplification of customs procedures, import of consigned equipment, and the right to operate a bonded warehouse. There has been discussion of redefining RESCOs as Pioneer Industries meriting BOI investment incentive.

Department of Environment and Natural Resources

3.19 The DENR's mandate is to implement environmental policies and to enforce the nation's natural resources and environmental laws and regulations. The DENR is responsible for environmental reviews of proposed power projects; all such projects, renewable and non-renewable, must obtain an environmental clearance from DENR before they can proceed. Thermal projects greater than 10 MWe and hydro projects greater than 6 MWe must file a full Environmental Impact Statement with DENR, and must obtain approval and endorsements from LGUs as well.

Laws, Regulations, and Policies Governing NRE-based Electricity Supply

3.20 The Omnibus Electricity Act under consideration in Congress[30] will replace some of the existing legislation and regulation with programs designed to create a functioning competitive electricity market throughout much of the country. The proposed act also contains specific measures to promote the use of NRE in the electrification of many off-grid barangays. It is discussed later in this chapter. In the more recent Electricity Industry Reform Act, other than provisions for a levy on the wires to pay for missionary electrification as well as to retire NPC debt, all other provisions related to NRE have been eliminated.

3.21 Independent and private power producers are currently affected by the Department of Energy Act (RA 7638), the Executive Order governing IPPs (EO 215), and the Build-Operate-Transfer Law (RA 6957, as amended by RA 7718). Mini-hydro projects are subject to the Mini-Hydroelectric Power Incentives Act (RA 7156). EO 462, the Ocean-Solar-Wind (OSW) executive order of the previous administration, establishes a production-sharing requirement for certain renewable energy projects, creating extremely unfavorable investment conditions for these types of projects. EO 462 is expected to be amended in 2000. Weingart (1998) discusses specific provisions and incentives more extensively.

3.22 Together these acts and their implementing regulations establish a framework for the electricity industry. They are specific about requirements for power supply reliability, financial strength of project backers, volume of proposed supply, and minimization of government subsidies. Except for the mini-hydro law and the ocean-solar-wind order, these generation-oriented acts are generally neutral on the subject of renewable energy. However, their requirements for reliability, reserves, and proponent financial standing generally favor large fossil-fired generation projects. RA 7156 and EO 462 are discussed in more detail in Boxes 3.1 and 3.2, respectively. This discussion includes identification of problems in implementation of

[30] See Annex 1.1 for the status of relevant legislative and policy initiatives as of June 2001.

RA 7156, or inherent problems in the design of EO 462. (See also Annex 3.2, which summarizes mini-hydro incentives, and Annex 3.3, which discusses a proposed revision of EO 462).

Box 3.1: The Unrealized Potential of Mini-Hydropower: Implementation of RA 7156

Despite the incentives embodied in RA 7156, mini-hydro development has virtually come to a halt in the Philippines. Only two projects have come to fruition in the last eight years, with the second of these (Bubunawan) still under construction. Several mini-hydro project development barriers were identified during the 1997 Annual Mini-Hydro Seminar-Workshop (September 4–6, 1997). One proposed solution is for the Philippine DOE to provide a one-stop shop that brings together all concerned government agencies under one roof, with the DOE exercising its authority for mini-hydro. Similar one-stop shops are already in place within the BOI and in the Philippine Economic Zone Authority (PEZA).

RA 7156 empowers DOE to be "the sole and exclusive authority responsible for the regulation, promotion and administration of mini-hydroelectric power development" and gives it "exclusive authority to issue permits and licenses relative to mini-hydroelectric power development." DOE has not taken advantage of this mandate because of concerns that the law requires the agency to consult with the National Water Resources Board and other government approving agencies, and follow their rules for projects. The mini-hydro law for a framework "to facilitate hydroelectric power development by eliminating overlapping jurisdiction of the many government agencies" appears to allow the DOE to act in behalf of other agencies, given proper consultation.

NPC's requirements for engineering and feasibility studies create proportionately higher transactional costs for smaller plants (less than 10 MWe). This has inhibited almost all mini-hydro development. Also, mini-hydro developers claim that the NPC's permitting and approval process for small hydro plants, besides being cumbersome, long, and costly, also threatens the security of commercial and proprietary information. The process leads to transactional costs for completing such proposals that go beyond the willingness and ability of most developers to sustain; this is reflected in a lack of activity in this sector. Increasing the maximum size in the definition of *mini-hydropower* would help reduce the transaction costs per kWe of capacity. Although DOE officials agreed in 1997 that the definition of *mini-hydropower* should be expanded from 10 MWe to 50 MWe, this has not yet been done.

Mini-hydro projects receive the following specific incentives, although they are insufficient to compensate for the major disincentives built into current procedures. This illustrates the inadequacies of purely financial incentives:

- Special privilege tax—this tax goes to the local community and is critical in obtaining siting and other permits for the hydro facility.
- Tax- and duty-free import of machinery, equipment, and spare parts for seven years.
- Tax credit on domestically produced capital equipment.
- Special, reduced tax rate on equipment and machinery.
- VAT exemption on gross receipts from sale of electric power.
- Income tax holiday for seven years after startup of commercial operation.

In addition to these provisions specifically for mini-hydro producers, all IPPs are eligible for incentives from the Board of Investment (BOI).

Box 3.2: Executive Order 462: Production-Sharing Issues to Do with Ocean, Solar, and Wind Renewable Energy

The government receives a share of the net proceeds from stock energy resource production (oil, gas, coal) if the government owns the resource. This production-sharing requirement also applies to geothermal energy used to generate electricity under energy conversion agreements.

Under Executive Order (EO) 462 (December 1997), use of renewable energy resources (sunlight, wind, water flows, marine currents, etc.) for power generation is subject to a substantial production sharing tax in which the government receives a share of the proceeds, net of costs. A major issue is the possible requirement for revenue sharing with the government for ocean, solar, and wind projects. Government policies and regulations leave this issue "to be negotiated"; the concern is that something similar to the 60/40 split of revenues for geothermal energy production and conversion will be required for renewable energy projects, with the government getting the 60 percent. One of the fundamental weaknesses of EO 462 is that it ignores the fact that renewable-energy generation projects, compared with fossil-based generation projects of similar capacities, require relatively larger capital investments in order to tap "free" renewable energy resources. At present, the main technology affected appears to be wind generation.

There may be a case to be made for a government production share in geothermal resources if the government has a similar right with respect to oil and gas, because geothermal energy can be a depletable resource depending on factors including how the reservoirs are exploited. But oil and gas are commodities with intrinsic value, internationally priced and traded. This is not true for geothermal steam or hot water. Only investment in an energy conversion facility can convert the energy into a commodity. Production sharing increases the cost of developing geothermal resources and creates disincentives for the use of those resources.

The government's claim of ownership of sunlight, wind, and other renewable energy *flows* is unusual and represents a serious barrier to renewable energy development. Renewable energy developers active in the Philippines are operating under the assumption that EO 462 will not be enforced. *EO 462 should be eliminated immediately or revised so as to remove the disincentives for private sector investment in renewable energy enterprises. If this is not done, the implicit message will be that the GOP is not serious in its claimed support for large-scale mobilization of renewable energy resources for power generation, cogeneration, and thermal energy production.* ***EO 462 as it now stands is a major impediment to investments in renewable energy projects in the Philippines, and will totally preclude private investment in projects such as windfarms.***

EO 462 also creates an unfortunate incentive for increasing the use of more-highly-polluting sources of energy, since the production-sharing arrangement taxes clean energy at a level commensurate with tax levels for coal and fuel oil. This contradicts the Philippines' commitment to the goals of the United Nations Framework Convention on Climate Change (UNFCCC) and the Global Environment Facility (GEF).

In May 1999 the Secretary of Energy approved an internal proposal to revise EO 462, and a draft of the proposed new Executive Order was prepared by DOE staff assisted by NREL experts. The assumption has been that EO 462 would be amended rather than eliminated. The draft revision (See Annex 3.3) addresses some, although not all, of the major concerns of the renewable energy industry. NRE projects below 1 MWe of rated capacity would be exempt from the EO. For projects greater than 1 MWe, the draft EO proposes that production-sharing contracts apply to projects meeting all the following criteria:

1. Harnesses OSW resources in lands of the public domain and/or offshore waters within the Philippine territory, contiguous zone, and exclusive economic zone.
2. Requires exclusive use of such lands and/or offshore waters.
3. Has a net electric power output of more than 1 MW for sale to an electric utility.

The draft circular revising EO 462 has been submitted to the DOE legal department and to the Energy Industry Administration Bureau (EIAB) for review. The EIAB has indicated informally that it has no substantive objections. The full text appears as Annex 3.3 to this report. While repeal or revocation of EO 462 would be preferable to revision, the proposed revision appears to be a positive step providing that: it can be assured that projects on private lands will not be subject to production sharing; it can be assured that production sharing "tax" will be capped at 15 percent of net (not gross) revenues; and that windfarms not requiring exclusive use of lands are not subject to production sharing. Finally, the production sharing concept could be employed in a more positive manner, for example if the Government supported investment and site costs such as by funding construction of transmission lines to a site where it wanted to encourage windfarm construction.

The Omnibus Electricity Bill and The Electricity Industry Reform Act

3.23 The Philippines has been debating a fundamental restructuring of its electricity sector for several years.[31] The consensus is that restructuring the sector is desirable, as evidenced by support for it both under Estrada Administration and the previous administration. The basic thrust of the restructuring legislation is to unbundle or separate the different functions or components of the power sector, namely, generation, transmission, distribution, and supply or marketing. The National Power Corporation (NPC) is privatized (most of its components are, at least), and a number of measures have been taken to maximize competition and achieve efficiencies, including the establishment of an Electricity Spot Market.

3.24 The theory and its promise are very attractive: allowing competitive markets to allocate resources will expand the economic pie by significantly increasing economic efficiency and relieving government of its large investment and financial risks. Competitive markets, however, do not allocate benefits and costs based on notions of fairness, social equity, or the government's social objectives. Rather, competitive markets reward economic and technical efficiency and punish inefficiency. Although society as a whole may be better off, not everyone wins. There are losers. As discussed earlier in this chapter, the restructuring and movement towards a short-term spot market for electricity will tend to disfavor grid-connected renewable energy generation. However, the impact of the legislation on rural electrification, including use of renewable energy technologies, is less clear. The legislation is more or less silent on the institutional or policy aspects of rural electrification, with no treatment of NEA and little mention of rural electrification. The RECs appear to be covered by the mandate to unbundle services (e.g., generation, distribution), and some that own modest generation facilities may need to divest themselves of these assets. There is brief mention of the Electricity Industry Reform Charge (EIRC) being, in part, used to support missionary electrification through SPUG and the RECs.

3.25 Negotiations on industry change were centered on the Administration's proposals as embodied in House Bill 4579. A competing version, comprised of five separate bills, was introduced in the recent Special Session of Congress. Agreement could not be reached during the Special Session, which ended in July 1999. Unresolved issues appeared to include the following:

- Whether any cross-ownership of generation and distribution assets would be permitted
- How to determine, allocate, and collect stranded investment resulting from broadening competition in supply
- The structure and governance of an independent system operator (ISO)
- How to permit and regulate access of retail customers to supplier alternatives
- The powers and responsibilities of the ERB to oversee a restructured ESI
- Specific details concerning NPC's privatization

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31 *See Annex 1.1 for the status of relevant legislative and policy initiatives as of June 2001.* This section refers to HB 4979 and was prepared prior to the preparation of the draft Electricity Industry Reform Act of 1999 (September 1, 1999). Because the latter bill had not yet been introduced when this chapter was drafted, the authors have retained the comments and recommendations regarding HB 4979.

- How to fund and achieve certain public policy goals such as universal service and rural poverty alleviation.

3.26 The draft Electricity Industry Reform Act of 1999, prepared by the House Committee on Energy, was introduced this past fall. This bill, which supersedes the original Omnibus Energy Bill, would establish the institutional and general policy framework for the electric power sector.[32] The more recent draft bill resolves several issues relevant to renewable energy raised by the omnibus bill, as we will discuss in this chapter. There is significant pressure to adopt restructuring legislation before the end of 1999. The main incentive appears to be the government's desire to privatize the NPC, remove the debt it carries from the public balance sheet, and shift the investment risk for future capacity to the private sector.

3.27 One other legislative initiative has the potential to affect renewable energy development: draft House Bill 4329, the New and Renewable Energy Act of 1999. The draft is currently available for comment; a revised version of the bill may be introduced for congressional consideration later this year. When this bill may be taken up if at all is unclear. Experience elsewhere suggests that, once restructuring legislation is passed—usually a lengthy and contentious process—there is normally an aversion to reopening of power sector issues through separate treatment of additional bills such as a renewable energy bill.

Limitations of the Government's NRE Programs

3.28 To date, the Philippine government's NRE programs and incentives have not resulted in the emergence of a significant renewable energy industry. The government's efforts in the past have relied heavily on technology-driven projects implemented by or for government agencies, with little stimulation of private sector activity other than selling and installing procured equipment. The goal of promoting grid-connected NRE projects through fiscal incentives has been mired in slow project certification procedures that discourage all but the most determined investors. In more recent years, the relative lack of need for new generation capacity and the extreme uncertainty due to the pending restructuring have resulted in an apparent disinterest on NPC's part in extending PPAs to new NRE projects, and constrained grid-connected project development.

3.29 In the case of off-grid renewable energy projects, there have been a number of activities, generally donor-funded, which have been implemented. These share a number of weaknesses from the viewpoint of development of a sustainable renewable energy industry and market. These include the following:

- NRE projects have been episodic, opportunistic, and well below the critical mass of activity required to attract private sector investment or to justify the investment in the infrastructure required for sustainability. In part this reflects the very limited financial resources made available to the DOE for renewable energy initiatives. (Significant increases in DOE funding are provided for in draft H 4329).
- Where projects have been technology- or donor-driven, little attention has been aimed at financial, economic, or even long-term technical viability in the

[32] Some actions on this or other proposed legislation may have been carried out since this was written.

implementation process. Investments have not been made in the post-installation service and supply infrastructure, and the procedures necessary to ensure sustainability have not been established. Consequently there has been no replication of or diffusion from individual demonstration projects.

- NRE projects have not taken advantage of NGO and private developers to propose innovative approaches to NRE development, including use of more-market-based mechanisms. There are as yet no incentives to encourage the formation of renewable energy service companies (RESCOs); rather, current laws offer many disincentives.
- Bilateral donor-supported projects, while providing desired resources, may interfere with the development of domestic renewable energy companies and market-based industry. Subsidies and incentives given to one project or supplier may interfere with the objectives of another project that aims to encourage domestic NRE firms. Current examples include projects supported by the German, Dutch, and Australian governments with NEA, the Department of Local Government, and the Department of Agrarian Reform. In several of these, foreign PV technology is released to the Philippine market at a substantial discount. As a result, local firms, unable to compete with subsidized imports, lose market share, and potential suppliers of NRE systems focus on marketing to ODA agencies rather than to potential customers.
- There are no approved standards for renewable energy equipment design, manufacture, or performance. For the PV industry there are international standards, but DOE has not been given the resources to permit it to promulgate and adopt such standards in the Philippines. Lack of standards allows suppliers of inferior equipment to capture bids and markets even though their equipment is more subject to poor performance and failure than higher-quality equipment. This is addressed in HB 4329 (draft).

Proposed Changes in Government Policies

3.30 The most effective way to promote NRE on a significant scale is to attract private sector investment within a supportive regulatory climate.[33] There is great potential—especially for off-grid[34] energy supply from NRE—if the risks and rewards of such investments can be made compatible with government policies. This may require that programs currently implemented and managed by the government devolve to the private sector. In other cases,

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[33] See Annex 1.1 for a legislative update as of July 2001.

[34] *Off-grid* does not mean the absence of power grids. Rather, it refers to regions that are not connected to the national backbone grid, nor part of one of the larger island or other isolated grids served by SPUG-operated generation facilities. In many cases, in these unelectrified regions, it will make sense to utilize small generation plants (e.g., micro-hydro, diesel, hybrids) coupled with small distribution mini-grids serving one or several small communities. Local and regional minigrids are expected to proliferate in the off-grid region, with both conventional fuels and renewable energy resources mobilized to energize them. It should be noted that outside observers and reports often confuse the island and isolated grids served by the NPC/SPUG generation (which usually are associated with multi-megawatt peak demand levels) with smaller distribution mini-grids (which are typically associated with peak demand levels in the tens or hundreds of kilowatts).

existing government programs might be modified to make private sector investment and development easier and more attractive.

3.31 In the case of grid-connected renewable energy development, it will be necessary to develop a specific incentive mechanism(s) and program to catalyze significant renewable energy generation under the restructured environment. There are a number of other recommendations for policies that can facilitate grid-connected renewable energy development by removing specific barriers or impediments. These include the "fast-track"[35] recommendations made to the DOE by NREL after consultations with the Philippine private sector and the Bank/ESMAP team (NREL and PEI 1999).

Privatization and Competitive Electricity Markets

3.32 Power sector privatization and restructuring will affect renewable energy development in several ways. By privatizing its electricity supply industry, the government aims to foster competition and attain universal electric service. At the same time, it is committed to poverty alleviation through, among others, access to electric service even in the remotest areas. These policies to some extent pose constraints on one another. Fully competitive electric supply markets are unlikely to serve remote rural areas, where costs of service are high and demand and ability to pay is low. Conversely, the service to such customers needed to meet universal service goals must generally be subsidized. In theory, fully competitive markets do not allow for subsidies. The result is that while market liberalization and privatization can still be pursued, it must account for the cost of achieving the public policy objectives. In practice this means that the economic efficiency gains sought through electric industry restructuring will be less than they otherwise would have been, in part because newly privatized entities may have to assume social obligations that will increase costs and thus reduce profits. Alternatively, a tax on the industry could be levied to pay the needed subsidies.[36] Both approaches divert funds from otherwise profitable commercial uses to achieve social goals. In the first instance, this is affected by reduced profits and thus lower tax revenues. In the second, it is affected by extracting wealth from paying customers through direct taxation.

3.33 It should be noted, however, that *no country has been able to provide universal service without some form of public subsidy* (Galen 1997). It can be argued that the public subsidy required for universal electrification is actually a long-term investment in the economy. This was an argument used to make the case for universal service in highly industrialized countries, including the United States. Providing universal electric service, while requiring a large up-front investment, has paid back many times over in the economic development that resulted. The challenge is to design and implement policies that minimize the amount of public investment and the time required for it to pay back. Later in this chapter and elsewhere in this report, recommendations are made to DOE concerning possible means of using limited government resources to leverage private sector investment in rural electrification.

3.34 The power sector restructuring and privatization can also be expected to have a significant impact on the investment environment for grid-connected renewable energy

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35 These are called "fast-track" recommendations because they are focused on measures that the DOE or the Executive Branch can implement without requiring legislation.

36 A levy on "the wires" has been proposed in the Omnibus Electricity Bill as a way to pay for meeting stated public policy objectives.

generation projects. Experience in other countries has shown that, in general, restructuring and privatization of a country's power sector will be highly unfavorable to development of grid-connected renewable energy generation projects, unless specific policies or measure favorable to renewable energy generation are adopted. In part, this is due to the tendency in restructuring to maximize competition, including through reliance on spot markets and other short-term pricing mechanisms. The problem for renewable energy generation is not just the generally lower level of power prices in the restructured markets. In addition, the short-term pricing mechanisms and movement away from PPAs will make it difficult to finance renewable energy projects, through creating uncertainty about power project sales and revenue streams. The higher investment costs and lower operating costs of renewable energy projects make it imperative that they sell all power and have a guaranteed revenue stream; otherwise, banks will be unwilling to lend for projects. Without a PPA, it is generally impossible for project developers to convince financiers of a project's revenue stream.

3.35 The government can use several different policy mechanisms to provide compensating incentive(s) for renewable energy generation in a restructured environment (see Annex 3.4).[37] In general, these fall into the categories of production incentives (e.g., per-kilowatt-hour payments or tax credits), guaranteed power purchases at favorable rates (e.g., Energy Feed Law, California Standard Offer contracts), mandated set-asides for renewable energy generation (e.g., U.K. Non-Fossil Fuel Obligation or NFFO, Renewable Energy Portfolio Standards), or renewable energy-specific waivers to certain restructuring-related restrictions (e.g., a provision in Bolivia that distribution companies can own RE-based—and only RE-based—generation equivalent to up to 15 percent of their peak demand). These mechanisms will differ in their degree of complexity, and in their applicability to a given legal and institutional environment. In many cases, they will involve some type of incremental or marginal cost, either in terms of an explicit payment or subsidy to generators/investors, or an implicit cost due to extending favorable treatment such as long-term PPAs. The proposed NRE bill described below incorporates a number of these mechanisms.

3.36 It is recommended that the DOE first examine a number of these alternative policies or mechanisms for attracting private investment, then select a limited number (i.e., one or two) for application in a program supporting renewable energy generation in the restructured environment. It may be possible to obtain external grant support, for example from the Global Environmental Facility (GEF), for the initial operation of such a program or mechanisms, and such a program could furnish a means of attracting and channeling other carbon-related resources such as from the Clean Development Mechanism (CDM) currently under discussion internationally.

3.37 Should the DOE choose not to intervene in the restructured electricity market to support grid-connected renewable energy generation, it may be possible that one or more generation companies (GENCOs) resulting from the NPC privatization will choose to invest in renewable energy generation. If the GENCOs sell their products (power, firm capacity, etc.) on a company-wide rather than plant-specific basis, by integrating some renewable energy generation into their mix they may be able to enjoy some of the benefits of renewable energy (e.g., low operating costs) while avoiding some of the disadvantageous treatment that intermittent renewable technologies such as wind farms often suffer.

[37] See also Shepherd (1998) and Armstrong et al.

Recommended Policy Initiatives for Off-Grid Renewable Energy Development

3.38 The following policy initiatives are recommended for developing off-grid renewable energy in the Philippines:

- Maximize the role of the private sector in off-grid rural electrification
- Promote and facilitate co-investments for social and economic development in conjunction with rural electrification.
- Clarify the role of SPUG in off-grid electrification.
- Support socioeconomic market characterization and documentation.
- Promote low-greenhouse-gas (GHG)-emission approaches to small-island electrification.
- Establish a certification program for RESCOs and other rural service/equipment providers.
- Establish national standards for renewable-energy equipment.
- Further characterize and document renewable-energy resources (relevant to both off-grid and grid-connected).
- Strengthen training and education in renewable energy technology.

Maximize the role of the private sector in off-grid rural electrification.

3.39 Most of the NRE development in the Philippines has depended on government programs. Particularly for off-grid electrification, efforts must be made to shift at least some investment requirements to the private sector. This recommendation is consistent with those from other parties (e.g., Winrock, NREL), and appears to have been well received by the DOE. This will require a number of actions, including clarifying the legal environment for RESCOs and other rural service providers, possibly designing incentive structures for such ventures, and working to coordinate activities of other federal agencies and bilateral donors with the off-grid rural electrification program.

3.40 A number of in-country and international companies are prepared to invest in providing electricity services in off-grid regions provided that they can be allowed to do this on a profitable fee-for-service basis. It is likely that a number of other Philippine and foreign companies would follow the lead of these early entrants if a favorable enabling environment were created.[38] The DOE should consider promoting several different implementation models for

[38] For example, Shell International Renewables (Shell IR) and the Community Power Corporation (CPC) have established a joint venture operation in Aklan to provide full-time AC power on a fee-for-service basis for a community in Aklan Province. The venture was a PV/propane hybrid power system and anticipates adding a small modular biopower unit in 2001. Eighty percent of the 123 households offered this service have subscribed for the service, which is projected to begin at the end of 1999. Shell has said that they welcome competition in this arena, and are not seeking an exclusive franchise. A number of other firms are explicitly interested in rural energy service ventures in the Philippines or are active in renewable energy in the Philippines and are initiating RESCO ventures in other countries: Shell IR, CPC, SOLEC (the Solar Electric Corporation), Sunlight Power, BP Solar (which has just established a RESCO joint venture in South Africa analogous to the Shell RESCO joint venture there), and CEPALCO. A number of the other solar firms have expressed interest in at least exploring

rural electrification in RECs territories where the RECs are unable to provide service in the near-to-medium term. Such implementation models could include (1) non-exclusive RESCO or leasing ventures; (2) the franchise approach to attract private investment for rural energy supply, similar to the Argentina model discussed in Annex 4.2; and (3) NGO/community approaches in regions where for-profit firms are unwilling to establish energy service ventures.

3.41 Certain regulatory issues will also have to be addressed if any of these models are to be implemented on a large scale in the Philippines. It will be essential to allow unregulated tariffs for wireless electricity service. It will be necessary to have (1) formal guarantees of private RESCOs' rights to enter RECs' unserved territories and (2) a procedure for establishing compensation or residual value when the REC grid is extended to a REC-served barangay.

3.42 Where private firms are willing to invest and operate systems on a fee-for-service basis, the DOE should facilitate this. For regions where market prospects are less favorable and where private investors are unwilling to enter, the DOE may choose to support project implementation by NGOs and community groups.[39] For photovoltaics in particular, the GOP should adopt a strategy that will put installation and supply into the hands of private firms. The DOE should work to develop the overall framework for off-grid electrification projects; donor agencies, currently the primary funders of such technology projects in the Philippines, should be advised where and how their particular projects will best fit into the overall national program. Such an approach will help keep the skills for site selection, sizing, installation, and service in the hands of local firms while institutionalizing whatever technical assistance accompanies the hardware.

Promote and facilitate co-investments for social and economic development in conjunction with rural electrification.

3.43 The DOE should support the energy component of initiatives that build rural community infrastructure (potable water, health, education, telecommunications, public lighting, etc.) or that develop and expand economically productive activities. This support should include coordination with other government agencies responsible for these non-energy sectors. There are two main benefits to this approach First, feasibility and sustainability of RESCO ventures can be enhanced by aggregating different markets (niches or applications). Second, sustainability of renewable energy for development (e.g., water supply, schools, clinics) applications can be strengthened through coupling of such programs with RESCO ventures where post-installation service infrastructure will be maximized.

3.44 For example, the DILG has been implementing the Municipal Solar Infrastructure Project (MSIP), an AusAID-supported project that provides PV-powered community systems for applications such as community water supply, schools, clinics, and public lighting. It appears that DILG may be interested in expanding this program. One of the potential weaknesses of the program, however, is the difficulty in ensuring an effective post-installation infrastructure for

possible RESCO ventures, and it is quite likely that some of the stronger RECs might be interested in collaborative ventures with some of the aforementioned companies.

[39] For example, the DOE has recently decided to support construction of a number of community projects, including several micro-hydro projects, through SIBAT, a Philippine NGO. The pre-investment preparation of these projects was funded by Winrock and undertaken by SIBAT and PEI. It appears there are many additional candidate communities for such NGO-supported projects.

maintenance and repair. DOE should consider working more closely with DILG to coordinate efforts in this field, for example, through joint activities for an expanded MSIP program and off-grid electrification. This could include designing projects so that they have a greater critical mass in specific regions, and encouraging (or requiring) vendors with MSIP-type contracts to also offer fee-for-service or financed systems to households. In another example, the federal Department of Education has a program to supply schools with computers. However, the schools must already be electrified in order to qualify. This is an opportunity for the two departments to collaborate so that computers, educational TV/VCR programs, lights, and other equipment can be provided as standard packages for primary and secondary schools. The DOE could define the power and energy requirements for these packages and use its grant funds to cofinance school power systems (using, for example, PV and hybrid power technologies). An analogous program could be established with the Department of Health for clinics.

Clarify the role of SPUG in off-grid electrification.

3.45 It appears to be clear that the Strategic Power Utilities Group (SPUG) will not be privatized and will retain an important missionary electrification role in the restructured environment. At present, it is not clear whether this role will continue to focus on generation of power for the island and isolated grids and sale of this power to RECs, or whether SPUG's role will expand to include some of the innovative off-grid electrification activities. It will be important to define the group's role such that it is clear whether it (1) will be a potential catalyst in favor of private sector RESCO development, (2) will be a potential competitor with exclusive access to public subsidy money, or (3) will focus on multi-megawatt generation for island and isolated grids. If SPUG is intended to focus on expansion of electrification, including through off-grid means, it is recommended that certain guiding principles be observed:

- Give SPUG the mission to expand electrification on a least-cost, maximum-sustainability basis (both technical and financial).
- Use SPUG funding as a lever for other sources of funding, not as the sole source.
- Divest NPC and SPUG of design and implementation roles to the extent practicable and change SPUG's role to administration, planning, and funding.
- Implement the SPUG mission, including isolated grids, through private firms, especially RESCOs, using competitive bidding for rights to build and operate systems.

Support socioeconomic market characterization and documentation.

3.46 There is a need to expand the limited understanding of the off-grid rural energy market and the willingness and ability of isolated off-grid consumers to pay for energy service.[40] Lack of such information has been a major impediment to development of effective public sector programs, private sector initiatives, and bilateral programs. Any necessary information available

[40] The DOE and the World Bank are already planning extensive rural energy survey and market characterization activities as part of the process of preparing the proposed Rural Electrification Project. The results of these studies will be very useful, not only for the DOE and for preparing the proposed project, but also for private sector firms considering RESCO ventures.

in government agencies needs to be verified, augmented through new surveys and assessments, packaged appropriately, and widely disseminated.

3.47 The DOE, on its own and through contracts to others, has developed substantial information related to the market for renewable energy products and services and, through the aforementioned activities with the World Bank, will be obtaining additional valuable information. However, this information is not easily accessed by the private sector. It is recommended that DOE make this information more readily available to the private sector, and expand the information available. This can substantially reduce the time and expense required by companies to make informed NRE investment decisions. Useful actions by DOE would be to (1) further characterize and document renewable energy resources, (2) support socio-economic market characterization and documentation, and (3) support the determination of the willingness and ability to pay for modern energy services (especially through new survey instruments recently developed with DOE). Detailed market characterization is the most important preparatory task for off-grid electrification projects. It is the principal basis of project design and the determinant of whether a convincing case can be made for private sector investment.

3.48 Although the practice of providing electricity and fuels at highly subsidized prices often stems from genuine concern for the rural poor, it may not always serve their interests. There is ample evidence that many rural households are willing to pay relatively high prices[41] for electricity, even if the availability and quality of the service is limited. This is reflected in the prevalence of small generators and charged auto batteries used to supply energy to houses and small systems throughout the Philippines.

3.49 In May/June 1999, at NREL's suggestion that DOE learn more about rural electricity needs, practices, and the willingness and ability of households to pay for electricity, the DOE launched a Rapid Rural Appraisal of some 200 barangays. The DOE was surprised to encounter small gensets in virtually every unelectrified barangay surveyed. In Palawan, where 43 barangays were surveyed, 40 contained numerous small gensets. These are typically owned by private individuals and serve three to five other households; gensets operated by barangay captains typically serve 10 or more households. The average payment for genset service is P60–P80 per month for one 20-watt lamp operated four hours each evening. This is about $2.00 for about 2.5 kWh/month, or $0.80/kWh. Even at this level, the surveyors were told that the basic costs of maintenance, fuel, and operation were not fully covered. This important initiative by DOE has provided the basis for designing a pilot rural electricity program that will provide residential and community electricity services using PV systems in two barangays in Palawan.

3.50 A related survey of rural electrification impact/benefits[42]—designed by the Department of Economics at Ateneo de Manila University in collaboration with the World Bank and the DOE—should also provide useful information.

41 This is not a justification for promoting expensive electricity options. However, when the choice is no electrification or access to high-value electricity services at a commercial or near-commercial price, many rural households in the Philippines opt for electricity access. Although it may be ten times more expensive than backbone grid power on a per-kWh basis, it services important needs at a price commensurate with household incomes.

42 Department of Economics, Ateneo de Manila University (1998), *Benefit Assessment of Rural Electrification Project* (Household Activity Survey for the Philippines).

3.51 In the meantime, a limited real-market, commercial test of willingness and ability to pay for rural electricity is underway in Aklan Province. A RESCO is being established there by Shell Renewables (United Kingdom and Netherlands) in collaboration with Community Power Corporation (United States). Some 120 households in Barangay Alaminos were offered full-time 220 volt AC power on a monthly fee-for-service basis with constraints on household peak power draw and daily energy consumption; 83 households signed up. Service is scheduled to start by April 2000. Surveys showed that the current expenditures for energy services are consistent with the target of $8 to $10 per month (roughly 10 percent of typical monthly income) generally deemed necessary for a viable rural energy services business. It is recommended that the DOE closely follow this and any similar small market "tests" because of the value of the empirical evidence, however limited.

Promote low greenhouse gas (GHG) emission approaches to small-island electrification.

3.52 The DOE should encourage minigrids using biomass, hydro, wind, and solar options for electrification regions on islands or even entire islands. In some areas it may be possible to achieve cost-effective reliable electrification with little or no use of diesel fuel. For the private sector to undertake this, the DOE will have to suspend traditional electric power tariff considerations and permit fee-for-service operations. Among other options, the DOE should encourage IPPs that wish to develop NRE projects to displace SPUG generation plants. In such cases, the NRE developers should be permitted to compete with SPUG's generation costs, not just with the much lower subsidized prices at which SPUG sells power to selected RECs.

Establish a certification program for RESCOs and other rural service/equipment providers.

3.53 If the DOE is considering providing incentives, subsidies, or special rights to RESCOs, it should consider establishing a certification program to help ensure the safety and sustainability of the service provided. Prerequisites to certification could include items such as adherence to distribution mini-grid safety standards, demonstrated expertise in rural and renewable energy, and certain minimal capital requirements. In addition, the DOE may wish to consider certification for vendors involved in procurement-oriented (i.e., publicly-funded) projects, and a certification system for technician/installers.

Establish national standards for renewable energy equipment.

3.54 For large-scale use of NRE to be sustainable in off-grid areas of the country, uniform and enforceable standards must exist for equipment design, installation, and performance. The DOE should expand its efforts in this area and make use of the work of international organizations already developing such standards for Europe, North America, and Japan.

3.55 Standards are needed for equipment manufacturing quality, field performance, systems installation, and maintainability. Although the Solar Energy Laboratory at the University of the Philippines has made progress in drafting standards for renewable energy equipment, as yet there are no official standards. The DOE should take advantage of current work with NREL, as well as with Winrock and the DBP FINESSE team, to adapt emerging international standards to the needs of the Philippines. DBP lending for renewable energy projects will require due diligence, which in turn will require standards against which the DBP can evaluate projects proposed for lending.

3.56 A committee of experts should be convened as soon as possible to publish preliminary standards (equipment, installation, testing, etc.) for PV, wind, and hybrid power systems. The first set of standards could be issued for freestanding PV systems, for both residential and non-residential applications. (NREL will provide access to international standards, not just those developed in the United States.)

Further characterize and document renewable energy resources (relevant to both off-grid and grid-connected).

3.57 Continued work in renewable energy resource characterization and documentation is advised. The DOE is currently working with NREL, Winrock, and others to make available wind and solar energy resource data. The new wind-resource map for the Philippines should be made widely available on CD-ROM (to date the government has not released the completed wind atlas). The DOE should assist LGUs in identifying and characterizing local wind resources that could be mobilized for community use. Wind resources that may be marginal for large-scale grid-connected wind farms may be well suited for small-scale wind electric and wind/hybrid applications. The USAID-supported collaboration with NREL to develop insolation maps for the Philippines should be the basis for widely available insolation data to guide the design and inform the cost and performance estimates for solar energy systems, both freestanding and hybrid.

Strengthen training and education in renewable energy technology.

3.58 The DOE should support the development of practical technical and engineering curricula in renewable energy for trade schools, colleges, and universities. This may or may not imply significant strengthening of the existing Associated Non-conventional Energy Centers (ANECs). On the one hand, it appears that the ANECs are underfunded relative to their intended purpose. However, if the DOE chooses to support a more private sector-orientated approach to off-grid electrification, the role of the ANECs would be less clear and should be critically reviewed. The proposed renewable energy center that would be established in Palawan under UNDP/GEF funding in partnership with the Provincial Government of Palawan and the Shell/CPC RESCO is an example of a new direction for practical capacity building in renewable energy options for off-grid communities. If there is to be rapid expansion in both public and private applications of renewables for off-grid communities, there will be an associated need for large numbers of technically skilled workers.

Recommendations for Grid-Connected Renewable Energy Projects

3.59 The principal recommendation regarding grid-connected renewable energy development is for the DOE to seriously consider establishing a strong incentive program in order to catalyze private investment in grid-connected renewable energy generation. As discussed earlier in this chapter, a number of different policy mechanisms may be used to provide compensating incentive(s) for renewable energy generation in a restructured environment, including various production incentives, guaranteed power purchase arrangements at favorable costs, mandated set-asides for renewable energy generation, and special waivers for renewable energy. In many cases, these mechanisms will involve some type of incremental or marginal cost, either in terms of an explicit payment or subsidy to generators/investors, or an implicit cost due to extending favorable treatment such as long-term PPAs. The proposed NRE bill described below[43] incorporates a number of these mechanisms. After examining a number of these alternative policies or mechanisms, the DOE should select a limited number (1 to 2) for application in a program supporting renewable energy generation in the restructured environment. A well-designed program would likely be able to obtain external grant support (from, for example, the GEF) for the initial operation of such a program or mechanisms, and in the future could furnish a means of attracting and channeling other carbon-related resources such as from the Clean Development Mechanism (CDM) currently under discussion internationally.

Grid-Connected Renewable Energy in the Restructured Power Sector: One Possible GENCO/Power Pool Approach

3.60 Proponents of NRE have spent considerable time and energy complaining about the difficulties of dealing with NPC, the NEA, and the cooperatives. At the heart of their problems lies a concern about both the lack of a standard contract and the long permitting and approval periods. In the reorganized electricity system, if DOE does not develop an incentive program for renewable generation, the only standard offer will be the marginal energy price dictated by the pool. Take-or-pay PPAs will be allowed to lapse, and no new ones will be given out by the pool. The national energy development plan outlines the probable form of the restructured electricity sector. The system is likely to assume some variant of the pool approach wherein generators are organized into generating companies, IPPs, and cogenerators selling undifferentiated electricity into a transmission system. Prices for electricity will be set throughout the day based on a least-cost dispatch model or a bidding system for each time period.

3.61 The following is an analysis of the potential for GENCOs formed by spin-off of NPC generation assets to incorporate renewable energy into their generation mix. As such, it represents one recommended approach—albeit a less desirable one—in the event that a renewable energy generation incentive scheme is not possible. It also illustrates that given certain benefits of NRE systems to GENCOs, it may be possible on the basis of relatively modest incentives to convince one or more GENCOs to invest in renewable energy generation. (See Annex 3.5 for further discussions of this topic.)

3.62 In a pool system, generators are paid only for specific services such as energy, capacity, spinning reserve, black start, and reactive power. Energy prices are based strictly on the marginal cost of energy at a given hour. Capacity payments are normally based on some combination of plant availability, reliability, and a chosen method of calculating periodic capacity cost for the system. Other payments are likely to be based on a formula, in the case of black start, or on congestion costs and losses, in the case of reactive power.

3.63 There is no place in this system for the traditional PPA between individual generators and a state-run power company, with its take-or-pay provisions at largely fixed prices. Consequently, IPPs will need either to sign bilateral contracts with large customers or to sell some or all of their output to the pool. In fact, there is no reason why they cannot do both. Stand-alone NRE electricity plants will generally receive only energy payments as stand-alone units. Normally, NRE plants cannot provide adequate availability to receive capacity payments under typical pool arrangements.

43 The NRE bill referred to in this document is superseded by the recently passed bill discussed in Annex 1.1.

3.64 Take-or-pay contracts that remain in the system will work largely as a means of getting power to the distribution companies, which will buy from NPC on the take-or-pay basis.[44] However, in the future individual plants will apparently not have this relationship with the NPC.

3.65 In general, a power pool arrangement will not be able to give capacity credit to an NRE plant if its availability is below a specified level, usually 85–90 percent.[45] Without capacity payments, it will be difficult to finance, for example, wind farms, so a means must be devised to obtain capacity payments for the NRE facility.

3.66 Under the future pool rules a GENCO, which may include NRE generating plants ("virtual hybrid" configuration),[46] could be responsible for providing capacity from its portfolio of generating assets rather than from any specified individual plant.[47] This gives the GENCO an incentive to acquire power plants with very low variable costs, such as NRE generators, that are "reasonably" available and reliable, especially if they can help meet peak period demands.

3.67 More specifically, the system operator would propose a certain availability for each GENCO plant and agree to provide capacity to the grid, if called, either from its other generation units or, if its renewable generator is called but is not available, from purchased power. In this way the company could obtain peak power payments for the NRE facility most of the time, only occasionally incurring the cost of providing high-cost turbine or diesel backup capacity. Payments would be made for all capacity available at or above the required level. This system would allow individual renewable plants to act as if they were parts of a hybrid facility. Subject to certain stability limitations on renewable capacity, such a pooling approach could result in a greater contribution from renewable sources than would otherwise occur. *A GENCO might find doing this economically attractive because, over the life of the investment, the lower operating costs of the NRE facility could offset the capital costs of both the NRE and the conventional plant firming up the NRE resource.*

3.68 For the Philippines, the chief benefits of this approach are that (1) older oil-fired plants can be retired more quickly without affecting system reliability and (2) the GENCO using the NRE plants may be able to obtain carbon offset payments from the GEF or other sources as a corporate entity, thereby maximizing the incentive to invest in renewable energy.[48] A similar approach, integrating dispersed biomass plants into generating companies, would enable a

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44 This provision insures that distribution companies cannot bypass the NPC system via bilateral contracts with individual generating companies.

45 The *availability* factor (the ability of the plant to produce when called) and the *capacity* factor are often confused. Plants with low capacity factors—for example, combustion turbines operated just a few hundred hours annually—will receive capacity payments because they are highly available to the system when called (usually more than 95 percent). On the other hand, a NRE plant with a high capacity factor, such as a mini-hydro plant that generates 60–70 percent of the hours of the year, might not be sufficiently available to receive a capacity payment.

46 A *virtual hybrid* is a GENCO with traditional and renewable energy capacity.

47 This is a traditional approach in wholesale power transactions. For years in the United States, wholesale transactions between utilities under FERC (Federal Energy Regulatory Commission) oversight sold what was deemed "system power," i.e., the selling utility guaranteed power not from a specific plant but from its overall system. The point of stating this is to make the "virtual hybrid" seem less "risky because new" because in essence it is simply the application of a conventional power contracting arrangement to a renewables plant.

48 The transactions costs required to obtain such payments are likely to go beyond the resources of a small NRE generator, whereas a larger company is more likely to have the wherewithal to navigate the application process.

GENCO to supply throughout the grid not only active power and energy, but also such auxiliary services as reactive power. It is important neither to underestimate the obstacles to renewable energy generation posed by restructuring nor to overestimate the GENCOs ability (and incentive) to support renewable energy generation development; however, it is conceivable that, in the restructured environment, one or more of the GENCOs may be agents for renewable energy generation. In its efforts to promote renewable energy generation, the DOE should consider designing incentives with GENCOs in mind.

Support incorporation of small hydro into GENCOS

3.69 For mini- and micro-hydropower it is suggested that the program be modified to allow small hydro plants to make the greatest possible contributions in both value and volume. To this end, the following changes in the programs for micro- and mini-hydro are recommended:

- Permit bundling of different hydro projects into one or more larger projects or into a larger power generation company.
- Speed up the permitting process.
- Maintain confidentiality of proposals that are submitted.
- Permit mini- and micro-hydro plant owners to join power generation companies in the restructured system.

3.70 Similar suggestions are valid for other intermittent renewable resources, including wind. In all cases, it is reasonable to permit such projects entrée to the grid through a power generation company. Under the rules of the restructured market, absent specific DOE measures to the contrary, that is the only way to obtain higher value (i.e., peak period prices and capacity payments) from a non-firm generation resource.

Proposed Fast-Track Actions Supporting Grid-Connected Generation

Action 1: Revise renewable energy project accreditation requirements

3.71 The Philippines government has used incentives to attract investment in high-priority economic activities. These incentives, embodied in the Omnibus Investments Code of 1987, have been applied to conventional energy projects and can be applied to renewable energy projects. The incentives, which include tax and duty exemptions, income tax holidays, and tax deductions, are substantial. To qualify for the incentive, Private Sector Generating Facilities (PSGFs) must receive accreditation from the DOE, according to EO 215 and the implementing rules and regulations in Energy Regulation (ER) 1-95. Accreditation also benefits projects by making it easier for them to obtain financing from government financial institutions. Unfortunately, the accreditation process hampers renewable energy development in a number of areas. Recommended actions include the following:

- The DOE's Energy Industry Administration Bureau (EIAB) should issue a statement clarifying that failure to show a five-year track record in power generation will not prevent an applicant from receiving approval of accreditation if the application meets the requirements in Section 3 pertaining to technical capability and financial soundness.

- The EIAB should revise the requirement for cogeneration projects to achieve a thermal efficiency of 60 percent. The revised requirement should be less absolute, with the goal of approving cogeneration projects that result in substantial improvements compared with current efficiency or conventional thermal generation.
- The DOE should modify ER 1-95 to remove the requirement for spinning reserves for small NRE plants. It should remove the requirement for a 10-year contract with NPC and submission of plans to the DOE for utilities that purchase renewable generation. Removal of the requirement would be consistent with the Administration's goal of fostering a fully competitive wholesale market for electricity.

Action 2: Revise the Definition of Renewables Used by NPC

3.72 This recommendation (regarding the limitations on hybrid power systems) was discussed previously.[49]

Action 3: Revise EO 462

3.73 This recommendation was discussed in some detail previously.

Action 4: Exercise full DOE powers under the Mini-Hydro Law

3.74 This recommendation was discussed briefly above. Republic Act No. 7156, the mini-hydro law, empowers the DOE to be the "exclusive authority to issue permits and licenses relative to mini-hydroelectric development." Until very recently the DOE did not exercise this mandate, deferring instead to other government agencies for various approvals. In a number of instances, new regulations are passed affecting the sector without due consultation with industry or consideration of project economics. A case in point is the recent several-fold increases in water rights fees. The hydro projects are made to absorb such fees even though hydropower plants do not actually consume the water (water is merely diverted, used to run the turbines, and returned back to the river). Mini- and micro-hydro facilities are also subjected to the same rules as larger hydro facilities even if they are run-of-river types (i.e., without dams) with smaller environmental impacts than larger hydro projects.

3.75 The DOE should work with all other relevant agencies to establish a new set of policies and standards specific to mini-hydro. The standards should consider project size as well as economics to allow the sector to make its optimum contribution to the development of the country while considering all other concerns, such as the environment and water use. A technical working group (TWG) should be created to develop these new policies and standards. The TWG may organize a consultative workshop to bring together developers as well as regulatory agencies to begin the process. As soon as new policies and regulatory standards are set and

[49] It appears that the issues related to the definition of *hybrid*, in terms of maximum permitted fossil generation fraction, may no longer be relevant. NPC representatives indicated that this requirement was only relevant to the now-defunct REPP program. If this is the case, and the definition is relevant neither to either DOE accreditation of projects (e.g., for BOI incentives) nor to future SPUG-related IPPs, then all references to this issue may be deleted from the final report.

approved, the DOE should decide to accept its mandate as the sole agency charged to carry out such polices, rules, and regulations.

4

Near-Term Investment Opportunities in Renewable Energy

4.1 There are many opportunities for commercial applications of renewable energy in the Philippines today. Private individuals and companies have already invested in commercial installations because they make financial sense.[50]

4.2 In this chapter we discuss two large-scale investment opportunities that can be implemented in the near term. The impetus for the first is the government's recently declared intent to substantially expand its rural electrification program. The second arises because of dramatic declines worldwide in the cost of grid-connected windpower technology, coupled with a recent nationwide wind mapping exercise that identified the most promising areas in the Philippines for large-scale wind farm development.

4.3 Of all the commercially available and proven renewable energy options for grid-connected power generation, only wind electric power is not being used in the Philippines. Photovoltaics, hydropower on all scales of application, biomass-based cogeneration and generation, and geothermal energy are all in commercial use.[51]

4.4 Although based on recent data and information available for the technologies and the proposed sites, the following analyses are theoretical. Their main purpose is to illustrate the types of decisionmaking required for project design and the approximate physical and financial requirements. A second purpose is to suggest implementation methods based on recent experience with similar projects in other countries. Chapter 5 discusses specific actions that the government must take to attract private sector investment and thus hasten realization of the projects.

Off-Grid Electrification: Quickest Market Entry-Point for Renewables

4.5 The quickest entry point for practical NRE applications is in off-grid electrification because most of the technologies involved (PV, small hydro, small windpower,

50 One example is biomethanation in pig farms, where stiff pollution penalties help make investment in biodigesters an economic decision.

51 Marine energy conversion technologies that harness currents, wave energy, and ocean thermal energy are of interest because of the significant marine resources in the Philippines. However, proven commercial equipment is not yet available.

diesel/renewable hybrid, etc.) are the least-cost options for sites far from the main grid. The principal conventional alternative is small diesel gensets, still generally the most economic solution when loads are concentrated and best served by a centralized system. Yet good wind or hydro resources in a particular site may make small windpower, micro-hydro, or hybrid systems cost competitive. Also, in many communities small diesel gensets may not be technically feasible due to institutional weaknesses impairing effective operation and maintenance (O&M).

4.6 The largest potential off-grid load is typically for lighting in individual homes. This is made up of large numbers of very small and highly dispersed individual loads that can be provided effectively by solar home systems (SHSs).

4.7 Note that even in projects involving thousands of households, the total megawatts of generating capacity is miniscule compared with traditional power projects. Even with near-saturation, off-grid electrification installed capacity would only be a few percent of the installed national generating capacity of 11.6 GWe.

4.8 The decision to implement off-grid projects emanates from a deliberate public policy to extend at least basic electricity services to unserved populations that are unlikely to obtain electricity connection in the foreseeable future. In the Philippines the impetus comes from Energy Resources for the Alleviation of Poverty (ERAP), a presidentially mandated program to energize all unelectrified barangays within five years. More than 10,000 barangays remain unelectrified. Roughly one-half are estimated to be suitable for grid extension. The rest, being too remote from the main grids, are more suitable for decentralized distributed power systems, including diesel, renewables, and hybrid systems.

4.9 NEA has estimated the number of off-grid barangays that will remain unelectrified by 2005 under current electrification plans to be between 3,500 and 5,000. Of these, the DOE estimates that 1,800 barangays are situated so far from the main network as to rule out grid extension.

An Illustrative Off-Grid Project

4.10 The project described in this section illustrates the initial phase of a long-term investment program. It targets 700 (about 40 percent) of the off-grid barangays, based on an estimate of 3,500 barangays where grid extension is not feasible. For nationwide impact, we propose selecting barangays from three regions: Region II (Cagayan Valley), Region VIII (Eastern Visayas), and Region IX (Western Mindanao). These regions have the highest number of off-grid barangays outside the Autonomous Region of Muslim Mindanao (ARMM).[52] At the end of the project, about 50 percent of the off-grid markets in these regions would have been served.

[52] The ARMM is excluded in this first project for reasons of regional instability.

4.11 The market segment in each barangay would comprise the following:[53]

1. Households, mainly for lighting—about 180 households, on average based on DOE data
2. Public service centers—assuming one school and one health clinic per barangay
3. Economically productive applications—assuming one per barangay, requiring an average of 0.8 to 1 kWe.

4.12 Thus, at 100 percent market penetration, the project would cover a total of 126,000 households, 1,400 public service centers, and 700 economically productive applications.

4.13 The household market would have two categories: (1) houses clustered together, normally around the public centers, making them amenable to centralized microgrids; and (2) separated houses. Most are dispersed widely over each area: for these, the least-cost solution would be individual PV systems.

4.14 To obtain an approximate estimate of financial requirements, several assumptions are made:[54]

1. 25 percent of the households would be connected to local centralized power systems; 75 percent would have individual SHS units of 50 W each.
2. 35 percent of the microgrids would be powered by pure diesel gensets, 40 percent by centralized PV, 5 percent by windpower-hybrids, and 20 percent by micro-hydro.
3. Each microgrid would have a capacity of about 30 kWe.
4. Individual systems would all be 50-W SHSs. (In a real project, the market for other system capacities should be investigated.)

4.15 The project would be carried out in three phases over five years, with the second and third phases overlapping. As the learning-curve cost declines, each succeeding phase covers more barangays than the previous phase. The coverage per phase and estimated minimum investment costs are shown in Table 4.1.

4.16 The estimated financial requirement for even this modest-sized project is in the order of $100 million, which is substantial. The implementation plan must be designed so that the budget is obtained not only from public funds but also from monthly payments by customers and, more important, from investments by the private sector. Normally, such investments are made through companies that specialize in providing off-grid electrification services.

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53 The assumptions are modest because communities will have other service needs (such as water supply, public lighting, and telecommunications/rural telephones) that also require electricity, and there is likely to be more than one economically productive application per barangay that would benefit from a renewable energy–based electricity supply.

54 Local cost data were used when available; otherwise, cost data from similar projects in other countries were used.

Table 4.1: Financial Requirements of Illustrative Project

Phase	*Number of Barangays*	*Households*	*Public Centers*	*Productive Systems*	*Investment Cost*	*Duration in Years*
I	100	18,000	200	100	12,815,000	2
II	200	36,000	400	200	25,630,000	3
III	400	72,000	800	400	51,260,000	3
Total	700	126,000	1,400	700	89,705,000	5

Note: The *estimated investment cost* is the economic cost of installed equipment only and does not include duties and taxes. Expenditures for project design and management and technical assistance will increase the financial requirements of an actual project.

Implementation

4.17 There are various ways to carry out this project so as to leverage the participation of the private sector, in terms of both financing and know-how. The three basic approaches are (1) dealer sales of equipment, with consumer financing (CF); (2) leasing of equipment by rural users from dealers or leasing companies; and (3) fee-for-service approaches by RESCOs. (See Annex 4.1 for a more-detailed discussion of these approaches as well as examples from other countries.) Centralized microgrids offer natural fee-for-service possibilities where a private company[55] could build, own, and operate the systems, charging customers a monthly tariff for the service.

4.18 A remote household needing a SHS is in a different situation. The SHS could be provided either through direct sale or through fee-for-service, where the system is installed with only a down payment or installation fee and a monthly tariff is charged. In this model the service provider would own the system and provide maintenance and parts replacement. For a barangay or group of barangays, one modality would be for a RESCO to provide fee-for-service to both centralized (minigrid) and dispersed customers. The concession system employed in Argentina (see Annex 4.2) is in essence one variation of the RESCO approach, and is the model employed for this model project.[56] The rights to serve an entire province would be awarded to a company selected through competitive bidding (see Annex 4.2, Figure 4.2.1). The size of the market would provide economy of scale in procurement and in operation and maintenance.

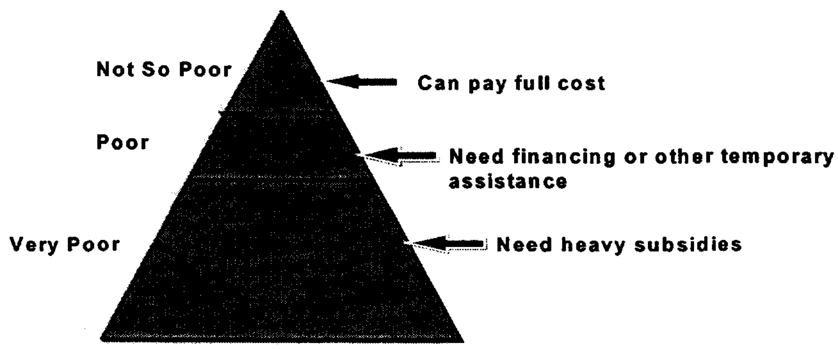
4.19 The most suitable modality would depend on specific market factors such as the levels of capability and willingness to pay (WTP) of different market segments, composition and magnitude of the loads, household density, and potential for attracting the interest of equipment vendors or private service providers to the particular locality. The difference between household incomes and WTP profile on the one hand and the monthly cost of service or equipment amortization on the other would determine the amount of public subsidies needed. On average, an off-grid community will have a few households that can afford service without assistance,

[55] This entity could also be the existing rural electric cooperative. In the discussion, the term "company" is used to refer to both the REC and an external private sector company.

[56] The use here of an "Argentina Model" RESCO with a defined exclusive service territory is not meant to imply that this is necessarily the appropriate model for the Philippines or that any one model will be appropriate throughout the Philippines. The DOE may wish to compare several approaches. Also, the RESCO approach is best for regions with fairly good market density. In some regions in the Philippines, other approaches may be more feasible, such as the dealer model with financing and NGO support.

more that can afford service with some long-term financing assistance or limited subsidies, and a large group that requires substantial subsidies (see Figure 4.1).

Figure 4.1: The Income Pyramid for Rural Households



4.20 The government would have to decide to what extent this last group would be included in its program to improve electricity access. Some governments have opted, given an insufficiency of public resources, to include only the first and second groups in their off-grid programs. Others with formal programs have merely allowed private companies to sell equipment or provide service. Such purely private-sector operations for off-grid electrification are invariably very small, as they cater only to the first group and a fraction of the second—the "cream of the crop," so to speak.

4.21 For the current model project, the following is envisioned:

- A RESCO would provide fee-for service to a *group* of barangays to achieve economy of scale and make the business more attractive.
- The RESCO would charge a monthly tariff based on the level of service and the actual cost of providing service (e.g., different tariffs for households using SHS and those connected to the minigrid with AC service).
- Through a competitive bidding process the RESCO would be granted exclusive rights to serve the market area for a long period (e.g., 15 years). The amount of subsidy requested from the government would be a selection criterion. Exclusivity would guarantee the size of a potential market for the long term and reduce somewhat the investment risks in this high-risk, minimally profitable business.
- The RESCO would be free to employ those technologies (diesel, renewables) and system configurations (centralized, individualized) that deliver the level of service its customers want.
- Special regulatory procedures would ensure that the RESCO delivers an agreed quality of service and that tariffs are consistent with costs.

Cost Sharing

4.22 For our purposes it is assumed that electrification of public service centers would be fully subsidized (or the actual monthly cost of providing service, including profits for the RESCO, would all be paid by the government). Households connected to minigrids would be charged a tariff commensurate with their share of the lifecycle cost of the installation and O&M. Depending on income and WTP levels, some subsidy may be provided.

4.23 Dispersed households with SHS would be charged a connection fee (about 10 percent of the installed cost of the unit) and a monthly tariff. The tariff will reflect the lifecycle cost of the system (installed cost, replacements, O&M) over the service period, less whatever subsidy is provided by the government or external donors. The subsidy must not exceed the difference between actual lifecycle cost of the unit and the WTP level. In all cases, it is preferred that subsidies be applied to capital costs and that customers pay the full cost of O&M, the recurring costs. Excessive subsidies, even if public or donor resources are freely available, tend to distort the market.

4.24 For productive applications, user equity or down payments could be raised to 20–25 percent of installed costs. It would be important to explore financing through existing programs of the DBP (especially Window III) for, say, 50 percent of the cost, with the balance preferably financed by the RESCO; in effect it would be assuming part of the risk. One imaginative approach proposed by a new RESCO in the Philippines is to take an equity position in a productive use enterprise, such as coconut milling, provide some business and management support to assure its profitability, and then supply electricity services to it.

4.25 Depending on the size and composition of the actual project package, the RESCO may be asked to finance—on an equity basis—up to 30 percent of the total investment cost for all market segments. Needless to say, no RESCO will take on an off-grid electrification project if a reasonable return on equity is not in sight. Before the competitive bidding such calculations must be provided as part of the bidding package. The government would finance the rest as subsidies and indirect loans to the users. The portion of the investment cost typically financed by external borrowings by the government is about 40 percent, which represents roughly the foreign exchange component of off-grid equipment. The external loan component for this model project would then be about $36 million.

4.26 In similar projects financed by the World Bank in other countries (e.g., Indonesia, Argentina), governments were able to obtain supplementary grant financing from the Global Environment Facility (GEF). The grants were used to buy down, on a declining schedule, the high first cost of certain renewable energy systems and to finance activities designed to reduce market barriers for new technologies. Properly justified, these grants can be substantial and can finance many activities (e.g., public information campaigns) that are too expensive for small private companies. The two most important barriers for off-grid electrification are that (1) private companies lack information on which to base investment decisions, and (2) potential rural customers are not aware of the available choices, including costs and benefits. GEF grants have financed activities that directly address these barriers. As an example, the financing scheme for the World Bank/GEF-supported off-grid project in Argentina is shown in Annex 4.2 along with the market-barrier-reducing activities GEF financed with grants.

4.27 The government may also realign bilateral funds proposed for pilot renewable energy projects so that they are used as part of the subsidy package for well-designed private sector off-grid electrification. Many of these pilot projects currently provide heavy subsidies to rural customers, benefiting particular households but effectively distorting the market and preventing the entry of private investors.

Other Issues

4.28 Detailed market characterization is the most important preparatory task for off-grid electrification projects. It is the principal basis of project design—the determinant of whether a convincing case can be made for private sector investment and a basis for decisions on subsidies. Annex 4.3 briefly discusses sampling design for surveying barangays. What needs to be emphasized here is that the surveys should not be used to identify specific barangays for renewable energy applications (criticized as "a solution looking for a problem"). They should be used to determine market demand, resource availability, and WTP in different market segments for electricity from whatever sources are available.

4.29 The question of promoting electrification by charging batteries for multiple users from a centralized source (diesel or renewables) has often been raised. If household usage of the battery is more or less constant, it is more economical for the household to be provided a 30-W or 50-W SHS—not even taking into account the inconvenience of hauling a heavy lead-acid battery to and from the charging station. The sole advantage of such a system over a SHS is that households need not make a long-term commitment for service but use a "pay as you go" approach, charging their batteries only when they have cash. This may be an unavoidable option in barangays that are extremely poor; battery charging stations and operations could be incorporated into an actual project.

4.30 One of the key issues that must be addressed in the Philippines involves the Rural Electric Cooperatives (RECs) and their service territories. In the Philippines, all unelectrified barangays are in sites that are assigned to an REC. Thus, the entry of an external RESCO into such areas is only possible if the REC allows it. Some RECs may want to go into off-grid electrification if they see significant incentives (such as the potential for large donor grants). However, it is extremely questionable if they can develop within a reasonable time the expertise and investment contribution needed for this type of undertaking.

4.31 Some financially stronger RECs might make excellent partners in a RESCO joint venture in which an external company brings investment capital and know-how. In a World Bank/GEF-supported project, the DOE might wish to encourage such joint ventures. In many cases, however, the local REC will not be capable of or interested in such a venture. The controlling principle should be that the REC's right to its territory goes only as far as the customer's right to be served. If serving certain areas would jeopardize the REC's financial viability, the government can seek another service provider. In such cases, the regulatory agency should have the authority to open sub-REC or permission areas.

4.32 It will be necessary to create the regulatory framework to handle relationships between RECs and RESCOs. For example, even where RECs are willing to allow RESCOs to operate in unserved portions of their territory, it would be useful to have a clear understanding of the RESCO's rights if the grid is extended (e.g., rights to compensation for useful infrastructure installed, such as village minigrids, or for power sales to the co-op from once-isolated micro-hydro plants). Where an REC is unwilling to allow a RESCO to enter its service territory but cannot provide service itself, there will need to be an accepted procedure for reallocating service territory boundaries or allowing the RESCO to serve a "sub-territory" for a specific period of time. Another possible means of handling the uncertainty regarding REC grid-extension timetables is to give RESCOs public support for selected investments (e.g., distribution minigrids) that would later be useful to the RECs.

Grid-Connected Wind Electric Power Plants: Justifications for Near-Term Development

4.33 The Asian economic situation has resulted in lower mid-term growth projections for the Philippine economy. For much of the coming decade there appears to be no need for additional generation capacity for the NPC backbone grid beyond projects in the pipeline. Yet there are important reasons why the government should encourage the development of wind resources for grid-connected power generation:

- The Philippine economy has weathered the Asian economic downturn better than many of its neighbors. Real GDP declined by only 0.5 percent in 1998 and is expected to grow at close to 3 percent in 1999 and close to 5 percent in 2000. Consequently, growth in demand for electricity may not drop as expected over the coming decade; indeed, the expansion and interconnection of backbone grids may further stimulate demand for capacity and energy.
- It will take close to a decade to get an active wind electric power development program underway and about 500 MWe of wind generation capacity in place. Several years of non-construction preparation are required to identify, characterize, and rank wind plant sites and to take detailed wind resource measurements (two years of detailed data are typically required). Developers, investors, and the government will all want a few years of experience with the first wind plants before expanding construction significantly. *If wind electric power is to emerge as a significant option for clean, indigenous power generation in the coming decade, development must begin now.*
- Wind electric power adds important diversity to the generation mix, with no consumption of fossil fuel resources and no emissions to the atmosphere or water. Care in site selection can mitigate other environmental consequences in terms of land use in sensitive areas.

Illustrative Grid-Connected Windpower Projects

4.34 The projects described in this section illustrate the possibilities for wind electric power investment projects. They summarize the results of a very preliminary analysis conducted by an NREL consultant.[57] As the analysis indicates, site characterization and ranking of the most attractive wind farm sites in the country, including one to two years of detailed on-site wind measurements, will be required before investment.

4.35 Preliminary Site Identification and Ranking.

4.36 Key considerations in ranking prospective sites include the following:

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[57] Kevin Rackstraw, *Philippines Wind Farm Project Scoping Analysis* (Consultant Report to NREL, March 1999).

- Wind resource measured hour by hour for speed and direction for at least one full year, with measurements at projected wind turbine hub height for several locations within a potential site
- Frequency and geographic distribution of extreme winds
- Proximity of the site to transmission corridors, transmission lines, and substations
- Electric load, growth expectations, and existing reserve margins
- Expected match of wind resource and electric demand (seasonally and daily)
- Site topography and accessibility via all-weather roads
- Site availability for sale, lease, etc.
- Environmental considerations (e.g., whether the site is in or near protected or sensitive areas)
- Availability of cranes (for erecting hardware) and their transport
- Feasibility of developing local operations and logistical support

4.37 Reflecting the needs of project developers, investors, and lenders, the following criteria were applied to evaluate several potential sites for which data are available. Slightly more weight was given to exposure to extreme winds from typhoons, but all other criteria were applied equally:

1. Quantity and quality of site wind data
2. Likely exposure to extreme winds from typhoons
3. Complexity of terrain
4. Physical obstacles (including vegetation)
5. Proximity to the grid
6. Electricity production estimates using both 600-kWe and 750-kWe turbines
7. Quality of access (roads, ports, etc.)

4.38 The NPC's wind resource measurement program[58] has focused on Ilocos Norte and on a few islands outside of Luzon. The wind in Ilocos Norte is the most extensively measured. Although opportunities may exist for wind projects on islands like Guimaras, Romblon, Palawan, Panay, Mindoro, and Cebu, they seem less likely to meet the 50-MW size standard set for this investigation.[59] Most of these sites are quite distant from Manila and the consultant was unable to visit them given the time available. For these reasons, and because of the logistical concerns about working in the relatively remote and undeveloped province of

[58] The program was discontinued in mid-1997 for lack of funds.

[59] The reasons for this range from a lack of appropriate sites to concern about ability (primarily because of small system capacities or weak grids) to absorb a substantial amount of intermittent wind generation without destabilizing the system.

Ilocos Norte, the consultant sought out additional potential sites on Luzon, closer to Manila, where wind farms could connect to the main transmission system.

4.39 After review of available wind data for all, and site visits to some, 16 sites were considered. Three of the sites visited—Tagaytay in Batangas Province, Sampolac in Rizal Province, and Caliraya in Laguna Province—are near Manila, are near major transmission lines, are part of the main (not a peripheral) grid system, exhibited some resource potential, or reflected NPC's strong interest.

4.40 Tagaytay and Sampolac are identified on the NREL wind maps as having high potential. Caliraya is located in what the consultant identified from topographical maps as a potential wind corridor. This location was identified on the wind maps as a moderate resource area. Caliraya is also near a pumped-storage hydro facility, which the consultant was interested in exploring as a potential user of wind-generated power. Only one of the three locations had any data from the site, and at that site only six months of data had been collected. *None of these sites could reasonably be the basis of a case study as envisioned in this scoping analysis because of the lack of wind data.* Further exploration of at least two of these sites is warranted.

4.41 The 16 sites are characterized in the Tables 4.2, 4.3, and 4.4. Most is known about the Ilocos Norte sites, which are listed separately along with wind speeds and wind power estimates. The other sites are less well known or have limitations, which are described in the "Comments" section of each table.

4.42 Catanduanes was eliminated because of vulnerability to typhoons. Romblon and Guimaras were eliminated because of limited ability to absorb a large wind project (unless an underwater cable to a significant load center already exists) and because of moderate resource indications (for large wind plants, not for wind/diesel or rural applications). In addition, access for constructing and operating a windfarm would appear to be more difficult than at the Ilocos Norte sites.

Table 4.2: Wind Measurements in Ilocos Norte

Burgos			Bangui			Pagudpud		
Site	*Annual Wind Speed (m/s)**	*Annual Power (W/m^2)***	*Site*	*Annual Wind Speed (m/s)*	*Annual Power (W/m^2)*	*Site*	*Annual Wind Speed (m/s)*	*Annual Power (W/m^2)*
Bayog	6.2	401	Bangui	3.8	84	Caparispisan	7.5	489
Pagali	7.4	594				Subec	7.6	669
Saoit	5.5	267						
Agaga	6.4	427						

m/s: meters per second
W/m^2: watts per square meter

Table 4.3: Wind Energy Potential at Other Sites

Site	*Annual Wind Speed* (m/s)	*Annual Power* (W/m^2)	*Province*	*Comments*
Sagada	7.1	393	Mountain Province	Difficult access, mountainous
Guimaras	4.9	136	Guimaras Island	Poor indications; siting of station should be examined
Romblon Island	4.6		Romblon	Good for rural applications
Catanduanes	5.2		Catanduanes	Extremely vulnerable to typhoons
Cuyo Island	4.9		Cuyo	Very vulnerable to typhoons
Basco	6.3		Batanes	Very vulnerable to typhoons; cannot absorb large wind project
Tagaytay	N/A		Batangas	No site data available, expensive land, limited area for development
Sampolac	~6.2		Rizal	6 months of data, during windiest period
Caliraya	N/A		Laguna	No site data available

m/s: meters per second.
W/m^2: watts per square meter

Table 4.4: Ranking of Potential Sites, Measured and Unmeasured

Rank	*Site*	*Comments*
Measured Sites		
1	Pagali	Excellent exposure, simple terrain, second highest wind power
2	Subec	Slightly interior but excellent NNE and SW exposure (dominant winds), highest wind power
3	Caparispisan	Anemometer may be suboptimally sited; good exposure
4	Bayog	Worth looking at more closely
5	Agaga	Difficult access
Unmeasured Sites (less than 1 year or no data)		
6	Sampolac, Tanay	Only six months of data; worth a closer look
7	Calirayan	Availability of sufficient year-round wind questionable but interesting potential match with pumped storage hydro
8	Tagaytay	Probably too expensive, but surrounding areas may be worth examination (no wind measurements yet)

Wind Turbines Considered for the Assessment

4.43 The performance and cost of a 50-MWe project were estimated for two sites (Subec and Pagali), each with three different advanced commercial wind turbines, the Micon 750 (750 kWe; Denmark), the Vestas 44m turbine (600 kWe; Denmark), and the Enron/Zond 46m turbine (750 kWe, United States). The study suggests that 50-MWe wind farms could be built for an installed cost of about $1,000 per kWe (a $50 million capital investment) and that the turbines would operate with an average annual capacity factor of 30 percent (+/- 3 percent).

Cost Estimates

4.44 Cost data[60] were based on experience with projects of a similar scale in the United States, Europe, and China (see Table 4.5). Where possible, local costs were estimated on the basis of actual quotes, and on anecdotal information and rules of thumb otherwise. Estimates, in general conservative, assumed that the wind project would have to absorb all costs (e.g., construction of a new transmission line) even though other partners might cover certain costs.

4.45 The estimates also assumed that import duties, VAT, and excise and other taxes would be waived under the Philippine government's "pioneer" status for foreign investment projects. Although such treatment is appropriate and likely for the first large wind electric power project, it is unknown whether such treatment would be warranted for later projects. O&M costs are reasonably estimated in the range of $0.005/kWh to $0.0075/kWh.

Table 4.5: Cost Estimates for Two 50-MW Wind Energy Project Sites: Pagali and Subec, Ilocos Norte, Philippines

	Price per Unit ($)	*Number of Units*	*Cost ($)*
Turbine*	525,000	67	35,175,000
Tower	50,000	67	3,350,000
Foundations	50,000	67	3,350,000
Balance of station (other civil and electrical works)	70,000	67	4,690,000
Corrosion protection	10,000	67	670,000
International shipping	30,000	67	2,010,000
Domestic transportation	6,000	67	402,000
Grid extension (100 kV class, 3-phase)	40,000/km	65 km	2,600,000
Total Cost**			52,247,000

* Rated capacity 750 kW; per-kW unit price $700.

** Assumes import duties, VAT and excise or other taxes would be waived under Philippine "pioneer" status for first-of-a-kind projects.

Note: O&M costs not included; a reasonable estimate at these sites might be $0.0075/kWh.

Annual Energy Production Estimates

4.46 Annual electricity production was calculated for the two theoretical plants for each of the three wind turbines considered (see Table 4.6). The plant capacity factor for net electricity production was in the range of 0.27 to 0.33, depending on site and turbine. These data, coupled with the capital and operating cost estimates shown above, are sufficient for developing a preliminary investment analysis once the specific investment rules and financial requirements are specified.

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[60] The cost estimates presented here were developed by Kevin Rackstraw, and are fully consistent with current cost data for U.S. and European wind turbines and wind farms, as presented in Chapter 2.

Table 4.6: Annual Energy Estimates (50-MW Project)

		Pagali			*Subec*		
		Micon750 (750 kW)	*Vestas44 (600 kW)*	*Zond46 (750 kW)*	*Micon750 (750 kW)*	*Vestas44 (600 kW)*	*Zond46 (750 kW)*
Gross Energy per Turbine (MWh/year)		2,231	2,053	2,576	2,392	2,194	2,743
Number of Turbines		67	83	67	67	83	67
Actual Project Size (MW)		50.25	49.8	50.25	50.25	49.8	50.25
Gross Energy for Project		149,481	170,399	172,590	160,262	182,105	183,799
Energy Losses							
Turbine Downtime	5%	7,474	8,520	8,630	8,013	9,105	9,190
Weather and Grid Downtime	5%	7,100	8,094	8,198	7,612	8,650	8,730
Array Losses	8%	10,793	12,303	12,461	11,571	13,148	13,270
Electrical Line Losses	2%	2,482	2,830	2,866	2,661	3,024	3,052
Control and Turbulence Losses	2%	2,433	2,773	2,809	2,608	2,964	2,991
Blade Soiling	1%	1,192	1,359	1,376	1,278	1,452	1,466
Net Energy for Project		118,007	134,521	136,251	126,518	143,762	145,099
Capacity Factor		26.8%	30.8%	31.0%	28.7%	33.0%	33.0%

Conclusions Regarding Wind Electric Power

4.47 As this analysis shows, despite some logistical concerns, Subec and Pagali are both very good candidates for a commercial-scale, grid-connected wind plant. Subec would appear to have a relative advantage in terms of productivity, with about 7 percent greater net energy production than for a similar wind plant sited at Pagali. For a 50-MWe project, a likely scenario would involve construction at both sites since neither alone appears capable of supporting 50 MWe. Because the two sites are close to each other, there is not likely to be a significant increase in total cost if construction were split between the two sites. The cost of the necessary transmission line is high but not necessarily prohibitive, depending on the contract terms. Still, the transmission line represents a significant burden for the project, leaving very little room for extra costs if it is to stay competitive with other sources on the island of Luzon.[61]

[61] For further details, see Rackstraw (1999).

5

Recommended Plan of Action

5.1 This chapter summarizes and re-emphasizes the key recommendations made in the previous discussions. The basic message is that the most effective way to promote NRE on a significant scale is to attract private sector investment within a supportive regulatory climate. The previous chapters have pointed out the great potential for private NRE investments if the risks and rewards of such investments can be balanced by the appropriate government policies. This may require that programs currently implemented and managed by the government devolve to the private sector. In other cases, existing government programs might be modified to encourage private sector participation and investment.

5.2 The potential is more immediate for off-grid energy supply. In the case of grid-connected renewable energy applications, the government must first develop special incentive mechanisms and a longer-term development program to catalyze significant renewable energy generation under the restructured environment. Specific actions that could be taken today include the "fast-track" recommendations[62] made to the DOE after consultation with the Philippine private sector and the Bank/ESMAP team (see NREL and PEI 1999).

Recommended Policy Initiatives for Off-Grid Renewable Energy Development

5.3 The maturity of NRE technology is no longer a significant constraint in providing high-value electricity services to off-grid communities, although the cost of electricity from PV systems remains an important factor in terms of supporting some economically productive activities. The limitation in the Philippines is the lack of an infrastructure to deliver, install, maintain, and service the systems on a scale that can make a difference within a decade to the majority of barangays currently lacking electricity services. Because the government has neither the financial resources nor the capacity to deliver renewable energy–based services to off-grid customers on a significant scale, the private sector must be the dominant source of equipment, expertise, and financing. The risks for the private sector of entering a new and largely untested market will require a new public-private partnership, in which the initial market entry costs and risks are shared. A prototype program for large-scale investment in off-grid rural electrification systems was described in Chapter 4. The following recommendations are intended to help the

[62] These are called "fast-track" recommendations because they focus on measures that the DOE or the Executive Branch can implement without requiring legislation. In a number of cases, these build on work done by Winrock and PEI under the NGO/REI and Renewable Energy Financing and Technical Assistance (REFTA) projects. Many of the recommendations that were within the authority of the DOE to act on have in fact been implemented.

DOE plan an off-grid rural electrification program complementing planned grid extension activities through the RECs:

- Maximize the role of the private sector in off-grid rural electrification.
- Select several different implementation models for off-grid rural electrification.
- Ensure effective donor coordination.
- Promote and facilitate co-investments for social and economic development in conjunction with rural electrification.
- Establish DOE policy on subsidies and targeting.
- Clarify the role of RECs in off-grid electrification.
- Clarify regulatory issues for RESCOs and other private sector models.
- Clarify the role of SPUG in off-grid electrification.
- Support socioeconomic market characterization and documentation.
- Establish a certification program for RESCOs and other rural service and equipment providers.
- Establish national standards or specifications for renewable energy equipment.
- Strengthen training and education in renewable energy technology.

Maximize the role of the private sector in off-grid rural electrification.

5.4 To date, most of the NRE development in the Philippines has depended on government programs. The government should now shift the locus of investment at least partly to the private sector. This recommendation is consistent with those of other parties, and appears to have been well received by the DOE. This will require a number of actions, including clarifying the legal environment for RESCOs and other rural service providers, possibly designing incentive structures for such ventures, and working to coordinate activities of other federal agencies and bilateral donors with the off-grid rural electrification program. A number of in-country and international companies are prepared to invest in electricity services in off-grid regions provided that they can be allowed to do this on a profitable fee-for-service basis. Other Philippine and foreign companies would likely follow the lead of these early entrants if a favorable enabling environment were created.[63]

[63] For example, Shell International Renewables and Community Power Corporation have established a joint venture operation in Aklan to provide full-time AC power on a fee-for-service basis for a community in Aklan Province. Eighty percent of the 123 households offered this service have subscribed for the service, which is projected to begin at the end of 1999. Shell has said that they welcome competition in this arena, and are not seeking an exclusive franchise. A number of other firms are explicitly interested in rural energy service ventures in the Philippines or are active in renewable energy in the Philippines and are initiating RESCO ventures in other countries: Shell IR; CPC; SOLEC, Sunlight Power, BP Solar (which has just established a RESCO joint venture in South Africa analogous to the Shell RESCO joint venture there), and CEPALCO. A number of the other solar firms have expressed interest in at least exploring possible RESCO ventures, and it is quite likely that some of the stronger RECs are interested in collaborative ventures with some of the aforementioned companies.

Select several different implementation models for off-grid rural electrification.

5.5 The DOE should consider promoting several different implementation models for rural electrification in REC territories where the RECs are unable to provide service in the near-to-medium term. Such implementation models could include (1) non-exclusive RESCO or leasing ventures, (2) the franchise approach to attracting private investment for rural energy supply (similar to the Argentina model discussed in Annex 4.2), and (3) NGO/community approaches in regions where for-profit firms are unwilling to establish energy service ventures. Where private firms are willing to invest and operate systems on a fee-for-service basis, the DOE should facilitate this. For regions where market prospects are less favorable and where private investors are unwilling to enter, the DOE may choose to support project implementation by NGOs and community groups.[64] For photovoltaics in particular, the GOP should adopt a strategy that will put installation and supply into the hands of private firms. Such an approach will help keep the skills for site selection, sizing, installation, and service in the hands of local firms while institutionalizing whatever technical assistance accompanies the hardware.

Ensure effective donor coordination.

5.6 Uncoordinated efforts of bilateral donors, although well intentioned, can lead to market distortion and undermine private sector participation. Several firms investigating possible RESCO investments have expressed concern about certain renewable energy projects for which bilateral donor funding is planned. The DOE should (1) work to develop the overall framework for off-grid electrification projects and (2) advise donor agencies, currently the primary funders of such technology projects in the Philippines, where and how their particular projects will best fit into the overall national program. In some cases, bilateral donors may have specific conditions attached to their funding regarding source of equipment or degree of grant funding. These conditions can be best accommodated by being channeled into a government procurement-type program (e.g., power systems for schools or clinics).

Promote and facilitate co-investments for social and economic development in conjunction with rural electrification.

5.7 The DOE should design the renewable energy component of the ERAP program in such a way that it (1) supports the energy requirements of rural community infrastructure (such as potable water, health, education, telecommunications, and public lighting) or (2) develops and expands economically productive activities. This support should include coordination with other government agencies responsible for these non-energy sectors. There are several advantages to this approach:

- The feasibility and sustainability of RESCO ventures can be enhanced by aggregating different markets (niches or applications).
- The sustainability of renewable energy for development applications (e.g., water supply, schools, clinics) can be strengthened by coupling such programs with

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[64] For example, the DOE has recently decided to support construction of a number of community projects, including several micro-hydro projects, through SIBAT, a Philippine NGO. The pre-investment preparation of these projects was funded by Winrock and undertaken by SIBAT and PEI. There appear to be many additional candidate communities for such NGO-supported projects.

RESCO ventures in which post-installation service infrastructure will be maximized.

- Multilateral resources available for renewable energy can be used to support broader rural development objectives.

5.8 For example, the DILG has been implementing the Municipal Solar Infrastructure Project (MSIP), an AusAID-supported project that provides PV-powered community systems for applications such as community water supply, schools, clinics, public lighting, and others. The DOE should work with DILG to coordinate the latter's current efforts with the DOE's more comprehensive plans for off-grid electrification. This could include designing projects so that they have a greater critical mass in specific regions, and encouraging (or requiring) vendors with MSIP-type contracts to also offer fee-for-service or financed systems to households. Education and health (including water supply) are two other areas where such co-investments could be encouraged.

Establish DOE policy on subsidies and targeting.

5.9 In designing an off-grid rural electrification program that can attract private investment, the DOE must determine what level of subsidy it is willing to support, and how to channel this subsidy to focus the benefits on the poorest segment of the population. This will include decisions regarding the magnitude of subsidies, the types of mechanisms used, and the eligibility of different entities (such as RESCOs and NGOs) to access such subsidies. The most suitable modality depends on the specific market: the capability and willingness-to-pay (WTP) levels of different market segments, composition and magnitude of the loads, household density, and potential for attracting the interest of equipment vendors or private service providers to the particular locality. The difference between household incomes and WTP profile on the one hand and the monthly cost of service or equipment amortization on the other determines how much public subsidies may be needed.

5.10 On average, an off-grid community will have a few households that can afford service without assistance, more that can afford service with some long-term financing assistance or limited subsidies, and a large group that requires substantial subsidies (see Figure 4.1, Chapter 4). The government must decide to what extent this last group will be included in its program to improve electricity access. Some governments have opted, given an insufficiency of public resources, to include only the first and second groups in their off-grid programs. Others with formal programs have merely allowed private companies to sell equipment or provide service. Such purely private sector operations for off-grid electrification are invariably very small, as they cater only to the first group and a fraction of the second—the "cream of the crop," so to speak.

Clarify the role of RECs in off-grid electrification.

5.11 One of the key issues the Philippines must address involves the RECs and their service territories. In the Philippines, all unelectrified barangays are in sites that are assigned to an REC. Thus, the entry of an external RESCO into such areas is currently only possible if the REC allows it. Some RECs may want to go into off-grid electrification if they see significant incentives, such as the potential for large donor grants. However, it is extremely questionable if many of them can develop within a reasonable time the expertise and investment contribution needed for this type of undertaking. Some financially stronger RECs might make excellent partners in a RESCO joint venture in which an external company brings investment capital and know-how. In the proposed World Bank/GEF-supported rural electrification project, the DOE might wish to encourage such joint ventures. It is clear that the role of the RECs in off-grid electrification is a complex issue, and that treatment of this is complicated by broader issues of power sector restructuring.

Clarify regulatory issues for RESCOs and other private sector models.

5.12 The government will also have to address certain regulatory issues if RESCOs are to be implemented on a large scale in the Philippines. For example, it will be essential to allow unregulated tariffs for wireless electricity service or allow higher tariffs that fully recover investment costs and allow for a profit. If customers of off-grid RESCOs are covered by the same tariff regime as grid-connected customers of RECS and private utilities, RESCOs and other private sector approaches will simply not be feasible.

5.13 In addition, the government must (1) formally guarantee private RESCOs' right to enter RECs' unserved territories and (2) establish a procedure for establishing compensation or residual value when the REC grid is extended to a REC-served barangay. Further, it must create or clarify the regulatory framework to handle relationships between RECs and RESCOs. For example, even where RECs are willing to allow RESCOs to operate in unserved portions of their territory, it would be useful to have a clear understanding of the RESCO's rights if the grid is extended (e.g., rights to compensation for useful infrastructure installed, such as village minigrids, or for power sales to the co-op from once isolated micro-hydro plants).[65] Where an REC is unwilling to allow a RESCO to enter its service territory but cannot provide service itself, there will need to be an accepted procedure for reallocating service territory boundaries or allowing the RESCO to serve a "sub-territory" for a specific period of time.

5.14 Another possible means of handling the uncertainty regarding REC grid-extension timetables is to give RESCOs public support for selected investments (e.g., distribution minigrids) that would be useful later on to the RECs. The controlling principle should be that the REC's right to its territory goes only as far as the customer's right to be served. If serving certain areas would jeopardize the REC's financial viability, the government can seek another service provider.

Clarify the role of SPUG in off-grid electrification.

5.15 It appears certain that SPUG will not be privatized and will retain an important "missionary electrification" role in the restructured environment. At present, it is not clear whether SPUG's role will continue to focus on generation of power for the island and isolated grids and sale of this power to RECs, or whether its role will expand to include some of the innovative off-grid electrification activities. The government must define this role SPUG and clarify whether SPUG will merely play a catalytic role to promote private sector RESCO development, be a potential competitor with exclusive access to public subsidy money, or focus solely on relatively large-scale generation for island and isolated grids. If the intention for the "new SPUG" is to focus on expansion of electrification, including through off-grid means, certain principles must be observed:

[65] The DOE and NEA have been working to clarify the legal issues involved in RESCO operation within an REC's territory, and have recently (10/99) made significant progress in clarifying this.

- Give SPUG the mission to expand electrification on a least-cost, maximum-sustainability basis (both technical and financial).
- Use SPUG funding as a lever for other sources of funding, not as the sole source.
- Divest NPC and SPUG of design and implementation roles to the extent practicable, and change SPUG's role to administration, planning, and funding.
- Implement the SPUG mission, including isolated grids, through private firms, especially RESCOs, using competitive bidding for rights to build and operate systems.

Support socioeconomic market characterization and documentation.

5.16 There is a need to expand the limited understanding of the off-grid rural energy market and the willingness and ability of isolated off-grid consumers to pay for energy service.[66] The DOE, on its own and through contracts to others, has developed substantial information related to the market for renewable energy products and services, and through activities with the World Bank will be obtaining additional valuable information. It is recommended that the DOE make this information more readily available to the private sector, and expand the information available. This can substantially reduce the time and expense required by companies to make informed NRE investment decisions. It would be useful for the DOE to (1) further characterize and document renewable energy resources, (2) support socio-economic market characterization and documentation, and (3) support the determination of the willingness and ability to pay for modern energy services (especially through new survey instruments recently developed with the DOE). Detailed market characterization is the most important preparatory task for off-grid electrification projects. It is the principal basis of project design and the determinant of whether a convincing case can be made for private sector investment. The DOE has already initiated a Rapid Rural Appraisal of some 200 barangays. A related survey of rural electrification impacts/benefits,[67] conducted by the Department of Economics of Ateneo de Manila University in collaboration with the World Bank and the DOE, should also provide useful information.

5.17 In the meantime, a limited real market commercial test of willingness and ability to pay for rural electricity is underway in Aklan Province. A rural energy services company (RESCO) is being established there by Shell Renewables (United Kingdom and Netherlands) in collaboration with Community Power Corporation (United States). Surveys showed that the current expenditures for energy services are consistent with the target of $8 to $10 per month (roughly 10 percent of typical monthly income) generally deemed necessary for a viable rural energy services business. Soon, the real-world marketing of energy services will test these surveys. It is recommended that this, and any similar small market "tests," be closely followed by the DOE due to the value of empirical evidence, however limited.

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[66] It should be noted that the DOE and the World Bank are already planning extensive rural energy survey and market characterization activities, as part of the process of preparing the proposed Rural Electrification Project. The results of these studies will be very useful, not only for the DOE and for preparing the proposed project, but also for private sector firms considering RESCO ventures.

[67] Department of Economics, Ateneo de Manila University (1998). *Benefit Assessment of Rural Electrification Project.* Household Activity Survey for the Philippines.

Establish a certification program for RESCOs and other rural service/equipment providers.

5.18 If the DOE is considering providing incentives, subsidies, or special rights to RESCOs, it should consider establishing a certification program to help ensure the safety and sustainability of the service provided. Since establishment of a RESCO venture may involve award of either special rights or government subsidies, and may either legally or in a de facto manner preclude other potential service providers in a given region, it is in the DOE's interest to ensure that aspiring RESCOs are capable of delivering promised services. Prerequisites to certification could include items such as adherence to distribution mini-grid safety standards, demonstrated expertise in rural and renewable energy, and certain minimal capital requirements. In addition, the DOE may wish to consider certification for vendors involved in procurement-oriented (i.e., publicly funded) projects, and a certification system for technician/installers.

Establish national standards or specifications for renewable energy equipment.

5.19 For large-scale use of NRE to be sustainable in off-grid areas of the country, the government must promulgate uniform and enforceable standards or other requirements for equipment design, installation, and performance. The DOE should expand its efforts in this area and make use of the work of international organizations already developing such standards for Europe, North America, and Japan.

5.20 Standards are needed for equipment manufacturing quality, field performance, systems installation, and maintainability. Although the Solar Energy Laboratory at the University of the Philippines, the Renewable Energy Association of the Philippines (REAP), and other stakeholders have worked to draft standards for renewable energy equipment, this effort appears to be stalled. Establishment of standards is often a complex process, in part because of potential legal issues. The DOE should work either to adapt emerging international standards to the needs of the Philippines and establish Philippine standards, or to adopt specifications for ERAP requiring adherence to selected international standards. For system installation, it is advisable to consider establishment of a certification program, both for firms and for individual installers, as well as establishment of training programs integrated into the certification and testing program.

Strengthen training and education in renewable energy technology.

5.21 The DOE should support the development of practical technical and engineering curricula in renewable energy for trade schools, colleges, and universities. The effectiveness and future role of the Associated Non-conventional Energy Centers (ANECs) should be reviewed, given the general recommendations for the DOE to support a more private sector-oriented approach to off-grid electrification. The proposed renewable energy center that would be established in Palawan under UNDP/GEF funding in partnership with the Provincial Government of Palawan and the Shell/CPC RESCO is an example of a new direction for practical capacity building in renewable energy options for off-grid communities. If there is to be rapid expansion in both public and private applications of renewables for off-grid communities, there will be an associated need for large numbers of technically skilled workers.

Recommendations Regarding Grid-Connected Renewable Energy Projects

- Establish an incentive program for grid-connected renewable energy generation.
- Support specific initiative for wind farm investment/industry development.

- Explore a possible limited "GENCO-Power Pool" model for NRE generation.
- Revise requirements for renewable energy project accreditation (Fast-Track Action #1).
- Revise or revoke EO 462 (Fast-Track Action #2).
- Exercise full DOE powers under the Mini-Hydro Law (Fast-Track Action # 3).
- Support incorporation of small hydro into GENCOs.
- Limit the DOE's NRE program to mature commercial technologies.
- Further characterize and document renewable energy resources, and collect and make available resource data.

Establish an incentive program for grid-connected renewable energy generation.

5.22 The principal recommendation regarding grid-connected NRE is that the DOE seriously consider establishing an incentive program in order to catalyze private investment and create initial markets in the medium term. As discussed earlier in this chapter, there are a number of different policy mechanisms that may be used to provide incentives for renewable energy generation in a restructured environment, including various production incentives, guaranteed power purchase arrangements at favorable costs, mandated set-asides for renewable energy generation, or special waivers for renewable energy (see Annex 3.4). In many cases, they will involve some type of incremental or marginal cost, either in terms of an explicit payment or subsidy to generators/investors, or an implicit cost due to extending favorable treatment such as long-term PPAs. The proposed NRE bill[68] incorporates a number of these mechanisms. The DOE is encouraged to examine a number of these alternative policies or and to select one or two it considers the most appropriate. A well-designed program would likely be able to obtain external grant support (from, for example, the GEF) to finance the "incremental costs" of its initial operation. Other carbon-related external resources could also be tapped for this purpose in the future such as from the Clean Development Mechanism (CDM) currently under discussion internationally.

Support specific initiative for wind farm investment/industry development.

5.23 It has become apparent, based on recently completed wind resource mapping, that significant potential exists for developing gigawatts of wind farm capacity in the Philippines. However, it will likely take close to a decade to get an active wind electric power development program underway and about 500 MWe of wind generation capacity in place. In general, when a country initiates wind farm development efforts,

- Several years of non-construction preparation are required to identify, characterize, and rank wind plant sites, and for detailed wind resource measurements (two years of detailed data are typically required);
- Developers, investors, and the government will all want a few years of experience with the first wind plants before expanding construction significantly; and

[68] The NRE bill referred to in this document is superseded by the recently passed bill discussed in Annex 1.1.

- There is a significant learning curve as local technicians and engineers are trained and gain experience in assembly, construction, and operation, and as increased local manufacturing of system components comes on line. (However, this time will be reduced significantly with the involvement of major international players in windfarm development in the Philippines).[69]

5.24 Thus, if wind electric power is to emerge as a significant, clean option for indigenous power generation in the coming decade, development must begin now or in the near future. The government of the Philippines, in concert with the private sector and the financial community, can stimulate commercial wind farm development through policy initiatives and financial incentives.

5.25 It is recommended that the DOE consider a specific initiative to provide incentives for privately developed wind farms, including seeking possible external support (e.g., GEF). The array of possible incentives is very large; no single initiative is likely to be sufficient to attract the scale of private investment needed if wind electric power is to become a significant source of electricity over the next 10 to 20 years.[70] Policy initiatives have stimulated ongoing commercial development of large wind electric power plants in Denmark, Germany, India, and the United States. Within the United States there have been many incentives at the state as well as the federal level. Recent reports from the U.S. Energy Information Administration (EIA) discuss incentives used in the United States and elsewhere (Guey-Lee 1998, U.S. EIA December 1998); these incentives are summarized in Annex 2.3. It is recommended that the DOE, in concert with other appropriate government agencies, carefully review, assess, and compare these incentives and their impacts, both negative and positive, in the countries where they have been implemented and determine the potential for adapting similar initiatives in the Philippines.

Explore a possible limited "GENCO-Power Pool" model for NRE generation.

5.26 In the reorganized electricity system, if the DOE does not develop an incentive program for renewable generation, the only standard offer will be the marginal energy price dictated by the pool. Take-or-pay PPAs will be allowed to lapse, and no new ones would be given out by the pool. The national *Energy Development Plan* outlines the probable form of the restructured electricity sector. The system is likely to assume some variant of the pool approach wherein generators are organized into generating companies, IPPs, and cogenerators selling undifferentiated electricity into a transmission system. Prices for electricity will be set throughout the day based on a least-cost dispatch model or a bidding system for each time period. Chapter 3 of this report includes a discussion of the potential for GENCOs formed by spin-off of NPC generation assets to incorporate renewable energy into their generation mix. This represents one recommended approach—albeit a less desirable one—in the event that a renewable energy generation incentive scheme is not possible. It also illustrates that, given certain advantages of NRE systems over GENCOs, it may be possible (using relatively modest incentives) to convince one or more GENCOs to invest in renewable energy generation.

5.27 If more-favorable investment incentives for grid-connected renewable energy generation are not available, it is recommended that the DOE encourage future GENCOs to

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69 Update note: As of 2001, wind farm development is beginning with a projected 40-MWe plant in Ilocos Norte.

70 Rackstraw (1999).

incorporate renewable energy into their generation mix. This will include ensuring that GENCOs are treated on the basis of their combined generation, for purposes of power pricing, rather than having each plant treated separately with respect to capacity factors, spinning reserve, firmness of power, etc. A GENCO might find investing in NRE generation economically attractive because, over the life of the investment, the lower operating costs of the NRE facility could offset the capital costs of both the NRE and the conventional plant firming up the NRE resource. While it is important neither to underestimate the obstacles to renewable energy generation posed by restructuring, nor to overestimate the GENCOs' ability (and incentive) to support renewable energy generation development, it is conceivable that in the restructured environment, one or more of the GENCOs may be agents for renewable energy generation. It should be stressed that this is not considered the most advisable approach, but merely an approach that may be feasible if a stronger NRE incentive program cannot be established.

Revise requirements for renewable energy project accreditation (Fast-Track Action #1).

5.28 The Philippines government has used incentives to attract investment in high-priority economic activities. These incentives, embodied in the Omnibus Investments Code of 1987, have been applied to conventional energy projects and can be applied to renewable energy projects. The incentives—including tax and duty exemptions, income tax holidays, and tax deductions—are substantial. To qualify for the incentives, private sector generating facilities (PSGFs) must receive accreditation from the DOE, according to EO 215 and the implementing rules and regulations in ER 1-95. Accreditation also benefits projects by making it easier for them to obtain financing from government financial institutions. Unfortunately, the accreditation process hampers renewable energy development in a number of areas. Recommended actions include the following:

- The DOE's EIAB should issue a statement clarifying that failure to show a five-year track record in power generation will not prevent an applicant from receiving approval of accreditation if the application meets the requirements in Section 3 pertaining to technical capability and financial soundness.
- The EIAB should revise the requirement for cogeneration projects to achieve a thermal efficiency of 60 percent. The revised requirement should be less absolute, with the goal of approving cogeneration projects that result in substantial improvements compared with current efficiency or conventional thermal generation.
- The DOE should modify ER 1-95 to remove the requirement for spinning reserves for small NRE plants. It should remove the requirement for a ten-year contract with NPC and submittal of plans to the DOE for utilities that purchase renewable generation. Removal of the requirement would be consistent with the Administration's goal of fostering a fully competitive market for wholesale electricity.

Revise or revoke EO 462 (Fast-Track Action #2).

5.29 EO 462, the Ocean-Solar-Wind (OSW) executive order of the previous administration (issued in December 1997), establishes a production-sharing requirement for certain renewable energy projects, similar to schemes used for fossil fuels. As it now stands, EO

462 is a major impediment to investments in renewable energy projects in the Philippines because it ignores the fact that NRE generation projects require relatively larger capital investments (compared with fossil-based generation projects of similar capacity) to be capable of tapping "free" renewable energy resources. Currently, the main technology affected appears to be wind generation. The government's claim of ownership of sunlight, wind, and other renewable energy *flows* is unusual and will discourage potential developers. *It is recommended that EO 462 be eliminated immediately or revised so as to remove the disincentives for private sector investment in renewable energy enterprises.*

5.30 In May 1999 the Secretary of Energy approved an internal proposal to revise EO 462, and a draft of the proposed new Executive Order was prepared by NREL at the DOE's request. The assumption has been that EO 462 would be amended rather than eliminated. The draft revision addresses some, though not all, of the major concerns of the renewable energy industry. NRE projects below 1 MWe of rated capacity would be exempt from the EO. For projects greater than 1 MWe, the draft EO proposes that production-sharing contracts will apply to projects meeting all the following criteria:

- Harnesses OSW resources in lands of the public domain and/or offshore waters within the Philippine territory, contiguous zone, and exclusive economic zone.
- Requires exclusive use of such lands and/or offshore waters.
- Has a net electric power output of more than 1 MW for sale to an electric utility.

5.31 The draft circular revising EO 462 has been submitted to the DOE legal department and to the EIAB for review. EIAB has indicated informally that it has no substantive objections. The full text appears as Annex 3.3 to this report. While the repeal or revocation of EO 462 would be preferable to revision, the proposed revision appears to be a positive step—provided that it can be assured that (1) projects on private lands will not be subject to production sharing, (2) the production sharing "tax" will be capped at 15 percent of net (not gross) revenues, and (3) wind farms not requiring exclusive use of lands will not be subject to production sharing.

5.32 Finally, the production-sharing concept could be employed in a more positive manner. For example, the government could support investment and site costs by, say, funding construction of transmission lines to a site where it wanted to encourage wind farm construction.

Exercise full DOE powers under the Mini-Hydro Law (Fast-Track Action # 3).

5.33 This recommendation was discussed briefly above. Republic Act No. 7156, the mini-hydro law, empowers the DOE to be the "exclusive authority to issue permits and licenses relative to mini-hydroelectric development." Until very recently, the DOE has not exercised this mandate and has deferred to other government agencies for various approvals. In a number of instances, new regulations are passed affecting the sector without due consultation with industry or consideration of project economics. A case in point is the recent several-fold increase in water-rights fees. The hydro projects are made to absorb such fees even though hydropower plants do not actually consume the water; rather, water is merely diverted and used to run the turbines and returned back to the river. Mini- and micro-hydro facilities are also subjected to the same rules as larger hydro facilities even if they are run-of-river types (i.e., without dams) and have a smaller environmental impact than larger hydro projects.

5.34 The DOE should work with all other relevant agencies to establish a new set of policies and standards specific to mini-hydro. The standards should consider size as well as economics of the projects to allow the sector to make its optimum contribution to the development of the country while considering all other concerns, such as the environment and water use. A technical working group (TWG) should be created to develop these new policies and standards. The TWG may organize a consultative workshop to bring together developers as well as regulatory agencies to begin the process. As soon as new policies and regulatory standards are set and approved, the DOE should decide to accept its mandate as the sole agency charged to carry out such polices, rules and regulations.

Support incorporation of small hydro into GENCOs.

5.35 For mini- and micro-hydro, the Bank suggests treatment of small hydro plants to allow them to make the greatest possible contributions in both value and volume. To this end, the following changes in the programs for small and mini-hydro are recommended:

- Permit bundling of different hydro projects into one or more larger projects or into a larger power generation company.
- Speed up the permitting process.
- Maintain confidentiality of proposals that are submitted.
- Permit mini- and micro-hydro plant owners to join power generation companies in the restructured system.
- Similar suggestions are valid for other intermittent renewable resources, including wind. In all cases, it is reasonable to permit the entry of such projects to the grid through a power generation company. Under the rules of the restructured market, absent specific DOE measures to the contrary, that is the only way to obtain higher value (i.e., peak period prices and capacity payments) from a non-firm generation resource.

Limit the DOE's NRE program to mature commercial technologies.

5.36 The DOE should focus its efforts on promoting mature, commercially proven NRE technologies. It should avoid funding projects involving certain emerging technologies (e.g., ocean energy in general) with significant long-term potential but no commercial "track record." At the most, the government's participation in international development efforts for emerging technologies should be limited to permitting the use of appropriate sites for field tests and pilot operation, observance at international technical conferences, and maintaining a "watching brief" on the progress of research and development for technologies especially promising to the Philippines.

Further characterize and document renewable energy resources, and collect and make available resource data.

5.37 The DOE is currently working with NREL, Winrock, and others to make available data on wind and solar energy resources; a new wind resource map for the Philippines will be made widely available on CD-ROM. The DOE should continue to characterize and document renewable energy resources (wind, solar, biomass, micro-hydro) make the data available. More specifically, the DOE should provide technical support to local government units (LGUs) to identify and characterize local wind resources that could be mobilized for community use. Wind resources that may be marginal for large-scale grid-connected wind farms may be well suited for small-scale wind electric and wind/hybrid applications.

5.38 The wind resource maps and other characteristics information are essential for identifying prospective areas for wind energy applications. However, very limited data of sufficient quality were available to validate the estimates. Therefore, it is strongly recommended that wind measurement programs be conducted in selected sites considered for future projects, to validate resource estimates and refine wind maps and assessment methods. With regard to the solar resource, the USAID-supported collaboration with NREL to develop insolation maps for the Philippines should be the basis for widely available insolation data to guide the design and inform the cost and performance estimates for solar energy systems, both freestanding and hybrid. Similar work in the area of micro-hydro resource assessment being done by NREL should give the DOE information valuable for estimating the role of micro-hydro within the ERAP program.

Annex 1.1: Status of Legislative and Policy Initiatives for Renewable Energy in the Philippines

As of June 8, 2001, the legislature had passed and President Gloria Macapagal-Arroyo had signed into law Republic Act No. 9136, *An Act Ordaining Reforms in The Electric Power Industry, Amending for the Purpose Certain Laws and for Other Purposes.*[71] This is known as the "Electric Power Industry Reforms Act of 2001." The act opens the power sector to significant restructuring and privatization. Among the goals of the act are "to assure socially and environmentally compatible energy sources and infrastructure, and to promote the utilization of indigenous and new and renewable energy resources in power generation in order to reduce dependence on imported energy." Many of the recommendations made in this report were subsequently incorporated or reflected in the act.

The new law provides for the opening up of unserved areas under franchise to third-party players when the existing franchise holder cannot provide the service. These areas are mainly off-grid areas where NRE technologies may be applicable. Section 59, "Alternative Electric Service for Isolated Villages," specifies that "the provision of electric service in remote and unviable villages that the franchised utility is unable to service for any reason shall be opened to other qualified third parties." The implementing rules and regulations for the new law will need about a year to be prepared. Meanwhile, the government has already implemented several important initiatives aimed at accelerating and broadening the application of renewable energy technologies for both grid-connected and off-grid applications.

Wind Electric Power Update

The wind electric power industry has continued to expand significantly since this report was initially completed. Some 3,800 megawatts (MW) of new utility-scale wind energy generating capacity were brought online worldwide during the year 2000, making total installed capacity about 17,300 MW at the end of the year—enough to generate about 37 billion kWh of electricity each year.[72]

Electricity from some of the new large wind electric projects has been contracted at less than US$0.03 per kWh—establishing wind energy as a low-cost power source in regions where wind energy resources are good. Additions to installed capacity in 2001 are expected to exceed 5,000 MW, with worldwide installed capacity growing to well past 20,000 MW by the end of the year 2001.

In addition to rapid growth in wind electric power plant installations, the cost of electricity from this source has been declining steadily. Also, the technology continues to evolve rapidly. Commercial wind turbines are now available in sizes ranging from 0.5 to 3.5 MWe, the higher sizes being employed in offshore wind farms in Europe.[73]

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71 This annex was prepared by Jerome Weingart, Alternative Energy Development, Inc. for the World Bank, under support from Winrock International and USAID.

72 American Wind Energy Association website (www.awea.org), June 2001.

73 *Renewable Energy World*, May/June 2001.

We should also note that, as a result of the completion of the high-resolution wind energy resource map of the Philippines, the development of the country's first commercial grid-connected wind power plant ("wind farm") is underway at Ilocos Norte province on northern Luzon. The plant will eventually have a capacity of 40 MWe, the first step in eventually realizing multi-thousand megawatts capacity in wind electric power in the country.

"Fast-track" Recommendations

The "fast-track" recommendations made to the DOE in the report were the following:

1. Revise/clarify accreditation guidelines under Energy Regulation (ER) 1-95 that affect New and Renewable Energy (NRE) projects.
2. Exercise full DOE powers under Republic Act (RA) 7156 (Mini-Hydro Law)
3. Use the Host Community Fund (HCF) for renewable energy development (ER 1-94)
4. Revise EO 462 (Private Sector Participation in Ocean, Solar and Wind Energy Projects) to eliminate or minimize the required "production cost sharing" for OSW projects.
5. Issue a new policy statement on NRE

The DOE has initiated policy reforms that are responsive to recommendations 1, 3, and 4. The Department of Energy has not yet responded to the mini-hydro law recommendations, and has not yet issued a comprehensive policy statement regarding renewable energy. Other relevant policy changes, such as those embodied in the Omnibus Bill, will affect future renewable energy initiatives by both the private and public sectors.

Revision of Energy Regulation ER 1-94

Recommendation: Use the Host Community Fund (HCF) for NRE Development. Communities that energy installations affect, "host communities," are entitled to benefits (because of the negative impacts of the installations), but the guidelines for planning compensatory projects do not include NRE projects as acceptable for proposal by communities. P-DOE should convene a task force charged with developing an approach that maximizes the ability of the HCF to contribute to rural electrification and economic development.

Government Action: On March 17, 2000 Secretary Tiaoqui announced the revision of ER 1-94. The amendment of ER I-94 has increased the amount of funds available to communities developing local energy supply projects. Under section 5(I) of the DOE Law, the P-DOE is mandated to provide direct benefits to these communities. ER 1-94 articulates guidelines for granting benefits to those host communities using the Host Community Fund, which is financed from a one-centavo per kilowatt-hour mandatory contribution made by power producers and energy resource developers. Under the revision, the allocation for rural electrification has been increased from 25 to 50 percent, with reforestation and watershed management remaining at 25 percent and livelihood generation reduced from 50 to 25 percent.

Revision of Energy Regulation ER 1-95

Recommendation: Revise renewable energy project accreditation requirements. The Government of the Philippines has used incentives to attract investment in priority economic activities. These incentives have been applied to conventional energy projects and can be applied to renewable energy projects. They include tax and duty exemptions, income tax holidays and tax deductions. To qualify for these incentives, Private Sector Generating Facilities (PSGFs) must receive accreditation from DOE. Unfortunately, the accreditation process hampers renewable energy development in a number of areas. These have been addressed by recent government actions.

Government Action: On March 17, 2000 Secretary Tiaoqui announced the substantial revision of ER 1-95. The amendment of ER I-95 has resulted in the following modifications:

1. Companies wishing to invest in New and renewable energy (NRE) power generation facilities do not need to show a 5-year company track record as long as the project is for self-generation purposes, or if the technology being proposed has already achieved commercial status and is adaptable to local conditions.
2. The requirement for continuous spinning reserve is now relaxed and subject to negotiation.
3. NRE facilities, including hybrid power systems combining NRE and fossil fuel systems, are exempted from the 60-percent minimum thermal efficiency standard.
4. Renewable Resource Power Production Facilities (RRPPFs) are now exempt from the ten-year power purchase requirement with NAPOCOR, and are only required to demonstrate potential net foreign exchange savings. Similarly, these facilities are exempt from the requirement for a DOE-approved power development plan. This change means that competition is allowed between generation from privately owned NRE facilities and generation from the National Power Corporation.

Revision of Executive Order 462 (Ocean, Solar, and Wind Energy)

Recommendation: Revise Executive Order 462. Executive Order (E.O.) 462 raised barriers to NRE and discouraged private investment, because it incorporates prior government policies governing the extraction of depletable energy *stock* resources and applies these policies inappropriately to the use of renewable energy *flows.* It was recommended that E.O. 462 should be revised to remove these barriers, and to offer new incentives for NRE development and use. Several of the members of the ESMAP team urged the DOE to eliminate EO 462, but this has not happened. The NREL/PEI fast track recommendations noted that:

> The production sharing system being applied in EO 462 has not worked well for geothermal energy development, which is a large and dispatchable resource. The only entity still developing geothermal, the PNOC-ERDC, has been granted royalty deferral. Production sharing requirements are even less likely to work for a more dispersed OSW.

Government Action: On April 23, 2000, President Estrada signed[74] into law Executive Order No. 232. This amends *EO 462, Series of 1997, Governing the Exploration, Development, Use, And Commercialization of Ocean, Solar, and Wind Energy Resources for Power Generation and Other Energy Uses.* As a result of the revision, ocean/solar/wind (OSW) projects below 1 MWe of rated capacity are considered to be private power projects and not subject to production sharing requirements. The required payment of 60 percent of net proceeds has been reduced to 15 percent, after full recovery of pre-commissioning costs incurred by the project developer and owner. EO 232 also provides for broad assistance to renewable energy project developers.

Other Recommendations (Off-Grid Applications)

The fast track recommendations mentioned above are part of a broader set of recommendations made for both off-grid and grid-connected renewables. The following are the recommendations for off-grid use of renewables, and relevant actions by the government.

1. **Maximize the role of the private sector in off-grid rural electrification:** Most of the NRE development in the Philippines has depended on government programs. It is recommended that the locus of investment be shifted, at least in part, to the private sector. *The DOE has strongly encouraged Shell International Renewables / Community Power Corporation to introduce rural energy services enterprises in unelectrified regions, starting with Barangay Alaminos in Aklan Province. The DOE facilitated an agreement that would permit a private company to offer AC and DC energy services to local communities on a fee- for- service basis, in cooperation with the local rural electric cooperative. The DOE regards the Shell initiative as a crucial test case and potential model for large-scale application of the RESCO model.*

2. **Select several different implementation models for off-grid rural electrification:** The DOE should consider promoting several different implementation models for rural electrification in RECs territories where the RECs are unable to provide service in the near to medium term. Where private firms are willing to invest and operate systems, on a fee-for-service basis, the DOE should facilitate this. For regions where market prospects are less favorable and where private investors are unwilling to enter, the DOE may choose to support project implementation by NGOs and community groups. For photovoltaics in particular, the GOP should adopt a strategy that will put installation and supply into the hands of private firms. *A UNDP/GEF project*[75] *is addressing this issue. Under the project preparation work being conducted by PEI for the DOE, alternative delivery mechanisms applicable for the off-grid sector are being identified. The Rural Power Sector Strategy Team, together with World Bank staff, are working with NEA to redefine the structure and role of franchises, to implement a new "off-grid regime." In this approach, the NEA will*

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[74] The text of EO 232, the text of the draft PDOR Department Circular elaborating on EO 232, and the NREL comments on the draft circular are contained in the separate Annex.

[75] UNDP/GEF project: Removal of Barriers to Commercialization of Renewable Energy.

provide operating permits/concessions to organizations other than the rural electric cooperatives.

3. **Ensure effective donor coordination:** The DOE should work to develop the overall framework for of-grid electrification projects; donor agencies, currently the primary funders of such technology projects in the Philippines, should be advised where and how their particular projects will best fit into the overall national program. *The DOE has been conducting coordination meetings among donor agencies. The World Bank project manager initiated this process. Two meetings were held in June and October 2000, and more are planned.*

4. **Promote and facilitate coinvestments for social and economic development in conjunction with rural electrification:** This support should include coordination with other government agencies responsible for these non-energy sectors. For example, the DOE should work with DILG to coordinate the Municipal Solar Infrastructure Project's present efforts with the DOE's more comprehensive plans for off-grid electrification. *This is a recommendation that is also being promoted in the Rural Power Sector Strategy. While the DOE and NEDA are discussing how to do this, no specific initiative has been taken as of November 2000. The focus remains largely on PV solar home systems for lighting and entertainment.*

5. **Establish DOE Policies on Subsidies and Targeting:** In designing an off-grid rural electrification program that can attract private investment, it will be necessary for the DOE to determine what level of subsidy it is willing to support, and how to channel this subsidy such that the benefits are focused on the poorest segment of the population. *NEA appears open to the restructuring of the REC franchises and on focusing on practical ways to implement off-grid solutions on a significant scale. NEA has requested technical assistance from the World Bank on this subject. This technical assistance should not only address the modification of the franchise system per se, but should include the design of a new off-grid rural electrification program that the DOE, through NEA, would implement.*

6. **Clarify the Role of the Rural Electric Cooperatives in Off-Grid Electrification:** In the proposed World Bank/GEF-supported rural electrification project, the DOE might wish to encourage such joint ventures. It is clear that the role of the RECs in off-grid electrification is a complex issue, and that treatment of this is complicated by broader power sector restructuring issues.

7. **Clarify Regulatory Issues for RESCOs and Other Private Sector Models:** In the proposed World Bank/GEF-supported rural electrification project, the DOE might wish to encourage such joint ventures. It is clear that the role of the RECs in off-grid electrification is a complex issue, and that treatment of this is complicated by broader power sector restructuring issues.

8. **Clarify the Role of the SPUG in Off Grid Electrification:** This is included in the Rural Power Sector Strategy, not only for only the SPUG but also for PNOC, local government units (LGUs), and others.

Annex 2.1: Commercial Status of Photovoltaic Power Generation

The direct solid-state conversion of light to DC electricity—the *photovoltaic effect*—is embodied in perhaps the most elegant power generation technology available. In the form of flat panels, PV arrays have no moving parts, a sunlight conversion efficiency in the range of 10–20 percent, and a potential lifetime of centuries. Invented as practical devices in 1955 by Bell Laboratories in the United States, silicon solar cells became the power source of choice for satellites and spacecraft. During the late 1960s spacecraft solar arrays cost a million dollars per kilowatt! Bringing the cost and the technology down to earth has been accomplished by a growing international industry in partnership with national research and development programs in many of the OECD countries.

PV Module Commercial Production and Wholesale Price Trends

The wholesale price for terrestrial solar panels has decreased from $90,000 per peak kilowatt[76] (in fixed 1997 dollars) in 1975 to about $4,000 per peak kilowatt today (see Figure 2.1.1). Between 1975 and 1986 the wholesale price declined exponentially at 28.5 percent per year. Between 1986 and 1998 the price declined by only one third, from $6 per watt to $4 per watt, reflecting an expanding market and a transition in the mid 1980s from demand-limited production pricing to supply-limited market demand pricing.

Annual shipments worldwide have grown from 2 megawatts peak (MWp) in 1975 to 135 MWp in 1998, with annual market growth in excess of 15 percent (see Figure 2.1.2). During just the last five years the quality, reliability (with 20-year warranties now standard), efficiency, and ease of interconnection have advanced to the point where the modern solar panel is the most reliable and simple power generation technology available. Single crystal module efficiencies are in excess of 15 percent and thin film modules are typically 10 percent. The prospect for further increases in efficiency is considerable, with prototype crystalline cells exhibiting efficiencies over 25 percent and thin film devices over 15 percent efficiency. Since the production cost per square meter is gradually decreasing, and is largely independent of device efficiency, significant efficiency increases will be reflected in substantial peak kilowatt cost reductions. (This may not affect wholesale *prices*, which are market-driven rather than technology-driven).

PV Market Applications

Because of the modularity of PV modules, with typical module ratings in the range of 30 to 300 Wp each, these have been widely used for providing small amounts of high-value electricity for remote telecommunications, cathodic protection of pipelines, roadside emergency telephones, and emergency lights. They also provide electricity for household, community, government, and economically productive activities in rural areas throughout the world. PV water pumping units are widely used in Sub-Saharan Africa, and in Asia, Latin America, and the Middle East, as well

[76] Solar panels are rated in terms of their peak wattage, defined as the output under standard sunlight and temperature conditions (30C and 1 kW/m2 of solar radiation with the spectrum of sunlight at the earth's surface with the sun directly overhead in a clear sky). This is referred to as the "Air Mass 1 spectrum".

as on farms in North America and New Zealand, and in remote villages in the Australian outback. Advanced charge controllers, reliable deep-cycle batteries, and proven end-use equipment from DC lighting to submersible DC water pumps have resulted in the supply of commercial PV-powered *packages* for a very wide menu of end use services, from water purification to on-demand AC power. The present markets for remote PV systems are those in which reliable electricity supply is justified or valued at a cost of more than $1.00 per kWh. Typically these applications involve high-value information rather than work in the thermodynamic sense. The principal PV markets are grid-connected applications (36 percent), industrial use (28 percent), rural households (27 percent), and small consumer applications for the balance.

Figure 2.1.1: Wholesale Price of Photovoltaic Panels (1997 fixed dollars per rated peak watt)

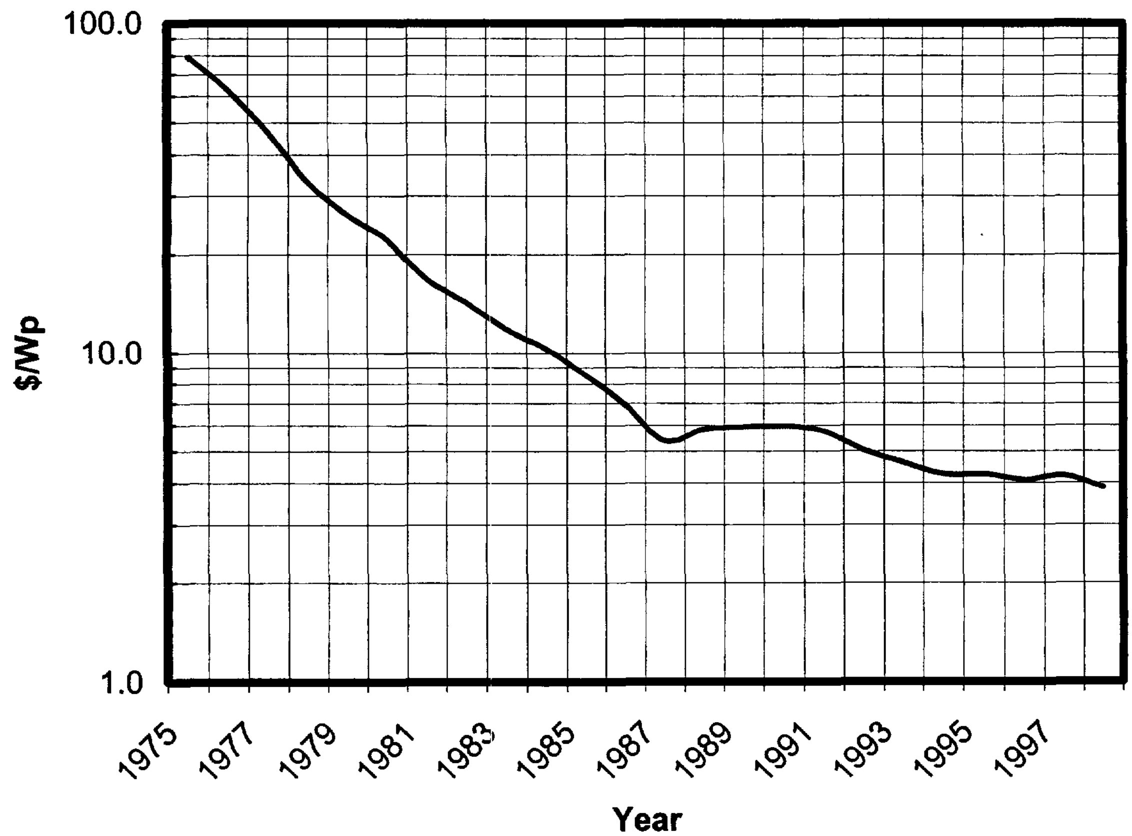
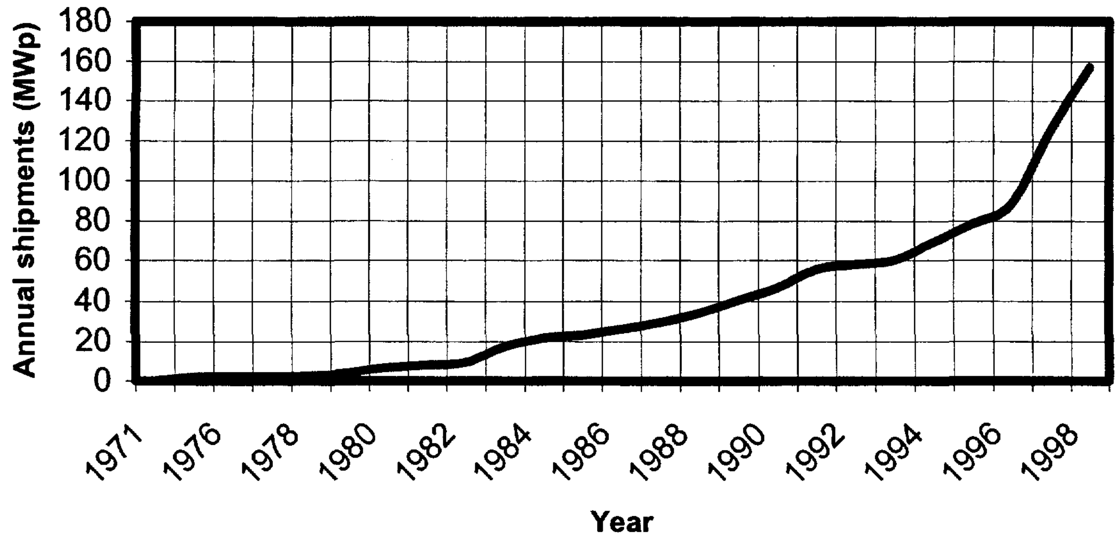


Figure 2.1.2: Worldwide Shipments of Photovoltaic Panels
(peak megawatts per year)



Recent Advances in Technology and Commerce

Advances over the past decade have greatly expanded the international marketplace for PV applications. These include advances in *systems* design and integration, and in the components that comprise the balance of systems. Sophisticated electronic controllers using powerful integrated circuit technology have made possible the design and reliable operation of PV systems for grid-interactive applications and in fossil fuel/PV hybrid power plants. The reliability and ruggedness of PV modules have advanced to the point where PV is the preferred option for small-scale power generation in physically challenging environments. PV modules offer high efficiency, physical and electronic resilience, high reliability (20+ year warranties), and technological advances including embedded inverters and rapid rugged interconnection. Single modules are available with ratings up to 300 Wp.

Today the Internet provides unprecedented and rapidly expanding access to hundreds of suppliers of quality PV equipment and packaged systems worldwide. The Internet and *e-commerce* are spreading rapidly throughout most of the developing world, at a rate and scale that was not considered possible just a few years ago. The Internet has already transformed our ability to learn[77] about, purchase, and use renewable energy products and services.

The manufacture of PV equipment is now the province of some of the world's largest companies including Kyocera, Siemens, Shell International, and BP Amoco (BP). Among them they dominate global PV production, with another dozen companies supplying the balance. Last year both Shell and BP announced their intention to invest roughly one-half billion dollars (US) in renewable energy applications for developing countries. Taken together, these developments constitute a transformation of PV technology and industry.

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77 The World Bank/ESMAP has sponsored a website with a user's guide for off-grid uses of renewable energy at www.eurorex.com/ugtoges. NREL has a Village Power website at www.nrel.gov, and hundreds of equipment suppliers have home pages on the World Wide Web. Many links to these sites are available at the NREL site.

Many of the services that PV can support (community water supply and purification, rural telecommunications, public lighting, basic power needs for health clinics, schools, government offices, community centers, etc.) are for public goods that are typically cofinanced by government and local communities. Just as community water supplies are increasingly operated by private companies through competitive bids, with financing by local government units (LGUs) using funds provided in part by the national government, a public/private partnership to provide electricity services for community needs can also be implemented on this model.

Building-Integrated PV Applications

For building-integrated applications the current costs for PV systems are in the range of $5 to $7 per Wp. In both cases (buildings and grid support), roughly 50 percent of this installed cost (price) is embedded in the cost of the PV modules, and the remainder is in the balance-of-system (BOS) costs. The BOS components include the physical structures, wiring and interconnects, and power electronics and control systems. There is general agreement, based on experience and analysis, that grid-tied PV systems will be economically attractive when the entire system installed price is at or below $3/Wp. That would correspond to a manufacturing cost of roughly $1.00 to $1.50 per Wp. U.S. experience and analysis suggest that the point for economic viability is only a factor of two or three away, not an order of magnitude, and that attention has to be focused on *both* the PV technology and the BOS components.

Table 2.1.1: Building-Integrated Photovoltaics Worldwide (Aggregate Peak MW between 1990 and 1997)

Year	*Off-Grid*	*Grid-Connected*
1990	9	1
1993	13	2
1996	23	7
1997	28	27

Cost-competitiveness Still a Constraint

A cautionary point was made in a recent U.S. Energy Information Administration report:

> PV prices and the delivered cost of PV energy have declined substantially in recent years. Major progress has been made in all areas of module performance, reliability, and cost. Competitiveness with conventional forms of generation has been constrained, however, by declines in the price of natural gas, the surplus of coal-fired energy, deregulation of generation, and other market factors. In most cases, PV systems are not currently economical for grid-interactive applications. Utilities are willing to invest money to develop a technical understanding of the technology and systems, and to respond to customer requests for "green" forms of energy. Given present uncertain market conditions, however, utilities are not willing to expend major investment funds to commercialize an uncompetitive technology at a utility plant scale.
>
> At current PV prices and levels of cost-competitiveness, public-private partnerships are the key to technology development. Partnerships such as UPVG and PV-USA combine the technical, economic, and regulatory expertise of many parties in ways that would not be financially feasible for the private sector alone. To a certain degree, the government role in these partnerships reflects

> the notion of societal benefits (reduced air emissions, reduced oil imports, etc.) that cannot be properly valued by electric utilities and nonutility generators. In the long term, photovoltaics must become more competitive in their own right—either through lower costs or through explicit recognition of the external costs of conventional energy supplies.

Development of these market applications in the Philippines would accelerate in-country use of and expertise with PV systems, in turn supporting the availability and use of PV systems for more decentralized rural development applications for local productive uses (especially for agriculture and fishing), community needs (water supply, health and educational services, etc.), and household uses.

Annex 2.2: Wind Electric Power Installations Worldwide

Note: Considerable consolidation and reorganization has occurred in the wind electric power industry in the past two years (mid-1999 to mid-2001); the following represents the situation only as of mid-1999. See www.jxj.com for information on current suppliers of wind electric turbines and other renewable energy products.

During the first half of 1999 installed grid-connected wind electric generation capacity worldwide reached 10,000 MWe. By the end of 2002 this is expected[78] to grow to over 20,000 MWe, with 3,000 MWe in Asia alone (primarily India and China).

Table 2.2.1: World Wind Energy Capacity by Region

Region	*Cumulative capacity beginning 1998 (MWe)*	*Cumulative capacity beginning 1999 (MWe)*	*Expected capacity end of 2002 (MWe)*
European Union	4,739	6,379	12,450
United States	1,584	1,819	2,900
Asia*	1,116	1,158	3,050
Rest of the world	309	449	1,900
TOTAL	7,784	9,805	20,300

* 1998 and 1999 data are for China and India; 2002 data for all of Asia.

Table 2.2.2: Wind Energy Capacity by Country

Country	*Cumulative capacity Beginning 1998 (MWe)*	*Cumulative capacity beginning 1999 (MWe)*	*Growth during 1998 (%)*
Germany	2,080	2,873	38.1
United States	1,584	1,819	14.8
Denmark	1,116	1,380	23.7
India	950	968	1.9
Spain	512	907	77.1
Netherlands	325	359	10.5
United Kingdom	320	330	3.1
China	166	190	14.5
Italy	100	154	54
Sweden	117	148	26.5
Total	9,268	11,127	

[78] European renewable energy institutions, as quoted in *Renewable ENERGY World*, May 1999, p. 135.

"Medium-sized" wind turbines with rated capacities around 600 kWe are now a mature technology, with units as large as 1.5 MWe currently being installed. One-third of all installed wind capacity worldwide is with turbines in the range of 500–700 kWe. The wholesale price per kWe of wind turbines in the range of 300 kWe to 1.5 MWe is roughly $700–1,000.

The cost of the electricity produced by a wind plant depends on the capital and operating costs of the plant, the plant financing structure, and the annual average wind speed (which determines the net annual energy output). A preliminary estimate for a 50 MWe wind plant in Ilocos Norte is $1,000/kWe (see Chapter 4).

Under good wind conditions, modern wind energy systems typically achieve annual average capacity factors of 25 to 35 percent and sometimes even more, in regions of 6 m/s to 8 m/s annual average wind speed. Capital costs continue to decline, reliability and energy conversion efficiency have increased, and unscheduled and preventive maintenance requirements have decreased. *Today the levelized cost of electricity from wind energy systems financed under fully commercial terms and conditions is in the range of 3 to 6 US cents per kWh.*

Figure 2.2.1: Global Wind Energy Power Generation Capacity

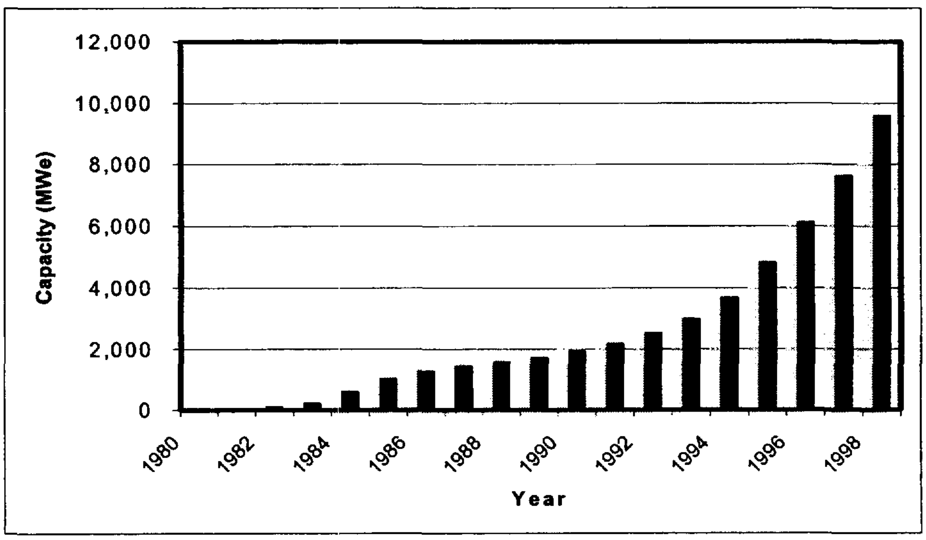


Figure 2.2.2: Annual Wind Electric Capacity Additions Worldwide

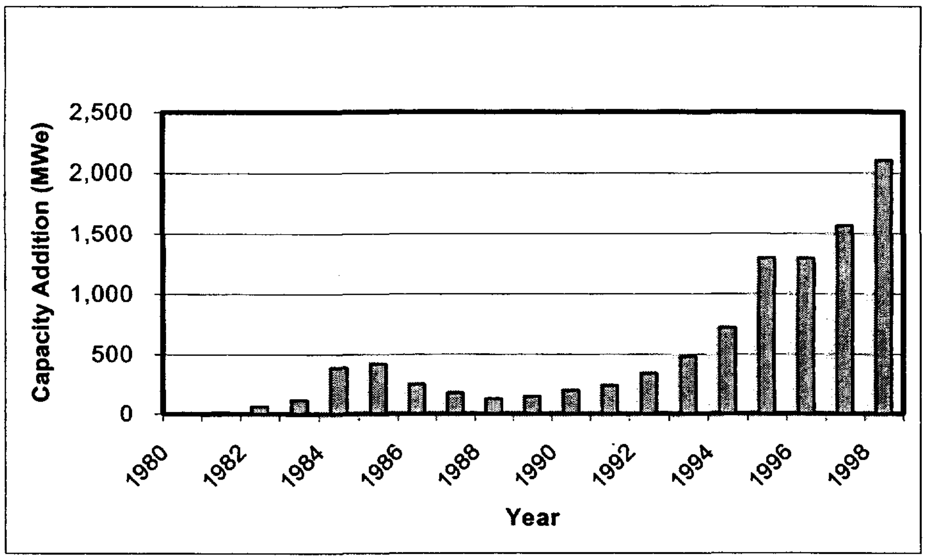


Table 2.2.3: Major Wind Turbine Suppliers and their Principal Products

Company Name	*Location*	*Market Share (%)*
Vestas	Denmark	20.6
Enron/Zond	United States	11.1
Micon	Denmark	8.4
Enercon	Germany	8.0
Bonus	Denmark	7.3
Nordtank	Denmark	7.2
Tacke	Germany	4.5
Nepc	India	4.1
Mitsubishi	Japan	3.2
Wind world	Denmark	2.9
Nedwind	Netherlands	2.4
Wind Master	Netherlands	2.2
Nordex Balcke-dürr	Denmark	2.1
Others		16
Total		100

Annex 2.3: Incentives for Wind Electric Power in the United States

Investment Tax Credits. Only a few states retain these credits. These include Hawaii, Massachusetts, Montana, North Carolina, Oregon, and Utah.

Production Tax Credits. This type of credit provides the investor or owner of qualifying property with an annual tax credit based on the amount of electricity generated by that facility. By focusing on production, improved project performance is encouraged. Section 1914 of the Energy Policy Act of 1992 (EPACT) created a 10-year, 1.5 cents per kilowatt-hour credit adjusted for inflation for new plants entering service before June 30, 1999. It has been estimated that this production tax credit can lower life-cycle levelized costs of wind power by about 25 percent. Much of new and planned capacity depends on this credit, which will expire on June 30, 1999, unless proposed legislation passes to extend the tax credit by five years.

Property Tax Reductions. Reductions in property taxes can be used to promote wind development by decreasing the tax burden associated with owning a wind power facility. The tax burden is relatively high compared to that for the use of fossil energy because of the greater land requirements per kWh of output. This policy is an effective incentive in several states. In Minnesota, where property taxes are high, property tax exemptions could reduce levelized costs by 1.0 cent per kWh in some cases. The disadvantage of this mechanism is that it produces an incentive for development, not a market *per se*.

Accelerated Depreciation. Tax depreciation is a non-cash expense meant to approximate the loss of asset value over time. It defined as the portion of an investment that can be deducted from taxable income in any given year. The federal Tax Reform Act of 1986, which established the modified accelerated cost recovery system (MACRS), set the current rules for federal tax depreciation. Under MACRS, wind property is currently provided a depreciation life of 5 years, substantially shorter than the 15 to 20 year depreciation lives of non-renewable power supply investments. Accelerated depreciation results in tax benefits early in a project's life, and is preferred by investors because an after-tax dollar is worth more today than in later years.

Direct Production Incentives. Although similar to a production tax credit, direct production incentives provide cash income directly. At the Federal level, Section 1212 of Energy Policy Act of 1992 (EPACT) provides a "Renewable Energy Production Incentive" (REPI) of 1.5 cents per kWh to nonprofit organizations that own wind facilities.

Direct Investment Incentives (Grants). These include programs like the Department of Energy's Turbine Verification Program in which cost sharing with utilities permits early development of wind systems preceding full-scale deployment of turbines. It also includes State funds used for seed grants to conduct resource assessments and feasibility studies.

Government-Subsidized Loans. Utility-scale wind system debt interest rates typically are 1 to 2 percent higher than rates for gas-fired projects. Subsidized loans can be provided at below market interest rates, thus reducing loan payments and levelized costs. Although there is no federally subsidized loan program, several States including Minnesota have established them.

This type of program promotes wind energy, but the effect by itself is insufficient to make wind electric power competitive.

"Long-term Avoided Cost Standard Offer Contracts" for Small and Distributed Projects. During the 1980s, long-term standard offer contracts (the so-called "Standard Offer 4 Contracts") that guaranteed energy and capacity payments 10 years into the future (and saved on transaction costs) were pivotal in the development of the wind electric and solar thermal electric industries. These contracts were developed to support the implementation of PURPA, and the most significant impact of these was in California, where over 1,000 MWe of wind generation capacity and over 400 MWe of solar thermal electric power generation capacity was developed commercially in the 1980s. The guaranteed prices were based on each utility's "full avoided cost" of marginal generation assuming continuously escalating energy prices (which did not materialize). As these contracts have been renewed, the new prices have been much lower and threaten the viability of operating wind plants.

Net Metering or Net Billing. Under this system, utility customers are guaranteed a market for their power by being permitted to operate a "reversible meter." When customers use more electricity than they generate, they pay for the additional electricity at retail prices as usual. Conversely, when customers generate more electricity than they use, the electric utility is obliged to purchase the additional electricity. The prices customers receive for their excess electricity varies widely by State and region and between wholesale and retail levels. So far, experience for wind and net metering is limited. Although California has a provision for net metering, it excludes wind as a source. Other States limit the size of eligible projects, so larger wind projects (greater than 50 or 100 kW) cannot participate.

Site Prospecting, Review and Permitting. Programs in California and at the Federal level have been developed to conduct site resource assessments, evaluate transmission issues, conduct bird population studies, settle zoning issues, and streamline permitting processes. This helped to promote the early development of wind energy projects in California. The U.S. Department of Energy Utility Wind Resource Assessment Program performed a similar function in later years.

Renewable Portfolio Standard (RPS). The terms of renewable portfolio standards vary among States, but an RPS generally requires every retail power supplier to provide a certain minimum percentage (or floor) of electricity from specified renewable sources for a given time period. A RPS can operate in tandem with a credit trading system, so suppliers sell credits for extra renewable power they generated or vice versa. If they are short of renewable power they can purchase credits to make up the difference to settle their account. Legislation establishing some sort of renewable portfolio standard has passed in a number of states including Arizona, Maine, Massachusetts, and Nevada.

Renewable Energy Setasides. In California, a recent ruling provides for a 0.7-percent surcharge on electric bills to support renewables during the four-year transition to a competitive market. Wind energy is earmarked to receive $70 million of an estimated $540 million total budgeted. Already, some 300 megawatts of new wind energy projects have won the opportunity to receive California Energy Commission financial incentive funds.

Auctioned Contracts. Increasingly, electric utilities have acquired renewable energy competitively by issuing requests for proposals (RFPs), which generator owners can bid on. In effect, the bidder guarantees to provide a given amount of electricity under specified terms for a given price. To date, most of these RFPs were issued as renewable only or technology specific only.

Green Marketing/Pricing. These are voluntary programs in which customers agree to pay a premium to purchase "environmentally friendly" or "green" electricity. This encourages development of a market for renewable power, wind included. So far, public response has been limited. It is estimated that only 1 to 4 percent of residential consumers will participate in the near future in California's green pricing program. Although there is some difficulty in determining what the premium should be, utilities like Sacramento Municipal Utility District and Traverse City Light and Power have begun to use green pricing to stimulate renewables development. In Sacramento, customers pay an additional $4 per month special premium to have a photovoltaic system installed and operating on their rooftop.

State Mandates. These provisions differ for each State. In Minnesota, the State legislature has required Northern States Power to phase in construction of 425 megawatts of new wind capacity by 2002 as compensation for being allowed to store nuclear waste on site. In Iowa, the Alternative Energy Law (AEL) requires investor-owned utilities to purchase a combined total of 105 megawatts of their generation from renewable and small hydropower sources. The majority of needed capacity will be from wind power and biomass applications.

Annex 2.4: A Possible Scenario for Wind Power Development in the Philippines

A "medium" scenario is presented for the possible development of commercial wind electric power plants ("wind farms") over the period 2000 through 2008. It is assumed that during this period the government (the DOE and others such as PNOC) will have conducted site identification activities, including detailed wind energy measurements with anemometers, to facilitate both private and possibly public sector investments in wind farm developments. The annual increments are shown in Figure 2.4.1 and the associated cumulative installed capacity in Figure 2.4.2. Table 2.4.1 describes how the commercial application of modern wind turbine technology might reasonably proceed in the Philippines, assuming that this is technically, economically, and financially justified, and that the necessary policies and practices (e.g. power purchase contracts) are in place. These issues are discussed in some detail below.

In this scenario 480 MWe of wind farm generation capacity are in place by the end of year 2008, representing roughly one-half billion dollars of investment. Assuming a 25 percent capacity factor on average, the annual electricity production would be 1,050 GWh, less than 2 percent of projected Luzon electricity demand in the year 2008. In the ten-year period from 1996 through 2005, installed wind generation capacity in Denmark is projected to increase by 1,300 MWe, from 839 MWe to 2,135 MWe. During that same period Spain is expected to add 2,200 MWe of wind electric capacity to the 1996 capacity of 249 MWe. In that perspective, installation of 480 MWe of wind electric capacity in 8+ years in the Philippines is a plausible scenario.

To illustrate the plausibility of the assumptions, the annual wind electric capacity additions for the period 1989 through 1998 are shown in Figure 2.4.3 and Table 2.4.2 for China, India, and several European countries. The scenario for wind electric capacity addition in the Philippines is also shown for a 10-year period one decade later (1999–2008). The wind electric capacity that will be installed in the Philippines will be through international joint ventures involving companies that have developed wind farms in Europe, the United States, and Asia. It is reasonable to assume that the deployment rates (MWe/year) in the Philippines could be comparable to those in other countries.

In the subsequent 10–15 years after year 2008 it seems reasonable to assume the further addition of 2–3 GWe of wind electric power in the Philippines, if there are technical and economic justifications for this. The wind resources are certainly sufficient to permit this scale of deployment. The challenge for the government, industry, and financial community is to establish incentives and a policy environment sufficient to attract the required investments.

Figure 2.4.1: Scenario for Grid-Connected Wind Electric Power (Annual Installations)

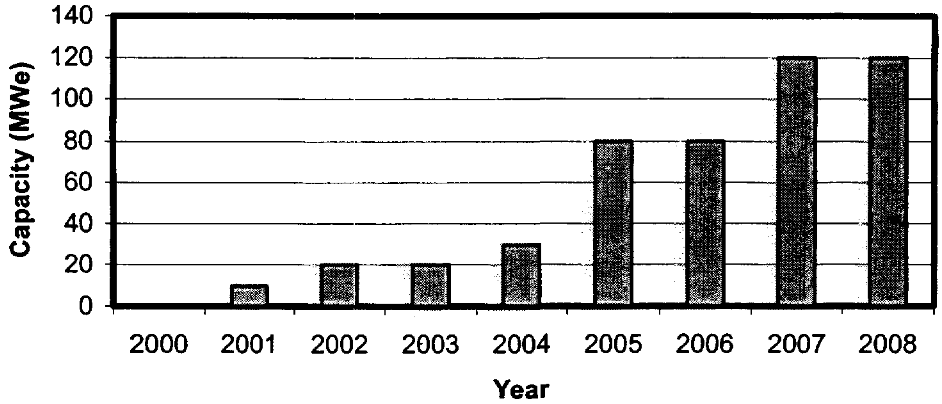


Figure 2.4.2: Total Grid-Connected Wind Generation (Scenario)

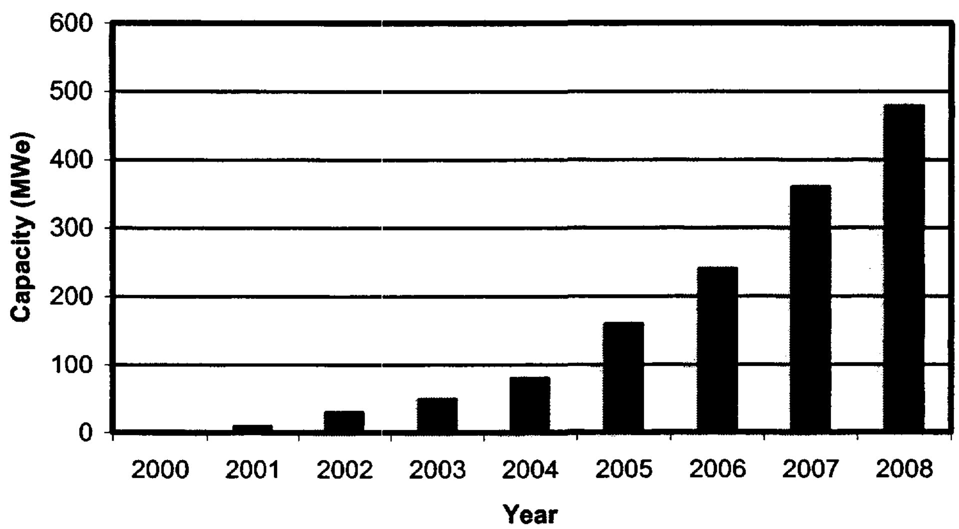


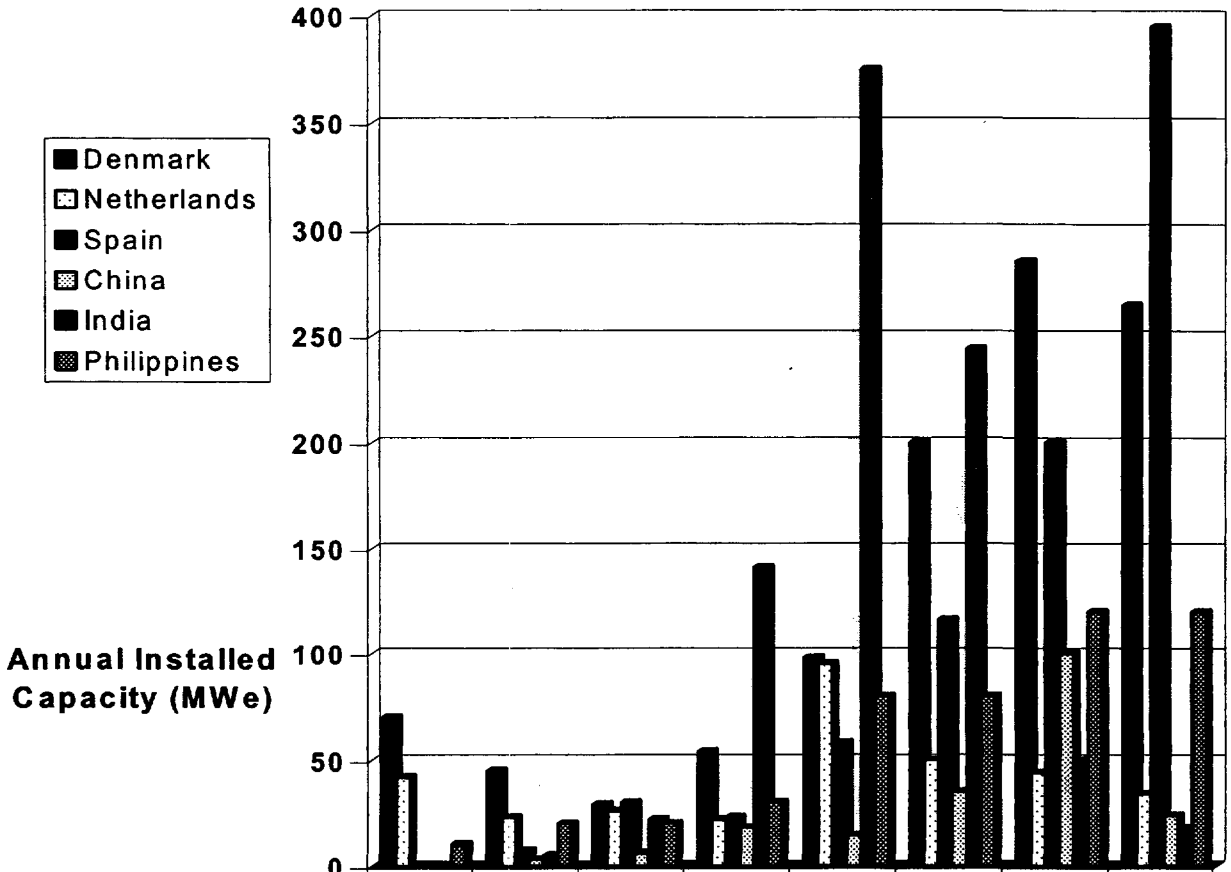
Table 2.4.1: An Illustrative Scenario for Wind Power Plant Development in the Philippines (1999–2020) with ca. $120 million in Near-Term Investments (through 2005)

Year	*Activity*	*New Wind Capacity (GWe)*	*Total Wind Capacity (GWe)*
1999	Completion of Wind Resource Atlas of the Philippines, preliminary identification of potential sites for wind farms	0	0
2000	Site identification, characterization, and ranking for development. Initiation of detailed anemometer measurements. Preparation for pilot 10 MWe commercial plant (public/private venture?)	0	0
2001	Ongoing wind resource measurement at the best sites; commissioning of the first 10 MWe plant; development of two 20 MWe wind farms	10	10
2002	First 20 MWe wind farm built and commissioned	20	30
2003	Second 20 MWe plant commissioned; additional wind power projects under development	20	50
2004	Commercial wind plants come on line	30	80
2005	Major international investment and development of wind farms, 40 MWe plants come on line	80	160
2006	Continuing and expanding commercial investments	80	240
2007	Continuing and expanding commercial investments	120	360
2008	Continuing and expanding commercial investments	120	480
2009–2020	*Expanded investment activities*	*>2,000*	*>2,500*

Table 2.4.2: Comparison of Historical Wind Electric Power Installations in Asia and Europe with the Scenario Projections for the Philippines

Year	*Germany*	*Denmark*	*Netherlands*	*Spain*	*China*	*India*	*Year*	*Philippines*
1988	10	81		0		12	1998	0
1989	14	65		0		20	1999	0
1990	40	80	15	8		3	2000	0
1991	50	70	42	2		0	2001	10
1992	65	45	23	7	3	5	2002	20
1993	150	29	26	30	6	22	2003	20
1994	307	54	22	23	18	141	2004	30
1995	500	98	95	58	14	375	2005	80
1996	420	200	50	116	35	244	2006	80
1997	533	285	44	200	100	50	2007	120
1998	797	264	34	395	24	18	2008	120
Total	**2,886**	**1,271**	**351**	**839**	**200**	**890**	**Total**	**480**

Figure 2.4.3: Comparison of Historical Wind Electric Power Installations in Asia and Europe with the Scenario Projections for the Philippines



	3	4	5	6	7	8	9	10
Denmark	70	45	29	54	98	200	285	264
Netherlands	42	23	26	22	95	50	44	34
Spain		7	30	23	58	116	200	395
China		3	6	18	14	35	100	24
India	0	5	22	141	375	244	50	18
Philippines	10	20	20	30	80	80	120	120

Year

Annex 3.1: Board of Investments (BOI) Incentives for Independent Power Generation

The Philippines Board of Investment (BOI) has been the primary institution providing fiscal and non-fiscal incentives to local industries. It has provided incentives for all large-scale independent power producers (IPPs) under the program of the National Power Corporation. These incentives are available to renewable energy firms provided they are BOI registered companies and fall within the category of qualified projects. Because these incentives are accorded to firms that are undertaking power generation projects (power plants), energization projects using PV solar home systems and freestanding renewable energy systems are excluded.

Fiscal Incentives

Tax Exemptions

- Duty of three percent on imported capital equipment and its accompanying spare parts.
- Imported capital equipment of BOI registered firms shall be subject to a duty of three percent, unless duty exempt under RA No. 7369. Many types of power and energy equipment are covered under this law. The same shall be subject to a ten percent VAT as provided under Republic Act No. 7716 (Expanded VAT Law).
- Enterprises locating in Metro Manila shall not be eligible for this incentive, unless exempted from the location restriction.
- To be eligible for the incentive, an enterprise must meet the guidelines on the granting of said incentive.

Income-Tax Holiday (ITH)

BOI-registered enterprises shall be exempt from the payment of income taxes as calculated from the scheduled start of commercial operations as follows:

- New projects with a pioneer status for six (6) years
- New projects with a non-pioneer status for four (4) years
- Expansion projects for three (3) years
- New or expansion projects in less developed areas for six (6) years, regardless of status

Firms may avail themselves of a bonus year in each of the following cases:

- The indigenous raw materials used in the manufacture of the registered product must at least be 50 percent of the total cost of raw materials for the preceding years prior to the extension unless the Board prescribes a higher percentage; or

- The ratio of the total imported and domestic capital equipment to the number of workers for the project does not exceed US$10,000 to one (1) worker; or
- The net foreign exchange savings or earnings amount to at least USS 500,000 annually during the first three (3) years of operation.

In no case shall the registered pioneer firm avail of this incentive for a period exceeding eight (8) years.

Exemption from Taxes and Duties on Imported Spare Parts

A registered enterprise with a bonded manufacturing warehouse shall be exempt from customs duties and national internal revenue taxes on its importation of required supplies/spare pans for consigned equipment or those imported with incentives.

Exemption from Wharfage Dues and Export Tax, Duty, Impost and Fees

All enterprises registered will be given a ten (10)-year period from date of registration to avail itself of tile exemption from wharfage dues and any export tax, impost and fees on its non-traditional export products.

Tax Credits

- **Tax credit on domestic capital equipment and/or spare parts.** Tax credit shall be granted on locally fabricated capital equipment. This shall be equivalent to the difference between the prevailing tariff rate and three percent duty imposed on the imported counterpart. If equipment is duty-exempt under R.A. 7369, the tax credit shall be equivalent to 100 percent of the impassable duty.
- **Tax credit on raw materials and supplies.** A tax credit equivalent to the national internal revenue taxes and duties paid on raw materials, supplies and semi-manufactured products used in the manufacture of export products and forming part thereof shall be granted to a registered enterprise.
- **Additional Deductions from Taxable Income.**
- **Additional deduction for labor expense (ADLE).** For the first five (5) years from registration, a registered enterprise shall be allowed an additional deduction from taxable income equivalent to 50 percent of the wages of additional skilled and unskilled workers in the direct labor force. This incentive shall be granted only if the enterprise meets a prescribed capital to labor ratio. This additional deduction shall be doubled if the activity is located in a Less Developed Area (LDA).
- **Additional deduction for necessary and major infrastructure works.** Registered enterprises locating in LDAS or in areas deficient in infrastructure, public utilities and other facilities may deduct from taxable income an amount equivalent to the expenses incurred in the development of necessary and major infrastructure works. This privilege, however, is not granted to mining and forestry related projects, as they would naturally locate in certain areas to be near their sources of raw materials.

Non-Fiscal Incentives

- **Employment of foreign nationals.** A registered enterprise may be allowed to employ foreign nationals in supervisory, technical or advisory positions for five (5) years from date of registration. The position of president, general manager and treasurer of foreign-owned registered enterprises or their equivalent shall however not be subject to some limitations.
- **Simplification of customs procedures** for the importation of equipment, spare parts, raw materials and supplies and exports of processed products.
- **Importation of consigned equipment** for an unlimited period, subject to posting of a re-export bond.
- **The privilege to operate a bonded manufacturing/trading warehouse** subject to Customs rules and regulations.

Annex 3.2: Mini-Hydropower Incentives

Mini-hydropower projects have the advantage of having its fiscal incentives specifically defined by law, Republic Act 7156 ("RA 7156," or the "mini-hydro law"). These incentives are as follows:

- **Special privilege tax of 2 percent of gross receipts.** While purporting to be an incentive to mini-hydro project developers, this is actually a benefit to host communities and a burden for developers. Unlike other special taxes, it does not replace any existing tax nor does it protect mini-hydro projects from additional tax burdens that may be imposed by local governments under the Local Government Code. However, since obtaining local community and government approvals is an essential element in the project development cycle, the presence of clear rules should simplify the negotiation process.
- **Tax and duty-free importation of machinery, equipment and materials for seven years from the date of award of the Operating Contract by the Philippine DOE.** This incentive extends to communication and control equipment directly needed by the project. The Philippine DOE is the only approving authority. It is responsible for issuing the necessary documents for Customs authorities.
- **Tax credit on domestic capital equipment.** This tax credit is equivalent to 100 percent of the value of the value-added tax and customs duties that would have been paid had these items been imported. The DOE undertakes the calculation of the tax credit and is the sole approving authority.
- **Special realty tax rate of two-and-a-half percent on equipment and machinery.** The Philippine Realty Property Tax Code adds the value of land improvements, including mini-hydro equipment, to the value of the land, thus, increasing the tax base. The prescribed rate of 2.5 percent is lower than what might have been imposed under the Code.
- **VAT exemption on gross receipts from the sale of electric power.** This incentive applies whether the power is wheeled through the NPC or through existing electric utility lines.
- **Income tax holiday** for **seven years from the start of commercial operation.** This seven-year income tax holiday is longer than similar tax holidays granted by the Board of Investments (BOI).

Despite these incentives, mini-hydro development has been extremely slow. Only two Operating Contracts have been issued in the last eight years. In the 1997 Annual Mini-Hydro Seminar-Workshop (September 4–6, 1997), several project development barriers were identified. The principal proposed solution is for the Philippine DOE to provide a one-stop shop that brings together all relevant government agencies under one roof. Such one-stop shops are already in place within the BOI and in the Philippine Economic Zone Authority (PEZA).

Review of the mini-hydro law shows that R.A. 7156, through Sections 5 and 6, specifically empowers the Philippine DOE to be "...the sole and exclusive authority responsible for the regulation, promotion and administration of mini-hydroelectric power development..." and that it will have "...exclusive authority to issue permits and licenses relative to mini-hydroelectric power development..." However, the Philippine DOE has not taken advantage of this mandate because it believes that since the law requires the agency to *consult* with the National Water Resources Board and other government approving agencies, this means that the DOE has to follow such rules and procedures now being administered by these agencies with respect to other projects. Thus, mini-hydro development projects are still required to follow the stiff rules and circuitous procedures set by other government agencies, regardless of capacity and type of design. However, the mini-hydro law's declaration of objectives specifically provides for a framework "...to facilitate hydroelectric power development *by eliminating overlapping jurisdiction of the many government agencies...*" which allows the DOE to act in behalf of other agencies, provided due consultations have been properly carried out.

Annex 3.3: Proposed Revision to Executive Order 462

MALACAÑANG

MANILA

BY THE PRESIDENT OF THE PHILIPPINES

EXECUTIVE ORDER NO._________

AMENDING CERTAIN PROVISIONS OF EXECUTIVE ORDER NO. 462 ENCOURAGING GREATER ROLE OF PRIVATE SECTOR INVESTMENT AND PARTICIPATION IN IMPLEMENTING NEW AND RENEWABLE ENERGY ACTIVITIES AND PROJECTS

WHEREAS, Executive Order No. 462 enables the private sector to participate in the exploration, development, utilization and commercialization of ocean, solar and wind (OSW) energy resources for power generation and other energy uses;

WHEREAS, it is in the national interest to accelerate the development and utilization of OSW energy resources by encouraging greater role of private sector investment and participation in implementing NRE activities and projects;

WHEREAS, in line with the government Thrust in poverty alleviation especially in remote rural areas, prioritize the use of New and Renewable Energy resources in electrifying off-grid barangays;

WHEREAS, considering the important role of the private sector, market-driven approach should be adopted in the development and utilization of New and Renewable Energy resources;

WHEREAS, hybrid systems (i.e., NRE and Conventional or both NRE) should be pursued for power generation with special consideration to the technical and economic aspects of the project."

NOW, THEREFORE, I, JOSEPH EJERCITO ESTRADA, President of the Republic of the Philippines, by virtue of the powers vested in me by law, do hereby order:

SECTION 1. Exploration, Development and Utilization of OSW Energy Resources. The DOE shall encourage private sector initiative and participation in the assessment, field verification, harnessing, development and utilization of OSW energy resources. As a means to provide concrete assistance to OSW project developers and subject to existing rights, the government through the DOE shall engage in the assessment, field verification, harnessing, development and utilization of OSW energy resources through the participation of the private sector under production sharing contracts awarded by the Secretary of the DOE, after due consultation with the host communities and local government units concerned. The production sharing contractor must meet DOE standards for technical and financial capability.

SECTION 2. Scope of Production-sharing Contracts. Production sharing contracts as herein authorized shall be applied to projects meeting all of the following criteria:

(a) Harnesses OSW resources in lands of the public domain and/or offshore waters within the Philippine territory, contiguous zone and exclusive economic zone.

(b) Requires exclusive use of such lands and/or offshore waters.

(c) Has a net electric power output of more than 1 MW for sale to an electric utility.

Projects that do not meet all of the above criteria shall be treated as Private OSW Projects and shall be subject to Section 3.

SECTION 3. OSW Energy Projects in the Private Domain. Developers of OSW projects in the private domain shall be called "Private OSW Developers". Energy generation with net output of more than 1 MW in private lands as well as privately-held offshore areas shall be monitored by the DOE. Such projects shall be required to submit regular reports on operations following a format to be determined by the DOE. Generation projects of 1 MW or less shall be required to submit annual reports on operations to their local government units.

SECTION 4. Government Share. Considering the prospectivity of generating profit from the operation of the contract, a government share (GS) shall be determined through bidding or negotiation between the DOE and the contractor. The GS shall include a signature bonus and production bonus. The signature bonus shall be given to the DOE at the date of signing of the Pre-Negotiated Commercial Contract upon the issuance of a "Letter of Confirmation" of the commercial feasibility of the project by the Secretary of the DOE. The government shall waive the signature bonus on the first project to reduce the pre-operating cost burden on the OSW production sharing contractor. The production bonus shall be paid to the DOE at the end of each calendar year during the commercial phase of the project. The production bonus shall be applied only after the project has fully recovered its capital, operating and maintenance costs. To protect the welfare of electricity consumers, the GS shall be limited to values that shall not result in electricity prices higher than the contracted selling rates to electric utility in the area where the project is located. The production bonus shall not exceed 15 percent of net proceeds where net proceeds is equal to the sum of gross sales less capital, operating and maintenance costs. Capital costs shall include all pre-operating expenditures.

SECTION 5. Incentives for Production Sharing Contractor. The production sharing contractor shall be given the following incentives:

- The DOE shall assist the contractor in obtaining all applicable fiscal and non-fiscal incentives, including registration as pioneer industry under the Board of Investments.
- To encourage the development of more OSW resources in other sites, the DOE may allow the contractor to charge the cost of assessments, field verification and feasibility studies of such other sites to its current commercial projects.
- The DOE shall assist the contractor in securing access to lands and/or offshore areas where OSW energy resources shall be harnessed.

SECTION 5a. Incentives for Private OSW Developers. The DOE shall assist the developer in obtaining all applicable fiscal and non-fiscal incentives, including registration as pioneer industry under the Board of Investments.

SECTION 5b. DOE Assistance in Providing an Appropriate Valuation of Intermittent Electrical Energy Generation from OSW Resources. The DOE shall undertake a regular study that will provide the basis for the proper valuation of intermittent electrical energy generation from OSW resources and reflect future developments. The DOE shall take note of the vast differences in scale and application of OSW energy resources.

SECTION 6. Effectivity. This Executive Order shall take effect fifteen (15) days after its publication in at least two (2) newspapers of general circulation.

DONE in the City of Manila, this ______th day of ________________ in the year of Our Lord, Nineteen Hundred and Ninety-Nine.

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Annex 3.4: Policies that Have Been Used to Create Initial Markets for Large-Scale Grid-Connected Renewables

Non-Fossil Fuel Obligation (NFFO)

Until 1990 it was probably fair to characterize the United Kingdom's policy towards renewable energy as being both ambiguous and primarily research-led (Grubb 1995).[79] British researchers were among the leaders of the world in several RETs despite the fact that the installed capacity in the United Kingdom remained low. Under the 1983 Electricity Act, electricity boards were required to buy electricity including renewable sources, from independent generators. However, the price that was actually paid for renewables was on average 30 percent less than other sources of energy (AIEP 1992).

The situation changed dramatically in 1990 as a direct consequence of the fall-out from privatization of the U.K. electricity supply industry. Thus, the U.K. policy for renewables arose as a consequence of privatization and the need to subsidize nuclear power. When the electricity supply industry was privatized in 1989, the nuclear power stations remained in public ownership, as they were not an attractive investment for private shareholders. The government made a provision for nuclear power through the Non-Fossil Fuel Obligation (NFFO) of the Electricity Act of 1989, to ensure that all of the available nuclear electricity generated would actually be purchased.

The NFFO is a guaranteed market enablement mechanism that functions by making a premium payment for the supply of electricity from non-fossil energy sources including nuclear and renewable generation in England and Wales. The NFFO introduced an obligation on the regional electricity companies (RegECs) of England and Wales to purchase a certain percentage of their electricity from non-fossil fuel sources, including renewables.[80,81] In 1993, the United Kingdom's Minister of Energy stated the government's policy on renewables and the objective of the NFFO Orders was to "create an initial market so that in the not too distant future the most promising renewables can compete without financial support." To achieve this goal, a steady convergence between the price paid for renewables under successive NFFO Orders and the market price was needed. It was realized this would only come about if there were competition in the allocation of RETs under the NFFO contracts (Mitchell 1996).

The Electricity Act of 1989 enables the Secretary of State to make NFFO Orders requiring each of the twelve public utility suppliers in England and Wales (the RegECs) to secure the availability of a certain amount of electricity from non-fossil sources. The main administrative duties are run by the following government agencies:

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79 This annex is excerpted from Shepard (1998). Appendixes and tables have been omitted.

80 Similar market-enablement mechanisms exist in Scotland (the Scottish Renewables Obligation or SRO) and Northern Ireland (the NI-NFFO).

81 The target amount was originally set such that the renewables NFFO would support 600 MW of electricity but was later increased to 1500 MW (BWEA 1998).

- The Secretary of State is responsible for making the Orders
- Department of Trade and Industry (DTI) handles the legislative side and sets the policy
- The Public Electricity Suppliers (PESs), which are the RegECs in England and Wales, are responsible for making arrangements to comply with an Order.
- Non-Fossil Purchasing Agency (NFPA) is a subsidiary of the RegECs. The RegECs are responsible for making the arrangements to comply with the order but must contract collectively through the NFPA. The NFPA manages the fossil fuel levy, administers the competition and lets the contracts
- Office of Electricity Regulation (OFFER) ensures the competition is conducted fairly and that the contracts meet the requirements of the Order.
- ETSU advise DTI from a technical standpoint and manage all the data/information arising from the competition.

The government decides what size order it wishes to make, along with which technologies it wishes to encourage (known as technology bands) based on their judgment as to the most effective way of pursuing market enablement. When setting the NFFO Order, DTI makes broad assumptions regarding the completion characteristics, profile, past performance and market knowledge. For example, if during the last round of NFFO there was a 40 percent fall out rate between contract and completion, when calculating the band size for the next order they may predict that fall out will be greater because of increasing planning constraints, or lower because of learning effects, or simply constant (Staunton 1998). In NFFO-3, for example, contracts were let for 626 MW declared net capacity (DNC),[82] although only 300–400 MW DNC are ever expected to be commissioned. The details of the actual commissioning profiles are extracted during the negotiations between NFPA and the generator. Specific technologies may be excluded from the Obligations as they approach competitiveness in the open market and do not require financial support.[83]

The RegECs invite renewable energy generators to submit details of their proposed NFFO projects to compete in a tender process. This competitive bidding element is what has enabled the NFFO to be so effective in reducing the prices for RETs (see section below). Once the bids are submitted they must pass the "will-secure" test. This is a test carried out by OFFER to assess the technical, economic, commercial, and legal aspects of the project, allowing OFFER to determine a project's ability to contribute to (or secure) the capacity required by the Order. This is an important element of the NFFO process, as failure to comply with the Order is classed as a criminal offense on the part of the RegECs.

To continue on, a project must have competitive price terms compared to the other projects in the same technology band. If so, the project will be awarded a contract to generate at its contracted

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82 *Declared net capacity* (dnc) is broadly defined as the equivalent capacity of base load plant that would produce the same average energy output.

83 An example of this is sewage gas projects which were included in earlier NFFOs, but were excluded from later NFFO rounds as their respective costs diminished to more competitive levels.

capacity for a period of up to 15 years,[84] receiving its bid price for each kWh generated.[85] Any generation in excess of the agreed capacity will have to be sold outside the NFFO agreements. Once a project has obtained a NFFO contract it must make the necessary arrangements, such as obtaining planning permission, licensing and financing to enable it to be commissioned within a 5-year time frame. Obtaining a NFFO contract is therefore no guarantee of a project ever actually being commissioned.

Calculating the rate at which the resource is exploited (i.e., knowing when real commissioning dates will be) is one of the most complex aspects, and is also the one with difficult access to the needed information. What the actual profile will be is essentially based on expert judgment. But, as indicated earlier, it has to be maintained within the annual financial cap (see below). Thus, once again the problem becomes one of interpreting historic performance and combining this with current market knowledge (Staunton 1998).

The additional costs incurred by the RegECs under these contracts, when compared with the cost of fossil power generation, are financed through the fossil fuel levy (FFL). The FFL is paid by the supply licensees (based on aggregate amount charged for fossil-sourced electricity supplied) but is ultimately funded by the final consumers of the electricity. Thus, the ratepayers pay for the extra cost of the NFFO program, but the effect on price has been minimal. The real price of electricity has increased 0.1 to 0.5 percent since 1990 or about $5.50 for a typical household per year (BWEA 1998). The fossil fuel levy was originally established to fund both renewables and nuclear, and until 1998 the vast majority of the levy funds went to nuclear (see Table 1).[86] But as of March 31, 1998 the levy no longer supports nuclear, the entire amount is now dedicated to renewables.

The levy is set on an annual basis, and is currently set at 2.2 percent of the price of electricity (it was originally set at 11 percent) (see Appendix I). A maximum annual cap (of £150M) has been set for renewables under the NFFO (Staunton 1998). Within this amount estimates are made by all parties as to should be the actual payments. However, OFFER has the final say and recommends the levy level, and NFPA collects and distributes it. If the amount paid out differs from the income then this is recovered in the next levy, or for over-payments netted off.[87]

As of April 1997, about £411M had been generated from the fossil fuel levy for renewable energy. Thus far, about 542 MW DNC[88] of renewable energy has been commissioned and is on

[84] This period and originally been set at only 8 years, but was changed to 15 years by NFFO-3.

[85] Initially, in NFFO-2 this was the 'strike price' rather than the bid price, which meant that the suppliers were paid the bid price for the most expensive contracted project in each technology band. This meant that some suppliers were receiving too high of payments to encourage cost minimization (and eventual price reductions) and some suppliers would intentionally under bid knowing that they would be receiving the 'strike price.'

[86] Up until recently only a small amount of the levy was used to support renewables. In 1995–96, for example, the FFL raised £1.105 billion, 91 percent of this (£1.005 billion) went to nuclear power and 9 percent (£0.099 billion) went to support all renewables (Mitchell 1995a).

[87] This mechanism has not really been seriously tested yet, since as until recently the vast majority (more than 95 percent for most of the early 90s) of the levy income went to the nuclear generators and hence renewables funds were only a small part of the equation and any variations were managed relatively easily (Staunton 1998).

[88] See note number 7.

line.[89] By simple calculations, this means that the NFFO scheme has resulted in a cost of approximately £758 (US$1244) per kW installed capacity.[90] This amount is consistent with other countries when looking at cost per unit of renewable energy installed. But the most interesting result of the NFFO has been its effect on the price of renewables (see below for more details).

NFPA pays the renewable energy generators *ex-poste*—which has to be the case as it is only when output is known that the payments can be made. Both NFPA and OFFER have the right to monitor the supply in order to ensure that contract terms are being adhered to, but in practice it seems that they do not currently exercise this option (Staunton 1998).

Determining the price differential between RETs and conventional energy sources is not an easy task. In the United Kingdom, the price of electricity is entirely set by "market forces" and is reflected in two sets of figures—one public and one not. The public figure is the pool price, which is the price at which a competitive bidding process clears at half hourly intervals during the day. The price it clears at is the system's marginal price, and it averages approximately 2.5 p/kWh (but varies widely over the course of a day as well as with season).[91] However, roughly 90 percent of electricity supplied is not traded via the pool, but instead comes from direct contracts with generators. The price (and conditions) for these contracts is not general knowledge. Therefore, it is difficult, if not impossible, to say what contract prices are like exactly. This is especially true as more merchant plants enter the system. However, for the purposes of determining the price of conventional energy sources, simple arithmetic based on the published accounts for National Power (the largest generator in the United Kingdom) is used. This document records electricity output and income from sales. Simply dividing one by the other can give some indication of the average price for electricity sold. This sum tends to give an electricity price of around 3.5 p/kWh, but the breakdown between cost of electricity from the different plants and fuel cycles cannot be determined.[92]

The government justified the renewables NFFO on the basis of two main principals. First, a "market-pull" support mechanism such as the NFFO was appropriate policy for supporting near-market technologies in the market place. The long-term objective is to help renewable technologies become economic so they can compete without support. Second, new renewable electricity generators would increase the number of independent power producers (IPPs) in the electricity supply industry, an aim of the utility privatization process. In addition, the encouragement of the non-GHG emitting technologies composes a large part of the United Kingdom's campaign against climate change and of its efforts to combat GHG emissions as mandated under the Kyoto Protocol.

89 But this amount is expected to sharply increase over the next few years as NFFO-3 and -4 schemes begin to come on line.

90 This calculation is a result of dividing the amount of funds generated thus far by the fossil fuel levy for renewable energy (£420M) by the amount of renewable energy on line 542 MW dnc and using 1997 exchange rate of $1.64: £1.

91 It is likely that the operation of the pool will be reformed following a review currently being carried out by the UK Government (Staunton 1998).

92 Thus, it is the case that the debate in the UK as to how for RETs have progressed, and still have to go, to achieve price convergence is a complex and dynamic one.

Benefits of the NFFO

Though the NFFO was originally established to subsidize the nuclear power industry during the transition to electricity privatization, it has turned out to be a great boost for renewables (Table 2 and Figure 3).[93] The NFFO demonstrated the ability of a government policy to institute a "market enablement" strategy for developing renewable energy sources. The government stated that the NFFO would help them 'to move towards' 3 percent (1500 MW) of the nation's electricity from renewable sources (DTI 1997). Between 1990–95 there was over 108 percent increase in the amount of installed wind capacity alone in the United Kingdom from NFFO (IEA 1997a). The NFFO enablement mechanism helped long-term capital investments in new technologies to become economically feasible (Mitchell 1995a).

The price of electricity from renewables has fallen dramatically, particularly for wind.[94] The average bid price for wind energy projects (regardless of size) fell by 31 percent between the third and fourth tranches, representing a larger drop in price than any other technology (BWEA 1998) The fall in prices are closely approaching the price of conventional energy (3.5 p/kWh) (Figure 2). These price reductions have made it possible for some RETs to be competitive with conventional fuel sources without the aid of the FFL. In fact, a contract outside the realm of NFFO was recently signed in the United Kingdom for a landfill gas project (ETSU 1998a).

The decline in price paid under NFFO contracts has occurred for several reasons. First, longer duration contracts allow the initial investment to pay off over a longer period of time—crucial for RETs since they tend to have high up-front capital costs. Second, there have been significant technology improvements resulting in decreased costs for renewable energy, especially wind turbines. Third, the cost of financing has declined as both investors and developers have gained experience with renewable projects. Fourth, competition within the technology bands of the NFFO Orders has resulted in slimmer profit margins required by developers further aiding in the price reduction.

Criticisms of the NFFO

The short duration of the first two Orders resulted in a higher price because developers had to cover all the capital costs before 1998, rather than spreading them over the lifetime of the project.[95] Therefore, the premium price paid was very high, giving renewable sources a reputation for high cost. Moreover, projects had to be developed as quickly as possible, resulting in some ill-considered projects (Brower and others 1997). As a result of these lessons, the procedures of the third tranche were altered so that contracts were set for 15 years, with an additional 5-year transition period before the contract lapsed.

The 'tranche system,' bringing projects together in clusters so that they can compete on price, resulted in flurries of activity interspersed with long periods of relative inactivity. The

93 There is no evidence to suggest that a renewable energy would have had such an injection of support without this link, particularly given the minimal level of support for renewables prior to privatization (Mitchell 1995a).

94 The fall in price can be deceiving as much of the decline from NFFO-1 to NFFO-3 can be attributed to contracts being extended to 15 years and for the switch from strike price to bid price. However, the fall in price between NFFO-3 and NFFO-4 is a result of a fall in the economic costs of renewable generation since the basis of the contracts is the same.

95 This shorter contract duration was due to European Union policy requirement on the first two NFFO Orders.

administrative costs were quite high because of the relatively complex nature of the NFFO scheme, and resulted in yet another task for the overburdened OFFER, whose primary task was economic regulation of the privatized electricity industry. The 'peaks' of work for the RegECs and OFFER created managerial problems and caused 'bottlenecking' of the contracts through the system (Mitchell 1995b). This caused problems for local authorities and for project developers, especially in the wind industry. For the wind industry, the stop-start nature meant it was problematic to support project development through periods of inactivity (BWEA 1998). For the RET developers the peaks and troughs for the renewable energy markets placed a strain on their cash flow. Developers are uncertain whether they will actually get a contract in the current tranche or even the next tranche, therefore they are unsure whether to spend development capital. The call for tenders results in stop-start schemes that do not allow for continuous market development and the time lags in between tranches can also be damaging. A constant, predictable market would foster lower costs since renewable energy industries would have to go through cycles of layoffs and rehiring, losing human resources and institutional memory along the way (Rader and Norgaard 1997). But the objective of the NFFO is on driving down the price of RETs and is not as oriented to assisting the domestic renewable energy manufacturer.

Since the RegECs are responsible for the NFFO contracts, a strange situation developed between the individual RegECs and their subsidiary, unregulated generating companies. As a result, accusations came from other generating companies that those with a close relationship to the RegEC gained an unfair advantage (Mitchell 1995a).

Obtaining finance has proved to be difficult for some NFFO projects, although less so with the larger scale projects (above £10 million). Small-scale projects like those developed in Denmark and Germany have occurred in the United Kingdom only if they have access to private or corporate finance.[96]

Some specific problems with the NFFO have come up, including high transaction costs. This has mainly been a result of the application process, which is costly, bureaucratic, and time consuming. Even though there are separate technology bands within the Renewables Orders, small RET projects are often excluded, either directly by allowing only large projects to take part in the tendering process, or indirectly due to the lengthy and expensive application procedures (e.g. wind farm capacities). In fact, due to this realization early on in the NFFO Orders, the band for wind was split in half to separate large and small-scale wind development projects (DTI 1997).

Another problem with NFFO has been that even when a project received a power purchase contract it often could not be implemented due to planning restrictions or local opposition. This is due to a characteristic of the U.K. government structure. In the United Kingdom, local government authorities, not the centralized government, make the planning decisions. Therefore, U.K. developers don't know if they will receive planning clearance until after they submit a bid for a project. If the developer disclosed the project plan at the same time as the bid, it would become public information—and its competitors could then use it to underbid the developer. If planning decision were centralized, there would be less risk for developers because the decision would rest with the same authority that accepted the bid. In the case of wind power, local opposition was often caused by limited involvement of the local population, or by limited profits

[96] There are a couple of exceptions to this where finance was obtained from a large generator (Mitchell and McKerron 1994).

for the local communities. Smaller schemes generally have greater acceptance and foster local involvement more than larger ones, but they cannot compete with the larger schemes on simply a the lowest bid-price basis. This was another reason that the wind band was split in half, so that large-scale projects would not compete with smaller ones.

Another problem with NFFO is that the established upper limits of funding for renewable energy does not allow for full exploitation of the technically and economically feasible potential of renewable energy sources in a country. This has been made evident by the heavy oversubscription of the national Orders in the United Kingdom. As to whether this is a major drawback or not depends on the objective of the renewable energy policy. The NFFO, as mentioned earlier, was a means to achieve price convergence for near-commercial RETs compared with conventional fuel sources, not as a means to necessarily increase installed capacity.

Lessons from the NFFO

The NFFO, as the first of these renewable energy policies, offered a couple of important lessons regarding necessary support mechanisms for RETs. First, a large pool of renewable energy developers exists if the institutional barriers are unlocked. Second, it is necessary to recognize the characteristics of the particular technology used and the framework structures in order to establish a support mechanism that manages to bridge any mismatched characteristics of the technology such as intermittent generation (Mitchell 1995a).

One of the most important lessons from the United Kingdom's NFFO is the flexibility of the legislation that has allowed for the procedural changes; these changes, in turn, have resulted in the gradual development of a successful system. For example, during NFFO-1 contracts were selected according to cost-justification principles. But this was altered from NFFO-2 onwards to competitive bidding within technology bands as the basis of awarding contracts. In addition, it became immediately apparent during NFFO-1 and -2 that the contract timeline needed to be extended farther than the 6–8 years originally set. This is important because of the high capital costs of most RETs, which tend to have lower variable costs. In the case of the NFFO, once the policy was expanded to 15 years, more developers became interested. It was essential that the potential developers felt confident that they would receive payment for a set number of years, decreasing the perceived risk involved in developing this type of industry. Also, the longer timeline makes the upfront capital costs of RETs less prohibitive for private sector participants. Only long-term projects will be attractive enough to draw a serious amount of private venture finance into the sector, without which there can be no major expansion of any applied RET (Schmidheiny and Zorraquin 1996).

Another key innovation and lesson for the NFFO was in establishing differentiated technology bands for funding separate categories of RETs. The concept of price convergence and competition within technology bands is more likely to encourage economic efficiency with the ultimate aim of renewable energy projects that are competitive against conventional energy technologies. The bands also allow the government to choose which renewable technologies to support rather than spreading resources thinly over all RETs. But with these separate bands there must be numerous IPPs within each band. Otherwise, the technology band could conceivably suffer from a lack of private sector participants, thus eliminating the price benefit derived from competition.

A last lesson learned from the earlier NFFO Orders was the abandonment of the 'strike price'. In NFFO-2, each technology band had a 'strike price' which was the last price accepted into that technology band and used to pay each developer within the technology band. The use of the strike price was expected to increase the rate at which price convergence happened, but in practice it was reported to slow it down. Many thought this was due to the bidders trying to guess the probable strike price and then bid this themselves instead of trying to comfortably beat it (Staunton 1998).

Since 1986, the main factor working against both renewables and nuclear in the United Kingdom has been cheap natural gas. If gas prices continue to remain low, it will be difficult for the government to maintain effective market support for renewables beyond NFFO-5 (Mitchell 1996). This increased usage of natural gas has helped the government achieve its objective of reduced GHG emissions, so the interest in increasing the installed capacity of RETs has declined. In the United Kingdom, it will be interesting to see what happens after NFFO-5 (which is the last of the NFFO Orders, due to take place in November 1998). This year is also of interest because 1998 marks the year in which NFFO-1 and -2 expire. It is questionable whether the government will continue to devote resources to RETs or whether it will let competition decide the fate of the RETs in the United Kingdom. If the government determines that the environmental benefits from increased RET use are great enough then it may decide to devote more resources to the support programs.

One key thing to remember when referring to the NFFO in comparison to other similar renewable energy policies is that it is the only renewable energy policy that the United Kingdom currently has in operation. All of the other countries' renewable energy policies discussed in this paper (RPS, SBC, and EFL) have other supportive policies (such as tax incentives, etc.) that aid in their respective success. Therefore, it is difficult to compare across countries and policies because the other countries have more than one policy in effect. Cross-country comparisons are also difficult because each nation is endowed differently in the amount of renewable energy available (e.g. wind power, solar exposure, etc.).

Surcharge-Funded Production Incentive (SBC)

Another more recent renewable energy policy, implemented in a couple of U.S. states, is the surcharge-funded production incentive also known as the "system benefits charges" (SBC). The SBC is patterned similarly to the NFFO. The SBC uses an electric service distribution surcharge as a way to collect funds from electric customers to support various policies with public benefits, including renewable energy programs. Distribution surcharges have generally been proposed as a volumetric fee, such as a charge per kilowatt-hour, but could also be applied on a fixed-fee basis. The charges are intended to be non-bypassable and competitively neutral.

Once the funds are collected there are a variety of ways they can be distributed including customer payments, production incentives to generators, grants, and financing assistance. For the renewable energy projects, the funds could be distributed as a per-kilowatt-hour production incentive awarded only to actual renewable energy generation from renewable projects. But in order to be effective, it is essential that legislators and regulators ensure funding throughout the payment period for the investors so that the risks are minimized (Kirshner and others 1997).

The level of per-kilowatt-hour incentive should be determined in a periodic auction. Winners would be those new renewables priced closest to competitive market prices—that is, those that bid the smallest incremental per-kilowatt-hour amount. An up-front auction would award incentives at a fixed kilowatt-hour level for a specified period—for example, 1.5 cents per kilowatt-hour for ten years. The total amount of incentives would be limited to the amount of surcharge funds available.

Funds could be allocated to renewable projects over several years in periodic auctions—during the transition to competition until a fixed amount of funds have been awarded. A periodic sunset review should be undertaken as the costs of renewable energies become more price-competitive. In practice, renewable energy developers could either propose contracts that would be contingent upon the results of one of the periodic auctions, or they might first secure an incentive allocation and then work to execute contracts. For example, if a renewable producer has costs of 6.0 cents per kilowatt-hour and needs to compete with gas-fired generation producers with costs of 4.0 cents per kilowatt-hour, then the renewable producer would apply to the credit fund for a production incentive of 2.0 cents per kilowatt-hour. If another developer had costs of only 5.0 cents per kilowatt-hour, that producer could bid 1.0 cent in the auction. Funds would be awarded to the lowest bidders until the available funds were exhausted (Wiser and others 1996). Thus the production incentive is simply an increment that helps renewables compete in the market.

California

The California Assembly Bill 1890 (AB 1890), enacted on September 23, 1996, provides a legislative foundation for the development of a competitive market for electricity based on a market-driven electricity industry in California. To achieve this the bill created an Independent System Operator (ISO) to manage California's electricity transmission network and a Power Exchange (PX) to establish a spot market for electricity access.

The Legislature established a surcharge to fund the California Energy Commission and its programs. The surcharge is two-tenths of one mil (or $0.0002) per kilowatt/hour (kWh) of electricity consumed (CEC 1997). The surcharge is collected by the electric utility companies and turned over to the state treasury. All electrical customers—residential, commercial, industrial and even government agencies—pay this surcharge. For a home that uses 600 kWh of electricity per month, the surcharge amounts to 12 cents per month or $1.44 for a year. The surcharge is anticipated to generate $540 million over four years (CEC 1997). Of these funds, the allocation varies across the following sectors (or broad tiers) rather than specific technology allocations:

- Existing RETs will initially account for 45 percent of the $540 million allocated to broad tiers. The first tier is allocated 25 percent ($135 million) for biomass and solar thermal, second tier is allocated 13 percent ($70.2 million) for wind, and the third tier is allocated 7 percent ($37.8 million) for geothermal, small hydro, digester gas, MSW and landfill gas.
- New and emerging technologies account for 40 percent of the $540 million. The 'new' technologies are allocated 30 percent and the emerging technologies 10 percent The new technologies are not banded together into specific technology allocations, rather, they are subject to a competitive bidding mechanism
- Of the remaining funding, 14 percent is allocated to developing a consumer-driver renewables market by reimbursing consumers who purchase renewable energy

from either existing, new, or emerging technologies. The remaining 1 percent of the funds is allocated to the consumer information and market-building subaccount.[97]

Unused funds roll over within the same account, potentially increasing available funds in later years. It is assumed that funds will be collected from utilities and allocated to accounts in four equal allotments over a four-year period. By the end of 2001 it will become apparent whether surplus funds can be reallocated elsewhere. The first 3 percent ($16.2 million) of the total AB 1890 funding for renewables, if available as rolled over funds at the end of 2001, will be allocated to emerging technologies. Any remaining rollover funds will be reallocated based on an assessment of market conditions at that time. In the event that the level of funds is insufficient to cover any shortfall, then the available funds will be proportionally allocated to the various accounts based on the different allocation percentages.

Distribution of these funds is even more complex as the CEC has developed four separate distribution mechanisms for the four accounts. The mechanisms for the existing technologies, the new technologies, and the customer side-accounts are all per kWh incentives, differentiated by characteristics particular to the circumstances of those accounts. Existing technologies are paid through a cents-per-kilowatt-hour production incentive for actual renewable generation. The incentive payment is based roughly on the difference between the market price these plants receive for their energy and a target price for each technology, subject to a cap, of the total funds available for each technology divided by the amount of generation from a given technology (whichever is less). Emerging technologies are paid by the differentiated incentive blocks (see below).

Since the inception of the SBC policy in California in March 1998, approximately $11.5 million has been distributed to existing plants through a cents per kilowatt-hour production incentive for actual renewable generation (Korosec 1998). The higher cost technologies (biomass and solar thermal) have been paid at the cap of 1.5 cents/kWh, because the market price has been below the target price for these technologies, and the amount of generation hasn't exceeded the available funds. In contrast, the lowest cost technologies (geothermal, small hydro, digester gas, landfill gas, and municipal solid waste) have only received payments for one month (February), because the market price was above their target price of 3 cents/kWh for January, March, and April. The medium priced technology (wind) has received payments, but because wind generation is seasonal, these technologies have not yet reached their peak performance period and consequently did not generate very much energy in the first quarter of this program. In January, wind projects received about half a cent per kWh (Korosec 1998).

The program is also designed to assist new renewable technologies. Almost no renewable generation has been built in California in the last 10 years. AB 1890 defines "new" technologies as those that are constructed after September 26, 1996, but the technologies themselves are actually the same ones being used in existing facilities (biomass, geothermal, small hydro, solar, and wind). The purpose of this part of the program is to encourage growth in the amount of renewable generation available to Californians. A bid for the incentive amount these new facilities wish to receive was recently held. A total of 56 bids were received which will be

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97 These amounts vary over time, the amount listed is their respective overall averages.

evaluated and the results announced in the first week of July 1998.[98] The facilities will have four years to come on-line, and will be paid the incentive payment that they bid for the first five years of generation.

A third facet of the renewable program deals with emerging technologies, which are those technologies that are out of the research, development, and demonstration phase but are not yet fully commercialized. When the program was designed, representatives of these technologies (defined by the legislation as photovoltaics, solar thermal, small wind, and fuel cells that use renewable fuels) made it clear that these technologies are going to be competitive at some point in the near future. The fund can help accelerate the learning curve so that they become cost effective earlier. The program was designed to provide a capital cost buydown for small systems that are installed at the customer's site to primarily offset their own load. The funds are divided into five blocks of funds with each block decreasing in its incentive amount. The first block's incentive is set at $3 per watt, or 50 percent of system cost, whichever is less, subject to a $1 million per project cap. System installers can reserve funds, and once the system is installed, submit a request for payment with proof that the customer has received the system and that it is operational. So far, 81 reservations for funds have been received, totaling about $5 million.[99] This part of the program has been rather slow, but it is anticipated to speed up as customers become more educated about their energy choices in the new deregulated market.

The final segment of the program provides a rebate to customers who buy renewable energy through direct access contracts. The rebate is paid to marketers, who then must forward it on to their customers. The idea is to offset the additional cost of renewable energy to customers. Because the direct access market was delayed in starting until March 31, 1998, marketers have not yet obtained direct access contracts for their customers. It is anticipated that requests for the rebate will be received over the next few months.

Thus far, the program is really too recent to be able to see any definitive effects on the renewable energy industry as a whole. However, there have been a few facilities that had been planning to shut down but decided to continue running because of the subsidy they would receive under the renewable program (Korosec 1998). Also, a major portion of the recent generation being planned is due to the production incentive offered for new technologies.

Benefits of the SBC

Proponents for this system argue that it is compatible with the transition to retail electricity markets and is the most effective at incorporating renewables into the marketplace (Kirshner and others 1997). By closing the gap between renewable generation costs and market prices these technologies will become more competitive. The surcharge system is also touted as lending itself readily to the creation of a green market, which is part of the reason it won support in California (Kirshner and others 1997).

Another positive attribute of the surcharge-funded mechanism is that it provides an efficient method of allocating these specified funds. For example, much of the funding can be used to

98 The total amount of MWs that were bid is undisclosed as well as the types of technologies.

99 Only about $16,000 has actually been paid out for installed systems (Korosec 1998).

assist in the development and deployment of new, rather than existing, renewable technologies, especially as they become closer to competitive market costs (Kirshner and others 1997).

Criticisms of the SBC

The major drawback to the SBC is that it has not withstood the test of time yet. In California, the policy has only been in effect for a few months so it is difficult to say what the effect will be on renewables yet. Though in essence it is similar to the NFFO, the complexity of its funding mechanisms needs to be tested to determine the private sector's (IPPs) response. In the case of California, SBC opponents contend that the policy will not provide sufficient support to increase renewable energy supply in the state and that resource diversity may actually decrease as existing projects are forced off-line at the end of their fixed price contracts (Wiser and others 1996).

It is difficult to determine the exact size of the renewables market that would be created by the policy. In the case of California, the SBC is very complex, with many different funding tiers and various mechanisms for allocating funds. Furthermore, the centralized fund allocation mechanism of this policy is administratively complex and invites gaming. Though this type of approach may work effectively in California, it may be too complex for a country that lacks a similar degree of administrative capacity and experience in dealing with RET projects.

To set caps on the different RETs means that the administrator will have to have an accurate handle on the domestic RET market. The administrator would need to know a fair amount about the market—though this may be the case in California it is probably not so in many developing countries. This means that funds will need to be used to ascertain this information—as it is essential that this cap be as accurate as possible. If it is too low, the private sector will be hesitant to participate and the level of competition will be minimal. If it is set too high, the potential for inappropriate or poorly planned projects is increased. Both the unknown price levels and the additional administrative costs detract from the appeal of the policy especially for developing countries, which often have limited government capability and dismal track records for corruption.

Renewables Portfolio Standard (RPS)

Another renewable energy policy, called the Renewables Portfolio Standard (RPS), is being explored in a few different states in the United States The intention of the RPS is to maximize market forces to establish a renewable energy industry in a restructured and competitive electric industry (Rader and Norgaard 1996). Under the RPS, each retail supplier of electricity must provide a minimum percentage (specified by the State or Federal government) of renewable energy in its portfolio of electricity supplies. Individual obligations would be tradable through a system of renewable energy credits, a provision intended to add flexibility in meeting the standard.

The renewable energy credits (RECs) concept is central to the RPS. A REC is a tradable certificate of proof that one kWh of electricity has been generated by a renewable energy source and sold to an end-user and is ultimately a separate commodity from the power itself. Thus the RPS mandates that every generator possess a number of RECs equivalent to a set percentage of its total annual kWh sales. For example, if the RPS is set at 5 percent, and a generator sells 100,000 kWh in a given year, then it would need to possess 5,000 RECs at the end of that year. The REC concept is patterned after the SO_2 credit-trading program from the 1990 U.S. Clean Air Act (Rader 1997). The sale of the RECs is the mechanism by which revenues are transferred from traditional generators to the least-cost renewable energy generators to maintain their economic viability. With trading of renewable credits, a RPS can harness competitive forces with modest administrative requirements to achieve the renewable generation minimum at least cost.

With a RPS, investors and generators make all the decisions about compliance including the type of renewable energy to acquire, the types of developers to use, the payment price and the contract terms. Generators decide for themselves whether to invest in renewable energy projects and generate their own RECs, enter into long-term contracts to purchase RECs, purchase renewable power along with RECs, or simply to purchase RECs on the spot market. Only the bottom line is enforced: possession of a sufficient number of RECs at the end of each year. The REC system provides compliance flexibility and avoids the need to "track electrons" (AWEA 1997b).

Government involvement would be limited to setting the RPS standard, certifying RECs, monitoring compliance, and imposing penalties if necessary. For generators that are not in full compliance with the RPS at the end of the year, the administrative agency would assess an automatic penalty for each REC that the generator fails to produce as required. To be effective, the penalty should be several times what it would have cost to purchase the RECs. A high penalty level makes the policy self-enforcing, avoiding the need to resort to costly administrative and punitive measures (AWEA 1997b).

The Tellus Institute analyzed the effect of a hypothetical U.S. Federal RPS implemented for three different levels by the year 2010: 4 percent, 8 percent and 10 percent generation by non-hydro renewables, wind, solar, biomass, municipal solid waste to energy and geothermal (Bernow 1997). They found the range for REC trade prices to be from 1 to 2.5 cents per kWh for the three different targets, while the rise in electricity prices would range from $0.0004 to $0.0026 per kWh. This price increase translates into a $0.20 to $1.30 per month jump for a household with 500 kWh electricity demand (Bernow and others 1997). The resulting savings in carbon dioxide emissions were substantial, ranging from 36.7 to 161.3 million tons by 2010 (or 2.1 to 9.3 percent of 1990 emissions) (Bernow 1997).

A RPS is best designed to preserve the existing level of renewable energy serving the nation, and then gradually increasing the percentage requirement to achieve greater diversity over time (Rader 1997). There should be an adequate amount of time for facilities to come on line, giving the generators the opportunity to bargain for RECs. A yearly increase in the standard would create the best conditions for renewable energy suppliers since it would prevent "boom and bust" cycles that might be caused by large percentage increases that occur every five years or so. A constant, predictable market will also foster lower costs since renewable energy industries will not have to go through cycles of layoffs and rehiring, losing human resources and institutional memory along the way (Rader and Norgaard 1997).

Benefits of RPS

A primary advantage of the RPS as compared to the SBC and NFFO method is that it does not require the centralized collection and dissemination of funds or require state agencies to make decisions about winners and losers. The market makes all decisions regarding which renewable plants to build, where, and at what price—thus, the market can be expected to deliver these results at the lowest possible cost.

There are several ways in which the RPS assures least-cost achievement of a nation's renewable energy goals. First, the certainty and stability of the RPS policy will generate long-term contracts and financing for the renewable power industry resulting in lower renewable power costs. Least-cost compliance is encouraged by the flexibility provided to generators, who can compare the cost of owning a renewables facility to the cost of purchasing RECs from others. Finally, since generators will be looking to improve their competitive position in the market, they will try to drive down the cost of renewables, perhaps by lending their own financial resources to a renewables project, by seeking out least-cost renewables applications, or by entering into long-term purchasing commitments. This fosters a "competitive dynamic" that is not achieved with policies that involve direct subsidies to renewable generators without involving the rest of the electric industry (Rader 1997). This is essential in a renewable energy market, because it encourages the direct integration of renewable technologies into the existing generators' portfolios.

When renewables become competitive with conventional electricity sources on a direct-cost basis, the RPS self-sunsets. When the difference between the cost of conventionally fueled power and renewable energy costs stabilizes at virtually nothing, the RPS will no longer be needed. It is important not to sunset the program before this point, since costs can be reduced substantially if the standard is expected to be in place until renewables are fully competitive (Rader 1997). Without long-term policy stability, the cost of renewable energy projects could increase by 25–50 percent as a result of higher financing costs (Wiser and Pickle 1997).

Criticisms of the RPS

There have been several arguments against the RPS. First, opponents cite the inability to contain costs as one of the main drawbacks to a RPS policy. As originally conceived, the RPS policy does not have an explicit cost cap; instead, the market determines the total cost. Thus, costs could potentially be higher than expected to achieve desired renewable energy level (Kirshner and others 1997). This can be ameliorated, however, by instituting a set of cost containment measures. In order to establish an upper limit such as a cap on the price that generators must pay for the credits. The cap should be somewhat higher than the expected marginal cost of credits, but considerably less than the penalty. A cap in the range of 2.5 cents/kWh,[100] for example, might be appropriate (Rader 1997). But this would require administrators having a knowledge of the market.

A second argument against the RPS is that it places the burden on the retail electric suppliers, who would be required to actively participate in the renewables (or at least the REC) market. The incremental effects on the electricity would differ by retail electric supplier—giving an advantage to those facilities with higher pre-existing levels of renewables in their portfolios. Third, some argue that once the minimum level for a RPS is reached than there is little incentive to increase the renewables development.

Another argument against the RPS is that it isn't structured to encourage specific technologies. Only the least cost ones will be pushed forward which can result in an inundation of certain technologies in the market and a dearth of others. Generators would only be concerned about paying the least amount for RECs that they can, instead of focusing on any sort of RET market development. Lastly, because the RPS is a new and untested policy, it is possible that unexpected

[100] This cap is estimated for a U.S. Federal RPS. This would vary for other countries.

or undesirable side effects (gaming, higher than expected costs, etc.) might result from its implementation (Wiser and others 1997).

It is questionable that the RPS could be effective in a developing country. In a strong market driven economy in an industrialized country there already exist regulatory agencies and checks and balances to ensure that the various RET developers are playing by the rules. The RPS is driven by the market—the government has a much smaller role to play in its development, which can result into chaos for a developing country that has a limited amount of regulatory experience. In the move to liberalization of the power sector market, a distinct regulatory agency would need to be established, but it is not realistic to expect this fledgling agency to initially have control of the various electricity sector stakeholders.

Electricity Feed Law (EFL)

Another renewable energy policy that has already proven to be quite effective is the Electricity Feed Law (EFL).[101] An EFL sets a premium price for the purchase of electricity from different renewable energy generators (usually stated as a certain percentage of the average price of electricity in the market). This price support is provided for as much renewable energy that is brought on line, with a cap neither on the amount nor the types of RETs employed. The power utilities are generally required to pay the renewable energy generators. The EFL has the main objective of increasing the installed renewable energy capacity, and is not necessarily focused on achieving the lowest price for renewable energy. The EFL is primarily geared towards developing and sustaining a domestic RET industry.

This type of policy has been employed in different parts of continental Europe. Germany was the first of several European countries to adopt this Electricity Feed Law. Spain has adopted a similar policy that has been extremely effective in promoting renewable energy, most notably wind power. The German approach differs slightly from that of Spain in that the Germans have differentiated the price-support levels depending on the type of RET. The set price, however, is slightly higher in general for the RETs in Germany compared to Spain. Both of these governments' policies will be outlined below to provide background into each, as well as to the level of efficacy within each nation.

Standard Offers of California

The fixed-payment production incentive was introduced in California amid the PURPA frenzy of the 1980s. In its efforts to encourage the development of RETs, the California Public Utilities Commission (CPUC) required California utilities to provide Standard Offer (SO) power purchase contracts based on avoided cost principles to RETs. These SOs turned into excessive price guarantees for over-extended periods. The amount of payment was based on escalating marginal fuel price projections for up to ten years of a 30-year contract (Sioshansi 1994). The SO objective was to make it possible for the fledgling RET industry to get the necessary financing to invest in new technologies. But the payments were set much higher than conventional sources because the price of oil declined instead of increased as was anticipated. Therefore, interest in RETs waned dramatically when it was realized that the actual 'avoided cost' of energy from RETs was low compared to fossil fuels.

[101] This is also commonly referred to as 'renewable feed-in tariffs'.

The SOs of California did, however, assist in making valuable improvements and gaining experience with RETs. Much of the current RET knowledge today, especially for wind, can be attributed to California. A key lesson from the SO policy is that setting RET payments at too high of a level can be extremely damaging to the industry because it can result in poorly planned projects. In addition, careful planning needs to go into the development of RETs to avoid any excess burden for the power utilities from overcapacity and operational problems. In retrospect, California would have probably been better off by lowering the price paid to RETs and for establishing a shorter amount of time for guaranteed funding to allow for periodic self-assessment of the policy.

REPI of the United States

It is also interesting to note that providing a fixed subsidy as the EFL does, is similar in concept to the United States' Renewable Energy Production Incentive (REPI) policy created under the Energy Policy Act of 1992. REPI was created as the nonprofit analogue to the production tax credit and investment tax credit under the 1992 Energy Act (Federal Register 1995). For tax-exempt power producers, the Federal subsidy is a $0.015 per kWh production incentive payment.[102] The $0.015 per kWh payments (both the tax credit and production incentive) have assisted in an increased number of RET projects, especially wind (Figure 4).

REPI, however, has been touted as a limited success in encouraging RET generation. The limited success is attributed to the uncertainty associated with the funding for REPI payments to developers. The Federal funding for the REPI program is subject to yearly Congressional appropriations and is therefore highly uncertain. Due to this uncertainty, the REPI cannot be used as security for debt repayment and is often not even included in the investment decision-making process for publicly owned RET facilities (Wiser and Pickle 1997).[103] Therefore, a lesson to be taken from REPI is in the need for guaranteed funding to minimize risk.

Germany

Germany was the first to initiate an Electricity Feed Law (Stromeinspeisungsgesetz) policy through the Act on the Sale of Electricity to the Grid, which went into effect back on January 1, 1991. With this Act, the Federal Government established minimum compensation rates for electricity generated from renewable energies, along with an obligation for the utilities to accept such electricity into the public network. As a result, the Act has considerably improved the framework for renewable energies. The Act was extended in mid-1994 to cover electricity generated from organic residues and waste from commercial wood processing (limited to plants of up to 5 MW of electrical output). In addition, the compensation for electricity from hydropower plants and from organic residues and waste materials was improved. Even higher compensation levels continue to be in force for electricity from wind and solar energy. In the fall of 1995, the Federal Ministry for Economics presented a report on experience gained with the Act on the Sale of Electricity to the Grid. Considerable technical and economic progress was seen especially in the area of wind power systems.

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102 For investor owned utilities the Federal subsidy is a $0.015 per kWh production tax credit (Federal Register 1995).

103 The production tax credits (for taxable owners), however, are guaranteed for 10 years (Federal Register 1995).

In Germany, the utilities are obligated to purchase renewable electricity from wind, solar, small hydro and biomass at up to 90 percent of the average electricity tariffs for all customers in Germany, excluding taxes (GFME 1997). This obligation has resulted in a guaranteed premium of around 17 pfennigs (roughly 10–12 cents) per kilowatt-hour (IWR 1998). These payments are granted over the lifetimes of the renewable energy plant but are not adjusted for inflation (Wagner 1998). For 1997, wind energy capacity cost approximately 1370 per kW installed (Allnoch 1998).[104] As a result of the policy, Germany has added approximately 2000 MW of wind power capacity by 1997, surpassing the United States to become the world's leading wind power generator (IEA 1998) (Table 3 and Figure 5). Solar power also increased significantly, with roughly a six-fold increase in PVs and solar collectors between 1990 and 1995 (IEA 1996). Initially the program worked in conjunction with tax incentives and other government programs to help get the new technologies off the ground, but today the feed law alone is enough to support the RET market.[105]

Since the utilities bear the costs of the program, they have fought it repeatedly in court since its inception—but strong public support has kept it in place. The policy, however, did go through a period of reform in the German Parliament at the end of 1997. The principles of the EFL tariff structure—that is, a certain percentage of the final consumer tariff—did not change substantially. But a cap-like mechanism was put in place to mitigate the so-called hardship that is inflicted on utilities that are located in regions with higher renewable energy resources (e.g. windy areas) and were therefore hit with an excessive financial burden from the explosion of RET development in their region. The utilities are now only obligated to cover 5 percent of their total electricity supply mix. Once the volume of renewables exceeds 5 percent of a given utility's sales, it can pass the exceeding amounts to the supra-regional utility. Once the supra-regional utility has reached the 5 percent limit, additional renewable energy power will no longer receive premium payments. This could happen by late 1998 in northern Germany, which is a popular location for wind development (BWE 1998).

Spain

Spain also has a policy similar to Germany in that a set premium price is paid for renewable energy. In Spain, renewable energy is referred to as Special Regime and is currently legislated by Royal Decree 2366/1994. For renewable energy, including hydro smaller than 10 MW, a premium rate between 80–90 percent of the average price of electricity (calculated by dividing the revenue from electricity supply billing by the power supplied) is paid. This works out to be approximately US 7.91 cents/kWh for wind, solar, and mini-hydro; US 6.97 cents/kWh for specific biomass; and US 5.49 cents/kWh for MSW among others (MIE 1994).[106] Spanish policies supporting domestic wind energy have included significant capital subsidies of up to 40 percent but are now relying primarily on the premium prices alone. Most of the RET capacity

[104] This amount in U.S. dollars is derived by using the 1997 average exchange rate of DM1.75: $1.

[105] Some of these earlier incentives were substantial including the 10/250 MW program which added an additional 6–8 pfennigs (4 to 6 US cents) per kWh. There were also tax incentives allowed at the federal and state levels. Most of these other support mechanisms are no longer in place (Wagner 1998).

[106] These calculations are the result of using the 1997 average exchange rate of Pta. 145: $1.

that has come on line has been wind energy, with an estimated 244 MW installed wind capacity in 1997 alone (IEA 1998) (Figure 6).

Over the last year, Spain has increased its installed wind capacity, and as much as 90 percent of the installations were from its domestic wind industry. Spain's wind energy industry is expanding rapidly to become a world leader at a break-neck pace. It is also making its presence known in the export market with one of the most aggressive government-backed export support programs in the industry (AWEA 1998). Short-term and long-term prospects for Spanish wind market are good, if for no other reason than Spain has much more available land for wind projects than other European markets. Within the next 10 years, many other European countries will have achieved levels near their maximum capacity, while Spain should be able to support hundreds or even thousands of MW per year for many years beyond (IEA 1998)

Benefits of the EFL

There are many benefits and advantages to the EFL-type policy. First, developers can apply at any time—making it easier for private sector entities to join into the scheme, thus increasing the number of IPPs. This also avoids the stop-start nature of the market, characteristic of the NFFO scheme, which has made it difficult for domestic manufacturers to survive. Second, RET developers know exactly what payment they will get—this will all be determined prior to entering the market, thus minimizing the risk. Third, there is no hurdle rate-of-return requirement. Again, because the premium rate is set, it is clear to the developers what to expect in the market, thus minimizing the risks associated with the investment. Fourth, the objective of increasing installed capacity is an easily quantifiable and transparent result, making it easier for evaluation. Lastly, though price reduction is not a stated objective of the EFL, proponents of this policy state that building the RET market over time will result in a decline in unit costs (Flavin 1998, Wagner 1997).

Another benefit of the EFL is that it allows for the development of a decentralized market, characterized by small developers and investors. The smaller projects may result in increased local employment and other economic benefits flowing directly to local communities thus facilitating local project acceptance. All of these factors can be particularly important to developing countries.

Criticisms of the EFL

The way the EFL has been set up there is no downward pressure on prices. Therefore, there is less incentive to reduce prices for developers. The EFL is not structured to have either competitive bidding or a specified amount of renewable energy. It is doubtful that price decreases will occur to the same degree that was seen in the United Kingdom's NFFO scheme because of the lack of competitive bidding. Costs caps have not been used until recently. Cost caps can be implemented, but this detracts from the objective of the EFL in these countries—to increase the installed RET capacity. In addition, the EFL is not set up on the incremental cost concept—it is more or less just a high subsidy. It is difficult to set the subsidy without resulting in either substantial economic rents for lower-cost projects or insufficient inducement to develop higher-cost projects. The rents could also result in less than desirable projects being developed similar to California in early 1980s.[107] In other words, by paying this higher rate the chances are increased that more projects that are not necessarily economically sound will be put in place.

This situation is analogous to Japan's subsidization of the auto industry in the 1960s and 1970s. The hope was that the government's heavy investment in the domestic auto industry would payoff in the future because of technology expertise and market share. This proved successful for Japan, as is the case for RETs in Germany and Spain—but should this be the goal of a developing economy? Developing countries cannot gain the technical expertise to become a global RET player without investing a tremendous amount of scarce resources in such an effort.

In Germany, the recent legislation that placed 5 percent limitations on renewable energy came from pressure by the utilities. Some utilities believed they were carrying an excessive financial burden through the EFL policy as compared to other utilities just because of geographic location. But this type of cap or limitation takes away from one of the main benefits of the EFL scheme—the open and secure market for developers. With this limitation in place, the risks for developers to push forward projects has increased because of the possibility that they may not receive funding if their utility is at its maximum renewable content level of five percent.

107 The incentives that were established in California helped cause a wind rush that resulted in large wind capacity additions and impressive cost reductions, but provided wind power owners with limited incentives for project performance (Cox *et al.* 1991).

Annex 3.5: Renewable Energy Generation in a Pool System

Structure of Payments in a Pool System

In a pool system, generators are paid only for specific services—energy, capacity, spinning reserve, black start, reactive power, etc. Energy prices are based strictly on the marginal cost of energy at a given hour. Capacity payments are normally based on some combination of plant availability, reliability and a chosen method of calculating the periodic capacity cost for the system. Other payments are likely to be based on some formula, in the case of black start, or congestion costs and losses, in the case of reactive power.

There is no place in this system for the traditional power purchase agreement between individual generators and a state-run power company, with its take-or-pay provisions at largely fixed prices. Consequently, IPPs will need either to sign bilateral contracts with large customers or sell some or all of their output to the pool. Stand-alone renewable electricity plants will generally receive only energy payments as stand-alone units. Normally, NRE plants will not provide sufficient availability to receive capacity payments under typical pool arrangements.

What take-or-pay contracts remain in the system will work largely as a means of getting power to the distribution companies. Such companies will buy from NPC on some take-or-pay basis.[108] However, individual plants will apparently not have this relationship with the NPC in the future.

The Role of Renewable Energy Generation in a Restructured System

As long as storage of electricity from solar and wind is both difficult and expensive, these power sources will have difficulty penetrating a pool-based grid system. In general, a power pool arrangement will not be able to give capacity credit to a renewable plant if its availability is below some specified level, usually 85–90 percent.[109] Without such capacity payments, most renewable plants cannot be financed and built. Therefore, a means must be devised to obtain capacity payments for the renewable plant. The success that hybrid generators have had in improving reliability in small grids and remote applications points the way for larger scale renewable systems.

Reliability from Renewable Generators: A Proposed Approach

Suppose that under the pool rules a power generation company (GENCO), which may include renewable generating plants, is responsible for providing capacity, not the individual plant. In such an arrangement, the generating company may have an incentive to acquire power plants

[108] This provision insures that distribution companies cannot bypass the NPC system with bilateral contracts with individual generating companies.

[109] The availability factor, the ability of the plant to produce when called, and the capacity factor are often confused. Plants with low capacity factors, for example, combustion turbines operated just a few hundred hours annually, will receive capacity payments because they are highly available to the system when called (usually > 95 percent). On the other hand, a NRE plant with a high capacity factor, such as a mini-hydro plant that generates 60-70 percent of the hours of the year, might not be *available* enough to receive a capacity payment.

with very low variable costs—e.g., renewable generators—that are "reasonably" available and reliable, especially if such plants can often help meet peak period demands.

More specifically, the system operator would propose a certain availability for each GENCO's plants and agree to provide capacity, if called, from its other generation units or from purchased power, if its renewable generator were called but not available to the grid. In this way, the company could obtain peak power payments for the renewable facility most of the time, only occasionally incurring the cost of providing high cost turbine or diesel backup generation capacity. Payments for providing capacity would be made for all capacity available at or above the required level.

In effect, this system would allow individual renewable plants to act as if they were parts of a hybrid facility. Subject to certain limitations on renewable capacity due to stability considerations, such a pooling approach could result in a greater contribution from renewable sources than would otherwise occur.

The chief benefits of this approach for the country are 1) that older oil-fired plants can be retired at a more rapid rate without affecting system reliability and 2) that the power generation company using the NRE plants may then be able to obtain carbon offset payments from the GEF or other sources as a corporate entity, thereby maximizing the incentive to invest in renewable energy sources.[110]

A similar approach, including dispersed biomass plants within generating companies, would enable a generating company to provide not only active power and energy, but also such auxiliary services as reactive power throughout the grid.

The proposed reorganization of the country's electricity system, coupled with planned plant retirements creates a definite potential for increased use of renewables for electricity.

Steps to Efficient Pool System Integration of NRE Power Plants

- Create a number of generating companies out of the assets of existing NPC and PPA plants.[111] For competitive reasons, the GENCOs would need to be roughly equivalent in terms of plant, size and technology;
- Distribute NRE plants among the new generating companies using a combination of incentives and mandates to achieve the desired level of NRE investment;
- Create pool rules that allow the *generating company* to receive a capacity payment, rather than the individual plant;
- Base capacity payments on the achievement of a requisite level of availability by the plants of a generating company, not by the individual unit;
- Allow the generating company to use the least costly means available to it to provide the capacity called for the NRE unit, should that unit be unavailable;

[110] The transactions costs required to obtain such payments are likely to go beyond the resources of a small NRE generator, whereas a larger company is more likely to have the wherewithal to navigate the application process.

[111] The proposed Omnibus Act supposes the creation of a number of generating companies from the NPC and other generating assets in the system.

- Allow NRE units to receive payments for such system services as reactive power (as in the Distributed Generation/Resources concept).

If the steps outlined above are undertaken and if the current disincentives and obstacles facing NRE development are overcome, then there is a potential to develop more NRE than is currently planned for in the power development plan. Consider a situation in which two intermittent types of plants, wind and small hydro (the latter with >24 hours of storage) totaling 600 MW of capacity, are backed up 60 percent by new, highly efficient combustion turbines. Let these units back out 600 MW of older, low efficiency oil-fired generation.

A simulation of this situation form the main Philippines grid has found that there can be significant savings of variable system costs, perhaps 20–30 percent or more, while the overall cost of generation does not change much. These savings are particularly apparent during intermediate and peak load periods. Indeed, as soon as the world oil price passes $21/bbl, the proposed integration of NRE with backup in generating companies will help reduce the overall cost of electricity generation.

Box 3.5.1: How Much Can Reliable Hydro or Wind Contribute to a Grid System and What Are the Financial Impacts?

The normal rule of thumb for wind systems is that no more than 20 percent of the receiving system's capacity can be non-firm. Taking that cautionary figure into account, it is useful to look at a simple example of early retirement of an older, inefficient and large baseload power plant using oil in favor of some combination of small hydro and wind with modern combustion turbine backup.

Suppose that 250 MW of wind and 350 MW of small/mini hydro are added to the Philippines system by 2005, along with 360 MW of GT backup, as part of a 5 GW expansion program over the next 6–8 years, the other units being fired by coal, gas and oil. The new capacity would be used to speed up the retirement of 600 MW of older oil-fired capacity. The alternative that is used is the current system expansion plan. Such a situation was simulated for the Philippines, using a financial simulation model of future system investments and current capacity. Various alternatives for capacity additions were then simulated and the results assessed.

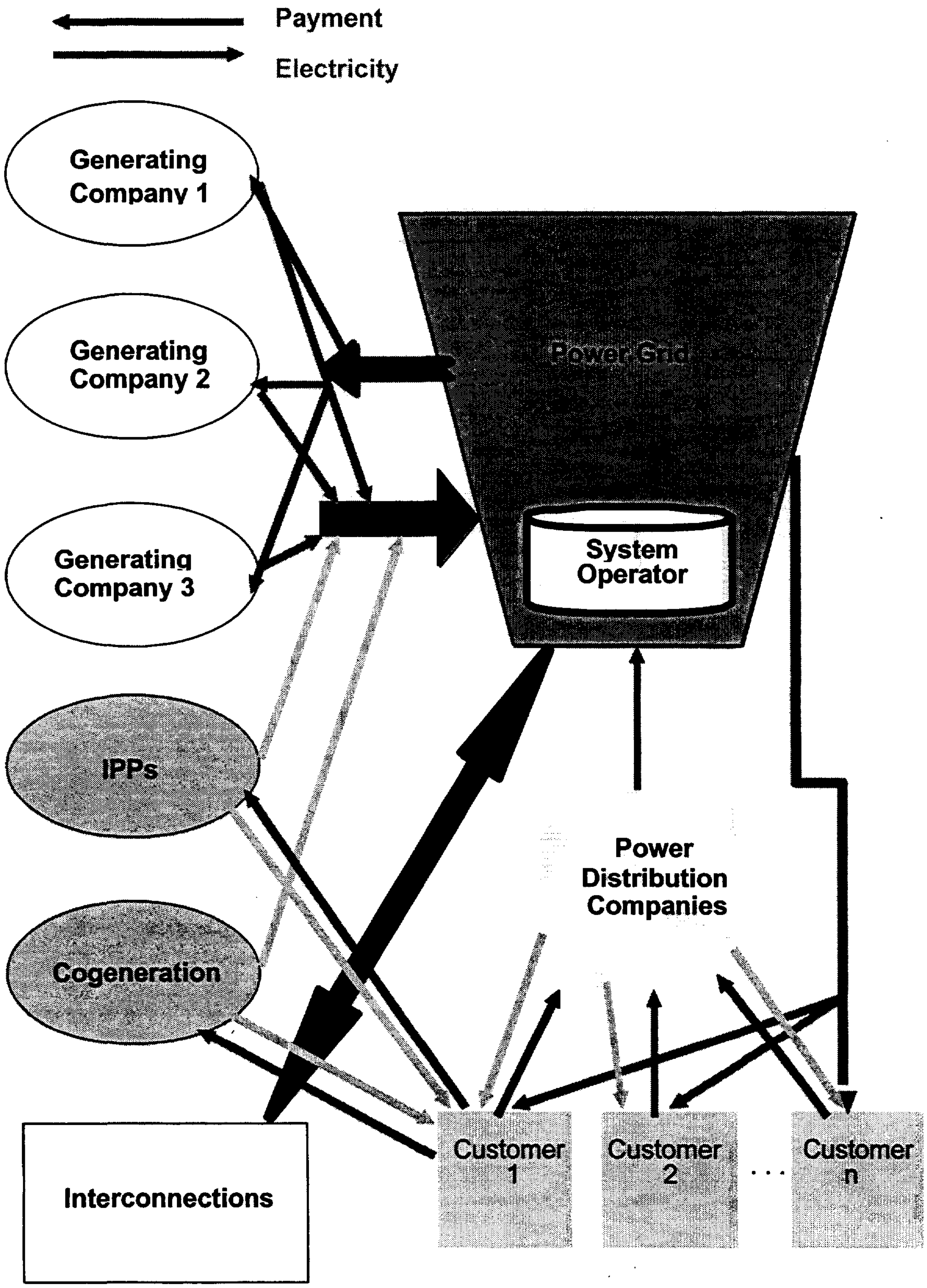
Current Oil Prices: Under the current low oil price situation, the new investment would raise average costs of all new generation, including the new NRE units, by about $0.003 per kWh (P0.14), an increase of about 7 percent. Energy costs of generation would fall by about $0.0055/kWh (P0.25), a decrease of about 40 percent.

Higher Oil Prices: If the price of oil rises to $20/bbl, then the average costs of generation from new sources are almost the same for the conventional expansion plan and the plan that adds NRE. Average generation costs in the NRE + backup scenario would be about $0.00062/kWh (P0.029) higher than average new generation costs for the conventional expansion plan. Significantly, the energy-only costs of generation under the NRE + backup scenario would be more than one US cent (P0.48) lower than the energy-only cost of generation under the conventional expansion plan.

What does this mean for the Philippines? If NRE can be built and dispatched cost-effectively, inside a generation company and with a modern combustion turbine backup, such systems can contribute cost-effectively to new generation capacity once the world price of crude oil goes above $20/barrel.[112] Savings on variable costs of generation are significant if the NRE generation additions allow early retirement of older, inefficient oil fired units.

112 The actual breakeven price for oil is about $21.75/barrel (1998 dollars), assuming that the backup GT capacity is added as a part of a larger combined cycle facility. Also, this does not include simulation of very dry years or the effects of typhoons on wind generation equipment.

Figure 3.5.1: Electricity and Payment Flows in a Pool System



Annex 4.1: Private Sector Roles in Rural Energy Service Delivery: Alternative Models

> "For potential users, particularly the rural poor in developing countries, the biggest single factor preventing widespread adoption of PV technology is the initial cost of purchasing the system. A solar home system to power a few lights and possibly a television may cost the equivalent of a whole year's income for a rural household. Few would-be purchasers have sufficient savings to buy such a system with a single cash payment, so some financial mechanism must be put in place to make the system affordable."[113]

The purpose of this paper[114] is to illustrate alternatives for promoting renewable energy-based rural electrification in a manner that reduces the demand on national and local government resources, thereby alleviating the energy-related aspects of rural poverty. It presents three basic models for providing economical and reliable electrical services to rural communities that cannot efficiently be served by conventional power grids. The focus of this paper is alternative models for delivery of energy services based on photovoltaic (PV) solar home systems (SHS). A number of the models discussed below are also relevant for rural energy service delivery based on other renewable energy technologies. The information is presented in three sections. The first section of paper presents, in a summarized manner, plausible options to help cash poor rural inhabitants to overcome the high initial cost of SHS, but which do not require large subsidies of equipment costs. The second section presents case studies of the different approaches.

Objectives for PV Electrification Models

Though no particular model is universally suitable, there are elements that are basic to any effective program.

- A high- quality product/service: Components should be dependable, and offer warranties. System design should maintain technical quality by sizing production to meet loads with adequate storage for periods of little sun. The system should include safety measures to protect the rural home. Since SHS are held up as an option for lower income families in rural areas, it is vital that the investment be protected, principally with regard to the battery. Periodic battery replacement is necessary, but can exceed the purchasing power of rural families given existing obligations. Finally, dependable post-installation service should be available.
- An affordable product/service: While quality should not be reduced, some features can be offered on an optional basis, to manage prices. Financing schemes should be flexible enough to spread out the recovery of the capital investment, so that the periodic payment is low. Down payments, or equity contributions, should

113 International Energy Agency and The World Bank Group, Industry and Energy Department, Renewable Energy Group. "Solar Photovoltaic Power: An Overview." Energy Note No. 10 (Washington, D.C.: The World Bank) 10.

114 Paper by Mark Newton and Chris Rovero, Winrock International, August 1999.

be kept to a level that ensures that the household can afford periodic battery replacement. Financial costs such as interest or leasing margins, while reflecting the cost of funds and operational margins, should not be punitive. This requires that the company/organization operate efficiently and take steps to reduce the perceived risk of PV electrification as an investment opportunity.

- Consumer protection: End users/consumers should be able to protect themselves from low quality services. This means that the equipment or service provider should be accountable to the user. This is not always possible with isolated systems. One method is to provide the consumer with the choice to return their system. Leasing programs provide a significant advantage in this respect. More generally, accountability is strengthened when the SHS/service sales are continuous and are the principal source of revenue for the provider. In this sense, PV electrification should move away from a project focus and toward an industry focus. Isolated bulk procurement and installations do reduce upfront costs, but the subsequent costs for the end user to obtain adequate service over the SHS lifetime may be much higher.
- Sustainable activity: If providers require large subsidies to operate in a region, they will probably depart when support is reduced. End users will be left without specialized assistance and after-sales service, and the technology may fail. A local presence, contingent upon a minimum level of business, is necessary. Effective programs may also rely on local organizations to manage the key processes such as collections, quality-assurance, and provision of after-sales support. Local entities are also often more accountable to the public. All programs should aim for financial stability, including capital recovery, debt service, operational margins, and an adequate return, to be able to maintain a continuous presence.

Models

This section discusses three models for providing solar energy services to rural households: consumer finance (CF), leasing, and fee-for-service. They allow successively larger segments of the population to have access to electricity services by spreading the repayment of the capital costs over longer periods and by reducing the initial payment. While affordability is a central issue, these approaches are also distinguished by a high quality installation and adequate post-installation service. Most important, the emphasis on financial sustainability does not imply significantly restricting access. Examples range from NGO efforts to evolving commercial ventures supported by specialized investment funds. They represent options to reduce public resources needed for rural electrification without sacrificing impact. The Argentina "Concessions" model, a variant of the fee-for-service approach, is not discussed here as it is presented in the main ESMAP report.

By reducing the need for heavy equipment subsidies, these options foster a framework in which private businesses can contemplate offering services.[115] Government can then leverage private capital with its resources without sacrificing development impact. In addition to reducing subsidies, government can also reorient them to reduce the distortion of the customer's decision-

[115] Covell, Philip, and Richard Hansen. *Full Cost Recovery: Debunking the Myths* (Somerville, Mass.: Enersol Associates, 1993) 1.

making process that stems from unevenly applied incentives across rural energy options. The goal is to provide rural households with a full range of choices to fulfill their electricity needs and options as to how to finance the investment.

No particular model, no matter how theoretically sustainable, is universally superior. For instance, the more affordable schemes for consumers require greater managerial skills. Different national and local frameworks make certain approaches more logical. As such the overall aim should be to define an approach that offers *quality and affordability of product/service, financial and technical sustainability, and consumer protection* that is suitable to a particular country's financial system and the situation of its rural communities. In the following sections three options are offered in summarized fashion that may help to stimulate such a thought process. These are followed by case studies that illustrate the approaches.

Consumer Finance (CF) Model

Consumer financing (CF) is used to sell many consumer durable products in rural communities. These include motorcycles, diesel generators, televisions, and sewing machines.[116] Consumers purchase their SHS on credit from equipment supply and service businesses that design, procure, market, install, and service the SHS. The buyer makes a down payment and finances the balance with a loan, making periodic payments of capital and interest. The customer takes ownership of the SHS, although some programs transfer this gradually. Consequently, the big questions revolve around the creditworthiness of the customer and in some cases, the on-lender. It offers a much larger impact than through cash sales because it allows the end user to spread out the repayment of the upfront cost. While only 10 percent of rural households can afford to purchase a SHS on a cash basis, roughly 20–30 percent could do so if the purchase were financed.[117]

The Consumer Finance model is also known as the dealer model or equipment sales model. The most common arrangement is for the SHS dealer to offer an installment loan plan funded by a separate financial institution (FI). Most businesses currently involved in rural electrification do not have the capital to offer affordable plans on their own and are limited in their ability to raise medium-term loans. Many of these businesses are small, partially informal sector enterprises, with limited or no formal credit records and management systems.[118] Formal FIs tend to see them as high-risk loans/clients. Larger established businesses may take on a liability for the value of the fund and on-lend the capital to its customers. One advantage of financing the dealer that it overcomes the reservations that formal FIs have in lending to rural households because of the cost of making numerous small transactions in unfamiliar conditions. However, it is more common to find businesses serving as channels for an institution's capital.

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116 Cabraal, Anil; Cosgrove-Davies, Mac; Schaeffer. *Best Practices for Photovoltaic Household Electrification Programs*. World Bank Technical Paper Number 324. Asia Technical Department Series (Washington, DC: IBRD, 1996) 39.

117 Sustainable Energy Solutions. *Guidebook for Financing New and Renewable Energy Projects*. Asia Pacific Economic Cooperation (APEC). (Japan: New Energy and Industrial Technology Development Organization, 1998.) 2-6. Note, figures may be somewhat lower in some countries. Enersol Associates, Inc. has estimated the cash sales figure for the Dominican Republic at 5 percent.

118 Finucane, James. "Financial and Capacity Building Intermediation in Asia RE Projects." SHS Project Support Group Indonesia. *Proceedings: Village Power Conference 1998*. (Colorado: National Renewable Energy Laboratory), 4.

Nonprofit institutions involved in rural development and other unregulated FIs have played a greater role in offering CF for solar electrification than formal FIs. Development organizations and rural financial cooperatives often have greater outreach than formal FIs, as well as greater familiarity with local economies and borrowers. Along with the ability to use innovative lending methodologies, these traits help to minimize the transaction costs of loans for borrowers and reduce the unit costs of managing loans for lenders. By contrast, formal FIs are limited in their ability to use alternative methods for loan security and credit management, and are usually located close to their urban formal sector clients.

The role of the dealer and the relationship with the collaborating institution varies greatly. System quality and performance are in different measures the responsibility of the dealer and the end user. Most dealers provide equipment warranties. Their technical personnel should be familiar with the basic system design so they can assist buyers to evaluate the cost-performance tradeoffs. Marketing is often most effectively carried out by the dealer, though there is a role for external assistance. Often the dealer carries out some credit activities, such as processing loan applications, making collections and repossessing systems when necessary. Dealer behavior can affect the health of the credit program because loan delinquency is frequently linked to substandard system performance. The responsibilities of the dealer should be clearly defined through contractually stipulated responsibilities for workmanship and credit management. Generally speaking, it is best if there is a legal basis for ensuring that all participants do as they are supposed to.

The affordability of a SHS is influenced by the term of the CF loan, the down payment, and the operational volume. The term is flexible, but should be set to avoid transacting with households too poor to afford periodic battery replacement. Ideally, the borrower should repay the loan before it becomes necessary to replace the battery, or the loan package should include a replacement. Controlling the size of the down payment may be more important to achieve widespread dissemination. Many rural families spend between $8.30 and $17.60 per month on kerosene, dry cell batteries and candles.[119] Thus the obstacle is often not poverty per se, but a lack of liquidity. Successful programs have kept the down payment at or below 25–30 percent of the cash cost of the SHS. By maintaining a high volume of installations dealers can also reduce the price of the SHS can be because fixed costs are spread over a larger number of units. The flexibility of interest rates is limited. Sustainable CF programs can only reduce rates by seeking affordable financing, control operating costs, minimize loan defaults, and ensure timely recovery of capital and interest.[120] Finally, adequate after sales service and end user education are important since they prevent poor system performance and therefore maintain cost recovery and achieve financial stability.

Affordability is also related to the indirect costs of qualifying for the loan. Since rural borrowers often lack steady income or formal credit records, complying with mainstream credit evaluation and loan security requirements is exceedingly costly. These *transaction* costs do not go to the lender, but do deplete the borrower's funds. It makes sense, therefore, to minimize by using unconventional lending approaches such as using the SHS as collateral. The ability to control

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119 Cabraal et al., 28.

120 Gregory, Jenniy; Silveira, Semida; Derrick, Anthony; Cowley, Paul; Allinson, Catherine & Paish, Oliver. *Financing Renewable Energy Projects: A Guide for Development Workers*. (London: Intermediate Technology Publications, 1997) 83.

these costs differs according to whether the lender is a regulated formal FI or an unregulated institution.

Finally, successful CF programs should protect the customer's investment. One approach is to use universal standards. However, in many countries weak institutions may hinder such an approach. Project-based efforts provide the opportunity to qualify participating dealers at the wholesale and retail level. These have included requiring well-established track records, equipment warranties, technician certification, and adherence to workmanship standards. However, this type of protection expires with the termination of a project.

Leasing Model

In a SHS leasing program the lessor or leasing company uses bulk financing to procure solar systems on a wholesale basis, which it markets to rural households through retail lease agreements. In contrast to the CF approach the lessor retains ownership of the SHS, although it often transfers this gradually to the lessee. The lessor can be a SHS dealer or a related financial or development institution. If the lessor is a third party, it will frequently have a formal arrangement with a dealer for the procurement, assembly and installation of the SHS, which may include marketing and the post-installation service. Payments from lessees cover the lessor's equipment costs minus a slight residual value, interest costs and a return on capital.[121] Most programs also allow the customer to purchase the SHS when the lease expires.

Leasing programs may potentially reach more customers than consumer lending by reducing the demands upon the liquidity of household incomes, and by controlling transaction costs. Leases often run longer than most loans, so the periodic payment is lower. The interest charge on the lease may also be cheaper since the lessor does not have to include loan loss reserves. Processing and management costs per lease should be lower than for rural consumer loans because the lessor retains ownership of the assets. Similarly, since the lessor retains ownership of the SHS and the periodic payments are smaller the initial payment can be reduced while still filtering out risky clients. This reasoning also applies to the customer's transaction costs of qualifying for the contract. Since disconnection often does not involve a transfer of ownership, there is no need for collateral beyond the SHS itself. Most rural households do not have access to traditional collateral, so the simplified security arrangements are a major advantage. The aforementioned advantages are greatest when local entities provide the financing.[122] Extensive outreach helps to minimize the transaction costs and maximize the number of secure business opportunities.

Leasing has advantages for the lessor as well. Service contracts can be bundled with the lease agreement if the lessor retains ownership over the life of the system. This can help to maintain system performance and thus contribute toward more dependable revenue flows. Similarly, it may be easier for the lessor than the consumer lender to secure capital because it can use the photovoltaic modules as collateral. Furthermore, maintaining the value of the lease portfolio should be easier because of the comparative ease recovering the SHS from lessees. This advantage can be formidable in countries with weakly institutionalized legal systems. Thus, leasing holds the promise of more dependable and secure operations.

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121 Gallardo, Joselito. "Leasing to Support Small and Micro Enterprises." (Washington, DC: Financial Sector Development Department, The World Bank, 1997) 6.

122 Cabraal et al., 44.

While some costs of providing rural energy services through leasing are lower, achieving financial stability is more challenging. The lessor still has to cover its costs with its principal source of revenue. The cost of debt may fall because the intermediary can secure wholesale financing[123] and because it can use the major SHS components as collateral. Similarly, reserves against losses should not figure as heavily in the cost structure because of the comparative ease of disconnecting delinquent customers. The ability to lower program costs contributes to lowering the break-even level of sales. However, reaching this point is more challenging for a leasing operation since lease lives are typically longer than consumer loan lives. Thus cash flow management is vital and more challenging, which makes operations more complex and expensive than under CF. Furthermore, if service contracts are bundled with the lease the lessor should define the nature of the service to ensure that it remains cost-effective.[124]

The options for protecting the consumer under a leasing approach are potentially better than under consumer financing (CF). Firstly, a longer-term service contract may be included with the lease, without exceeding the level of a loan repayment under CF. Similarly, a replacement battery could be factored into the lease payments. However, it is important to concentrate installations within a certain radius to keep the cost of service under control. In this manner, a leasing customer may be able to enjoy a greater quality of energy services for a similar cost to that paid under a CF program.

Fee-for-Service or RESCO Model

A fee-for-service approach, also known as a Rural Energy Service Company (RESCO) model, appears to offer rural households the best prospect for widespread access to sustainable energy services. An estimated 50 percent of the off-grid population should be able to enjoy basic electrical services under this option.[125] It also overcomes many obstacles related to the long-run performance of the SHS. It is also a more challenging strategy, however, that requires greater management sophistication.

In some respects fee-for-service is a simpler approach than the alternatives. Instead of purchasing equipment the customer pays for energy services. The customer signs a contract with a service provider (SP) for the installation of the SHS, maintenance and repairs, and agrees to make periodic payments in return. The end user never takes ownership of the SHS. This relationship most closely approximates the manner in which urban households get electricity from utilities. For the SP this is advantageous because it can deal with more customers while focussing less on their creditworthiness.[126] Similarly, the SP does not have to recover the costs of the SHS from one particular customer. If the customer stops payment, the SP simply has to remove the system and transfer it to another customer. Fee-for-service thus provides flexibility to both parties.

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123 However, equity financing may actually turn out to be more expensive due to the higher risk assumed by the investor.

124 Philips, Mike & Browne, Brooks. "Accelerating PV Markets in Developing Countries." (Washington, DC: Renewable Energy Policy Project, 1997), 7.

125 Northrop, Michael F.; Riggs, Peter W.; Raymond, Frances A. "Selling Solar: Financing Household Solar Energy in the Developing World." (New York: Rockefeller Brothers Fund, 1995) 3.

126 Gregory et al., 56.

For the rural household this approach offers affordability and convenience. Both the financial and the transaction costs are lower than for the alternative models. Since the SHS investment can be recovered over the life of the system, the periodic payment can fall to a level close to what many households already spend on lighting and batteries.[127] This allows the costs of routine maintenance and components to be factored in. Since the likelihood of default is lower for a short-term service contract, the need to filter out risky clients is smaller, and the initial payment can be lower. The SP does not require credit checks or collateral. Further savings arise because the SP can lower capital and equipment costs by aggregating household demand.[128] The non-financial or transaction costs of qualifying for the contract are also lower than for a consumer loan or a lease. Making payments and obtaining repair service is also more convenient. The SP often contracts a local business to make collections. Since these expenditures of time and money on the customer's part do not strengthen the SP, the ability to minimize them adds to the development impact.

Overall fee-for-service offers a better chance of delivering the quality-of-life improvements that most SHS programs promise. Foremost, the customer is not required to learn the rudiments of system design to have reliable lighting and power. Furthermore, the household does not face sudden large-scale expenses for major components or repairs as with other options.[129] Moreover, customers should be better able get value for their money since contracts are for energy services at specified levels, not equipment. The financial commitment with the SP also allows the household greater flexibility to respond to emergencies by discontinuing service (with notice) than a conventional credit agreement. Fee-for-service also appears to be amenable to regulatory protection of the consumer since it should be easier to monitor a few SP than hundreds of informal sector enterprises. Consequently, this approach may eventually allow for an improved and uniform standard.

However, the management requirements are considerably more complex than under CF or leasing. Reaching the break-even point, which may rise into the thousands, is more challenging because cost recovery is spread over a longer period. Servicing this volume of installations and managing the liquidity requirements is daunting in comparison to a CF operation. Without a critical mass of customers the cost of service will become prohibitively expensive, and the business will incur short run losses, or default on its debt. Maintaining tight control of costs becomes more crucial, while managing greater obligations for operation and maintenance. To ensure repayment dependable mechanisms for customer relations and collections using local entities must be in place. Soluz proposes to use one technician to manage the collections for a thousand SHS.[130] Thus, while the fee-for service approach promises greater impact, it has offsetting complexities.

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[127] Sustainable Energy Solutions, 2–7.

[128] Cabraal et al.

[129] Gregory, Jenniy et al., 56.

[130] Hansen, Richard. "Solar Electric Energy Delivery: A Business Model." Soluz, Inc. Village Power Conference Proceedings. (Colorado: National Renewable Energy Laboratory, 1998) 13.

Table 4.1.1: Characteristics of the Energy Service Delivery Models

	Model		
Characteristic	*Fee-for-service*	*Leasing*	*Consumer Financing*
Affordability	High	Moderate	Low
Interest rate	Low	Medium	High
Repayment Period	Long	Medium	Short
Down-payment/Fee	Low	Moderate	High
Security/Collateral	System	System	System/other collateral
Risk to lender	Low	Moderate	High
Administrative Cost	High	Moderate	Moderate
System Ownership	SP owns generation components only	User (at end of lease)	User
Potential Consumer Protection	High	Medium to Low after final payment	Medium to Low after final payment
Level of Customer Service	High	High during lease; Low to Medium after	Medium to High during Loan; Low to Medium after

Source: partially reproduced from Best Practices for Photovoltaic Household Electrification Programs.

Case Studies

This section presents one or two case studies of each approach. To the extent possible, the same format is followed for each study. However, much of the data is proprietary.

Consumer Financing: Enersol Associates, Inc.

Enersol Associates, Inc., a U.S.-based nonprofit organization, was started in 1984 by former Westinghouse engineer, Richard Hansen. Its mission is to promote lasting solutions to the energy needs of rural communities in developing countries. As such it supports the dissemination of solar-photovoltaic technology for unelectrified households. Enersol's early activities, which centered on the Dominican Republic, have since expanded to Honduras and Mexico. Enersol pioneered a particular approach known as the Solar Based Rural Electrification Concept, (SO-BASEC). Based on its implementation in the Dominican Republic approximately 8,000 households now have power and light, roughly 2 percent of the rural market.[131] The SO-BASEC approach includes various processes that are designed to build a sustainable solar energy market:

Decentralized Provision of Consumer Credit: Local NGOs manage revolving funds from which they provide short-term consumer loans, usually 24–36 months. Loans are made at market rates,[132] and are channeled through a group of retail microenterprises (ME), known as the Solar Network (Red Solar). Some of the NGOs require loan applicants to contact their offices. Richard Hansen helped to start the first SHS credit fund, in February 1985. Known initially as Familias

[131] Enersol Associates, Inc. "Enerso's SO-BASEC programs." http://www.enersol.org/sobasec.html (1998)

[132] For rural households the market is not the commercial banking sector, so this means that market rates are higher than those for banks. In the Dominican Republic commercial bank rates in the mid nineties ranged between 23 and 30 percent.

Dominicanas para la Energía Solar, it was later incorporated as an NGO, the Asociación para el Desarrollo de Energía Solar (ADESOL). ADESOL remains the only NGO exclusively dedicated to the dissemination of solar energy in the Dominican Republic. Enersol has also worked with other local NGOs to capitalize loan funds and provide the technical assistance to implement PV rural electrification.

Enersol has collaborated with the Small Grants Program (SGP) of the Global Environment Facility (GEF) to facilitate the scale-up of the NGO credit programs. The SGP funded three NGOs, including ADESOL to offer wider consumer financing. Enersol provided the technical assistance to strengthen the role of the NGOs, which centered on credit management and quality assurance. The one-year $50,000 project resulted in roughly 300 cash and credit sales. It was identified by the GEF as the approach that, "most closely approximates the goals pursued the SGP/GEF, not only with regard to the environment problem, but also in its focus on the attainment of social and economic sustainability."[133]

Appropriate Credit Methodology: Enersol/ADESOL tailor their lending practices to work with rural households that are not traditionally served by the banking sector. They rely on a relatively quick and simple process that is both convenient and economical for the customer and the NGO. Customers contact one of 14 collaborating microenterprises (ME) to fill out an application, which is forwarded to any of several NGOs providing consumer loans. The application is simple and requires no formal documentation beyond a national identity card. No collateral is required, except for the PV system itself. Nor is any formal credit check carried out. Many of the borrowers have irregular incomes, and ADESOL tailors its loan products to them by offering appropriate repayment schedules. The sum effect of these measures is to substantially increase the market to which ADESOL can profitably lend.

Though the process is tailored to the rural market, the NGOs do take steps to mitigate risks. First, the microenterprises (ME) are charged with evaluating clients, and have an incentive to make judicious loans. They are legally obligated to collect payments, and repossess systems if necessary. A microenterprise (ME) may also find its credit facilities suspended if there is a substantial increase in arrears among its clients. Another measure is to pay the loan proceeds directly to the ME to prevent misappropriation. The NGOs also focus on the borrower by requiring a down payment equal to 25 percent of the system's cash price. Since this payment represents up to twice the monthly minimum wage, it filters out the riskier households. In any case, the NGO retains ownership of the unpaid portion system, and the contract allows it to repossess the SHS. By taking preventive measures the NGOs avoid conventional credit analysis and loan security procedures that banks have found prohibitively expensive to carry out in rural areas.

Effective Payment and Service Channels: Service is offered and payments are recovered through the same channels. Borrowers usually make payments to the ME. They work within a limited region, and are able to visit borrowers whose payments are late. This gives borrowers the opportunity to request service for any system deficiencies that may have caused them to withhold payment. Even with timely payments, borrowers maintain regular contact with the dealer. The MEs aggregate these payments and transfer them to the lender. In the case of regional NGOs, the ME visits their offices. ADESOL works at the national level, so the MEs deposit payments into nearby banks, with which the NGO has an account. The ME periodically sends the lender a list

[133] Programa de Pequeños Subsidios, 5.

of payments and deposit slips. In return, the NGO sends the IOUs to borrowers via the MEs. By combining these processes ADESOL has, almost without exception, kept its arrears rate below 5 percent.

Equipment Supply and Service Networks: Enersol's emphasis has been on building a commercial distribution chain. With ADESOL it has trained and strengthened a network of fourteen MEs. They in turn have established contacts with approximately six independent wholesale importer/wholesalers with offices in the principal cities. MEs can shop comparatively, so end user prices are competitive. They can also transfer the warranties on PV modules to their customers. For rural households Enersol's emphasis on industry means that they have dependable and economical access to spare parts and reliable equipment warranties. Enersol's focus is on the retail end of the chain. It consists primarily of informal sector businesses employing one to three employees. These enterprises drive the rate of installations. There have been few wholesale installation contracts.[134] Customers purchase systems, in single units or in small groups, through both cash and credit. This maintains a steady rhythm of sales, which has allowed businesses to grow gradually and evolve rudimentary management systems characteristic of informal sector businesses. In the end, end users will only have dependable service if the retail business is able to earn a steady income.

Full cost recovery: It is important to realize that this label applies to the equipment, O&M and financing costs of solar rural electrification.[135] A 1995 Enersol paper states that, "a project in an area with a history of equipment subsidization will lure private investors only if the subsidies can be expected to continue long into the future. But that is generally not the stated long-term intention of many PV projects." There may be a justification for subsidizing market conditioning or development activities, in order to ensure that private retailers have adequate technical and business management skills to market, install and service SHS.

Reducing Capital Constraints: In attempting to keep up with the demand for SHS loans, Enersol has sought innovative means of capitalizing credit portfolios. The NGOs have traditionally done this through grant funding (bilateral, multilateral or private). At the scale they have operated until now, the five Dominican NGOs operating SHS financing programs have had some success. Enersol has sought to overcome the capital constraints to scaling up access by tapping the commercial banking sector. Toward this objective it created a guarantee fund called *Fondo Solar* to back local currency bank loans to NGOs. Two Dominican and three Honduran NGOs and cooperatives have accessed $US138,000 in loans, allowing them to finance over 500 SHS. Repayment has proceeded smoothly on all accounts. ADESOL has maintained an excellent repayment record, which allowed it to take out a second loan with only an 80 percent guarantee, and the NGOs have repaid all their loans. This experience has been instrumental in familiarizing NGO implementers and rural beneficiaries with credit procedures, and increasing bank's awareness of solar-based electrification.

Building quality through training and technical assistance: The Enersol approach is focussed on energy enterprise development and on institutional strengthening.[136] Enersol and its local

134 An exception is the recent 750 home PV electrification project in the Northwestern part of the country funded by the European Community. Competitive bidding was run for 150 unit blocks, installed in the same region. Demand was high because end users only paid approximately 25 percent of the value of the system.

135 Covell & Hansen. 1–2.

136 Enersol Associates, Inc. http://www.enersol.org/sobasec.htm

affiliates offer three levels of technical courses on PV design and installation. The basic and advanced courses focus on the SHS market, while a third course teaches design and installation for PV water systems. There are also courses for decision-makers in official agencies and NGOs that focus on the design of PV electrification projects. Training is reinforced up by individualized technical assistance in all cases. Efforts are centered on regions where there is no local energy enterprise.[137] Enersol seeks promising candidates through NGOs and individual channels to participate in the first level course where they learn basic PV design and installation, and limited business management skills. Those candidates who pass the exit examination receive individualized technical assistance to help them start their microenterprise. To qualify for the second level course, which includes advanced design and installation, and additional business and credit management skills, candidates must demonstrate entrepreneurial capabilities by selling a certain number of cash systems. It is only after graduating from the second level course that entrepreneurs may begin offering credit to their customers from ADESOL's portfolio.[138] This focus appears to have paid off. Many of the entrepreneurs that collaborate with Enersol/ADESOL have been in business for over ten years.

Limited government role: Due to technical and financial limitations the Corporación Dominicana de Electricidad (CDE), the national utility, has been unable to provide electricity to 70 percent of the rural population (approximately 400,000 households). While the CDE has not provided support for private SHS dealers, nor has it constrained them. The solar-based electrification in the Dominican Republic has generally occurred in a policy and programmatic vacuum, as far as the national government and utility are concerned.

Constraints to the NGO Model

Limitations of Grant Funding: The NGO programs are dependent on grant funding, which poses several problems. Foremost, they must provide market-conditioning services, such as training and technical assistance, whose cost is not easily recovered from beneficiaries without limiting access. Grants are not a dependable means of capitalizing loan portfolios, and it typically requires much time and expense to raise such funding,[139] and there may be costly stipulations for monitoring and reporting.[140] For approaches that combine commercial and nonprofit entities, donors may require complicated arrangements to guard against conflict of interest. However, since NGOs do still have alternate sources of financing unavailable to the MEs the playing field is not level, and the customer service imperative may be weaker for NGOs. By comparison, a ME that does not sell an affordable, high quality product will see it only source of funding—its sales revenue—go to its competitors.

Disparity of Interests among Actors: In some cases incongruities arose between the interests of NGOs and the MEs. In the first place, NGOs wished to minimize the upfront costs of SHS, and were concerned that commercially supplied systems were not affordable enough. This drove them to consider becoming suppliers. Dominican NGOs enjoy tax free importing privileges that

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137 In Nagua there was no established business. This limited the SODIN program's sustainability because beneficiaries experiencing problems with their SHS had to rely on businesses located over an hour away by highway and another hour into the interior.

138 Not all of the NGOs in the Dominican Republic follow this process.

139 Enersol has estimated that it spent US$60,000 raising US$400,000 from USAID.

140 However, commercial loans may have even tighter requirements.

SHS dealers lack. The question arose whether the NGO's role was to substitute for or support the private sector in promoting solar electrification. This tendency was exacerbated by the need to show donors that their funds are having an impact. This led one NGO to attempt to increase the number of households served by undersizing the SHS. During the rainy season, program beneficiaries experienced widespread system failures, which led to problems with late payments and an open conflict with the program. Private installers did not have a similarly strong incentive to undersize, especially those who bundled post-installation service with the sale.

High administrative costs: This is a problem for specialist institutions. ADESOL has to recover some administrative and operational costs through the spread between its cost of funds and the rate at which it lends. Partially as a result of this situation the interest rate has been set at 2.5 percent monthly on a flat-line basis. The effective interest rate is quite high. Furthermore, the high transaction costs associated with doing numerous small loans in remote, dispersed populations also increase the spread, which must be charged over the cost of funds. Consequently, a homeowner that purchases a 50-Wp SHS with a two-year consumer loan ends up paying 25 percent of the final cost in interest payments.[141] Capitalizing loan portfolios with funds from the banking sector exacerbates this because it raises the weighted average cost of funding for the program.

Consumer Financing: PT Sudimara, Indonesia

The territory of Indonesia is composed of more than 3,000 islands. Its geography does not lend itself to conventional grid electrification except for the two largest islands of Java and Bali. Consequently, 40 percent of the population has no access to electricity. This means that more than 25 million rural households[142] in rural areas have no service.

PT Sudimara Energia Surya is a privately held company headed by Robb de Lange. Operations started in 1993 when he bought the Indonesian operations[143] of R&S, a Dutch PV company. R&S was the principal supplier for the 3,300 home Presidential Assistance Project (BANPRES), and withdrew from the market when its participation ended in 1992. The project was heavily subsidized, so it is significant that Mr. de Lange saw a viable market in commercial sales to rural households[144] rather than through bulk sales to the government. By following this approach Sudimara has distinguished itself from that of most PV dealers in Indonesia that sell primarily to public agencies for their subsidized projects.[145] Through R&S Sudimara has experience dating back to the 1987 Sukatani village electrification project.[146] While the company is currently not operating due to a fire at its production facilities and the effects of the currency crisis, it is the largest reported case of direct consumer financing (CF). Prior to these events Sudimara employed 200 people and manufactured or assembled many of its own components. It has

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141 This assumes that interest is calculated over the original balance at 2.5 percent monthly and that the system costs roughly US$640.

142 Sustainable Energy Solutions, 3–17.

143 Mr. de Lange was the managing director of R&S in Indonesia prior to starting Sudimara.

144 Flavin, Christopher & O'Meara Molly. "Shining Examples." *World Watch*. Volume 10. (Washington, DC: Worldwatch Institute, May/June 1997) 28–36.

145 De Lange, Robb. "Sudimara Marketing Strategy." *Seminar Proceedings, Decentralized Electrification Issues*. (Marrakech: ADEME, 1995).

146 Gregory et al, 112.

provided consumer financing (CF) since March 1994,[147] and claims to have sold over 30,000 SHS,[148] of which 8,000 were on credit.[149]

Strong government role: Due to Indonesia's geography there is strong government support at the highest levels for decentralized rural electrification options such as solar. Following the pilot Sukatani Village project in 1987 the government substantially increased support, and the experience of different public agencies with solar electrification has grown. The national technology agency, BPPT, is the manager of most official projects. Rural financial institutions within the official sphere are familiar with lending practices for solar electrification. This includes the Bank Rakyat Indonesia (BRI) and the village cooperatives (KUDs) under the Ministry of Cooperatives. Most recently the government embarked on its 50-MWp project. This effort incorporates different delivery mechanisms ranging from the public agency, subsidized approach, exemplified by the AusAid project, to the market-based commercial models supported by the World Bank.[150] On balance, the public sector projects have been a positive influence on private companies like PT Sudimara. Bulk equipment sales allowed companies to build a working capital base through retained earnings. They also seeded the market by increasing consumer awareness and acceptance of SHS as a viable option for rural electrification. However, it is undoubtedly true that equipment subsidization has distorted consumers' expectations of the cost of SHS and has reduced their willingness to pay market prices, which can stifle the development of businesses like Sudimara.[151]

Appropriate Credit Methodology: Sudimara's strategy emphasizes decentralized consumer financing (CF) based on methods appropriate to working with rural communities. It provides credit through a network of 50 service centers located throughout the country. It is able to do this because it is partnered with a local distributor, Cibareno.[152] As a consequence, loans are processed and managed locally. This makes it easier and cheaper for customers to obtain and service their loans. For Sudimara the strategy is a means of managing its lending costs. Proximity to its clients is augmented by customer-friendly lending practices. To keep the periodic payment within an affordable range, Sudimara offers consumer loans up to 48 months. The company offers multiple credit plans with shorter repayment periods for larger systems. Since the loan is secured by the SHS itself, customers do not have to offer separate collateral. This is a significant advantage because obtaining conventional collateral can be a costly and time-consuming process for rural households. Another means by which Sudimara increases the number of cash-poor rural households it can transact with is to manage the size of the down payment. Company managers are conscious that raising the down payment above 30 percent SHS cost net of interest would severely limit demand. Sudimara's customers appear to pay commercial interest rates. Before the crisis a 50-Wp SHS, including 5 lamps, capacity to run a

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147 Ibid.

148 PT Sudimara Energi Surya. http://www.xs4all.nl/~sudimara/English/uk%20profile.htm (Indonesia, 1997)

149 Flavin & O'Meara, 6.

150 International Institute for Energy Conservation (IIEC) and Yayasan Bina Usaha Linkungan (YBUL), *High Value Applications for Renewable Energy and Energy Efficiency Technologies in Indonesia* (Washington, D.C.: U.S. ECRE, 1997), 28.

151 Northrop et al., 3.

152 De Lange, Robb. "Marketing Solar Home Systems." Proceedings, *Roundtable on Rural Energy and Development*. (Washington, DC: The World Bank, 1997) 1.

radio and television, and a one-year service plan cost approximately $450, net of interest.[153] By making a US$130 down payment, a customer could pay off the system in 48 installments of roughly US$12,[154] bringing the system cost to $610. Thus financing costs are 26 percent of the final price.[155]

Incentives to Optimize Cost Recovery and Control: Since Sudimara's operations are decentralized, it is essential to have in place tools to reduce the temptation to make risky loans (moral hazard), control the cost of managing loans, and encourage timely capital recovery. Moral hazard is controlled through incentives that also reward timely payment recovery.[156] Service centers that recover 100 percent of their customer payments on time earn a fixed bonus. If any borrower pays after the set date each month that bonus is forfeited. There is also a variable bonus for each on-time installment. If customers do delay payment, a center representative visits them, starting on the day after the payment period ends.[157] They complete a payment agreement with the customer, whose violation triggers a penalty equal to 15 percent of the quota in arrears. Managers located in the satellite offices on West/Central Java and Lampung monitor the performance of the service centers. They hold monthly meetings with "delinquent" centers and their customers. In the final instance, if a customer fails to pay for three months, the SHS is subject to repossession.[158] One advantage that Sudimara possesses in this respect is its high sales volume, which provides a ready secondary market for repossessed SHS. However, the company claims to have a 100 percent collection rate so it would rarely use this option.[159]

Effective Equipment Supply and Service Networks: Sudimara combines credit, marketing, equipment sales and after-sales service under one roof, and locates close to the customer. There are roughly fifty Sudimara-Cibareno Service Centers, each serving a sub-district, which is a territorial jurisdiction that covers 5,000–15,000 homes,[160] and employing three to four technical and marketing personnel. Satellite offices on West/Central Java, and Lampung support the centers. Sudimara assembles all SHS at its production facilities in Sukabumi, West Java and ships them to the service centers. The company's business arrangement with Cibareno distributorships allows it to expand its outreach without heavy investment in new facilities, and to build on Cibareno's familiarity with local economies. The company has also taken steps to increase the reliability of product supply. Although it imports its modules from Europe, it makes, assembles or locally purchases the other SHS components. It makes it own automatic charge controllers, fluorescent lamp ballasts and low-watt incandescent lamps. By concentrating its activities within sub-districts and building a dependable distribution chain Sudimara can cost-effectively serve thousands of rural customers.

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153 *Ibid.*

154 Flavin & O'Meara. 6.

155 This is similar to the outcome for a SHS financed over two years with ADESOL, but since the Sudimara loan is repaid over four years, the effective interest rate is lower.

156 PT Sudimara Energi Surya. http://www.xs4all.nl/~sudimara/English/uk%20profile.htm (Indonesia, 1997)

157 De Lange. "Sudimara Marketing Strategy."

158 Ibid.

159 United Nations Development Program. *Energy After Rio: Prospects and Challenges*. (New York, United Nations, 199x)

160 De Lange, Robb. "Sudimara Marketing Strategy."

Sudimara customers can be reasonably assured that their purchase will perform adequately. Quality control begins with individual testing of the electronic system components before the production facility transfers the systems to its centers. Sudimara warrants its "solar energy generators" for one year and the output of the solar cells for ten years.[161] The other components are covered by individual guarantees transferred from the company's suppliers. All SHS sales come with a one-year service contract. Since installations are clustered in sub-districts, the company can cost-effectively monitor their performance on a monthly basis during the first year. Customers can extend the contract at their expense. Through this combination of guarantees, warranties and service contracts Sudimara's rural customers obtain a level of protection that the clients of public projects do not enjoy.

A Focus on Consumer Marketing: While PV electrification has been approached primarily as a development effort, much of Sudimara's effectiveness can be ascribed to its focus on consumer marketing. The company researches consumer acceptance of its existing products and investigates the services that might interest potential customers.[162] Its extensive network of centers facilitates this effort. The objective is to segment its market and provide targeted responses to customer needs. One result of this orientation was a plan to increase emphasis on larger SHS and on alternating current (AC) systems in the future (400–500 Wh/day). The retail sales strategy relies strongly on marketing. Each center designs a one-year marketing plan when it is established. Promotion is initially carried out through village level meetings followed by household visits.[163] The centers receive promotional support from local government. Finally, each center has a monthly sales target of 20 SHS.[164] The biggest constraint has proved to be insufficient capital.

Full cost recovery: If it is to provide consistent services and quality Sudimara cannot afford to subsidize its customers unless that subsidy comes from an external party such as the government. However, part of Mr. De Lange's outlook has been that with the appropriate consumer financing packages rural households are able and willing to pay the full costs of providing SHS. This includes after sales service. Had its facilities not been destroyed Sudimara would have participated in the 200,000 home World Bank SHS project, which does involve a US$75–125 subsidy of the initial cost using GEF funding. However, it is supposed that the subsidy will be provided in a transparent way that does not prejudice the expectations of future customers. Sudimara had already been selling to large numbers of households without such a subsidy.

Constraints to the Independent Model

Insufficient Capital: Until the crisis Sudimara needed capital to meet burgeoning demand. It had difficulties in raising funds from commercial banks.[165] This limited investment in inventory, loan disbursement, and sales growth. Despite Sudimara's 100 percent collection rate banks have also been unwilling to lend to its customers through an arrangement similar to the one that ADESOL has with the Solar Network in the Dominican Republic. Consequently Sudimara capitalizes its

161 Ibid.

162 De Lange "Marketing Solar Home Systems." 1.

163 Ibid.

164 De Lange. "Sudimara Marketing Strategy."

165 Northrop et al., 4.

loan portfolio with its own capital. The company's initial capitalization of US$500,000 came from Sudimara BV Amsterdam (80 percent) and Mr. De Lange (20 percent).[166] Its capital base has been augmented by customer interest payments, which come to about US$40 annually per SHS. Only part of this capital is likely to flow into the portfolio. However, by 1995 its portfolio included roughly 5,000 clients and was reportedly valued at US$1.4 million.[167] By 1996 it had grown to 8,000.[168] Sudimara appears to have used retained earnings and short-term supplier credits to finance customers.

Insufficient Risk Mitigation: The crisis has put Sudimara's SHS out of the reach of formerly potential customers. More important, Sudimara's receivables are in local currency. While it was producing, assembling, or purchasing most of its components in the country, the company accrued hard-currency liabilities with its European module suppliers. Consequently, it was exposed to a substantial foreign exchange risk.

Leasing: Indonesia Solar Home System Project (SHS)

Indonesia's rural population, comprising over 30 million households in 62,000 villages, is spread throughout an archipelago of more than 13,600 islands.[169] Except for the principal islands of Java and Bali, population density is too low to pursue cost-effective grid-extension. In many cases SHS are also more efficient than isolated diesel mini-grids, whose estimated marginal cost of supply ranges from US$ 0.15–0.25/kWh (1996 prices).[170] The Government of Indonesia (GOI) has been pursuing solar rural electrification since the 1987 demonstration Sukatani project. Since then various large-scale projects have been implemented. In 1996 the World Bank reported that over 20,000 Indonesian households were getting their electricity from SHS. However, 40 percent of the rural population still has no access to basic electrical services.

Based on the experience of the Presidential Assistance (BANPRES) Project the GOI has sought to expand the role of SHS in rural electrification. Since 1994 it has become interested in diversifying from the public agency-led centralized procurement model characterized by BANPRES to include support for a private sector-led, commercial approach where appropriate. The World Bank (WB) has supported this move. The result of this process is the *Indonesia SHS Project*, whose central elements include, "private sector based and market conforming supply, delivery and financing mechanisms, with a key role for the government in raising technology awareness and promoting quality equipment and performance by setting standards and certification."[171]

Implementation has been delayed due to restrictions on all lending in the wake of the crisis. However, the design demonstrates how governments can catalyze the support of the private financial sector for large-scale market-based approach to solar electrification. As a result of the SHS project roughly 1,000,000 Indonesians (200,000 homes or 10 MWp) residing predominantly

166 Ibid.

167 Flavin & O'Meara., 6.

168 *Ibid.*

169 Indonesia Policy and Operations Division. *Staff Appraisal Report. Indonesia Solar Home Systems Project.* Report No. 15983-IND. (Washington, DC: The World Bank, December 1996) 10.

170 *Ibid.* 12.

171 *Ibid.* 18.

in West Java, Lampung, and South Sulawesi will gain access to basic electrical services.[172] If the effort is successful, not only will PV dealers begin tapping local private financial institutions (FIs) on their own, but these businesses will have reached the critical mass of customers allowing them to reap some economies of scale and expand to the more distant communities.

Overcoming Capital Constraints by Building Relationships: Since there is insufficient public funding, progress will depend on the ability of SHS dealers to present themselves as viable borrowers to private financial institutions (PFIs). Consequently, the project attempts to overcome the reluctance of PFIs to lend to dealers or their customers by allowing the PFIs to use multilateral on-lending facilities. In the process they will gain familiarity with lending to dealers. These businesses, partially in the informal sector, are primarily small to medium-size, family operations that progress based on the drive of an entrepreneur.[173] Consequently, their traditional source of capital has been family and friends, with some supplier credit. Some dealers have dealt with PFIs on a limited basis. A few have finance and training links with international NGOs.

The central element of the project is a US$25 million WB credit to the Bank of Indonesia (BI), to support an onlending/refinancing facility. Participating PFIs and state banks provide Rupiah-denominated loans at commercial rates to SHS dealers for up to five years so that they may offer leasing (hire-purchase) plans to their customers. These sub-lenders may then refinance 80 percent of their dealer credits over 20 years, including a five-year grace period.[174] The 20 percent commitment from the sub-lenders is intended to reduce moral hazard. Mismatching the maturities between refinancing loans and sub-loans will reduce the risk that sub-lenders become delinquent if the dealers are unable to service their loans. The PFIs and state banks use their own appraisal techniques,[175] so the project should build a sufficiently strong credit history for sub-lenders to continue to offer financing to the dealers after its conclusion.

Affordability through Appropriate End User Financing: The structure of the transaction between end user and dealer increases the affordability of the SHS by managing the size of the down payment and the periodic payment. The dealer offers a leasing plan to its customers, which is capitalized by the loan from the PFI. Interested households have to make a down payment of US$75–125, which is considered affordable within the target markets, and is supplemented by a GEF grant of US$75–125. The combined contribution is equal to between 25–30 percent of the US$636–750 cost of a 50-Wp SHS.[176] This payment serves to filter out high-risk households with insufficient cash flow. The end user would then have approximately four years to pay off the balance of the loan. The periodic payment is in the range of what rural households have been spending on kerosene, candles and other energy sources, making SHS affordable to target household.

The leasing structure minimizes transaction costs to the dealer and the rural household. There is no need to secure the transaction beyond that provided by the SHS itself since the end user only

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172 Gallardito, Joselito. 18.

173 Finucane, Jim. "Financial and Capacity Building Intermediation in Asia RE Projects." SHS Support Group, Indonesia. Presentation at *Village Power '98*. Washington, DC: October 8, 1998.

174 *Ibid.*

175 Indonesia Policy and Operations Division. 1.

176 Gallardito, José. 19.

gradually takes ownership in proportion to his/her payments.[177] This is a major advantage since rural households rarely possess traditional collateral. Furthermore, in contrast to the situation that a PFI would face under direct consumer financing (CF), the dealer has a ready-made secondary market for repossessed systems. Both parties benefit with a simpler security arrangement since the dealer can expand its market and customer minimizes the non-financial costs of purchasing a SHS.

Building Market Bases for Future Expansion: The project attempts to create commercial markets for off-grid solar electrification in West Java, Lampung, and South Sulawesi as bases for the future expansion to other areas. These last areas are those where, in the meantime, the BPPT will continue to pursue the public agency-led model relying on central procurement and financing subsidies to increase affordability. Consequently the SHS project will function alongside other projects done on a, non-commercial basis, such as the 20,000 home AusAID project.[178] This is based on the GOI's belief that solar electrification will require a variety of delivery mechanisms to achieve balanced regional development. Within the three provinces the target segment consists of households and small businesses that are isolated from the PLN grid but reasonably close to the urban centers to be economically served.

Cost-effective Channels for Collections and Service: While under BANPRES the GOI sought to build cost-effective channels for providing service and for collections by relying on Indonesia's extensive network of decentralized rural banks and cooperatives, the SHS project proposes to achieve the same ends by concentrating efforts with three geographic regions. In this manner the SHS dealers can themselves provide system servicing and collect the capital with which the PFIs and State Banks will eventually repay the Bank of Indonesia (BI) and the Ministry of Finance (MOF) respectively. Reflecting this arrangement, the leasing contracts include the cost of servicing the SHS.

Equipment Supply and Service Network Development: The central element of a sustainable mechanism for delivering reliable and economical electricity to rural areas is the commercial supply and service chain. By taking this focus, the project departs strongly from the public agency-led model. Participating dealers will be responsible for procurement of the SHS components, assembly, installation and maintenance. In this process the focus is on the retail end of this chain, the SHS dealers. The aim is to increase the number of dealers providing leasing services to rural households from two to at least eight.[179] In this manner, one project output will be a strengthened commercial supply and service chain proceeding from factory to end-user.

High Cost Recovery with Targeted Use of Grants: The public agency-led model has relied on centralized procurement, interest rate subsidies and non-commercial repayment terms to reach the poorest households. While the SHS project departs from this model, it also contemplates the use of subsidies. However, they are targeted to overcome the key barriers to the establishment of a sustainable rural market for SHS, which would ostensibly lead to a fall in the price and an increase in the quality of SHS. The principal barriers identified were a lack of established high-volume supplier-dealer chains, high system prices due to low sales volumes, and a lack of

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177 However, as pointed out by a World Bank report, the issue of shared ownership between the dealer and the rural household, is a major disadvantage vis-à-vis a fee-for-service operation.

178 Indonesia Policy and Operations Division. 13.

179 *Ibid.* Annex 3.1. 3.

installment credit. The subsidy, roughly US$24 million or 20 percent of the total project value, comes from the Global Environmental Facility (GEF).

The GEF grant covers the incremental costs of meeting rural lighting and power needs with SHS as opposed to relying on the traditional energy sources. This includes a US$75–125 payment designed to reduce the size of the down payment that the customer has to make to a level consistent with rural household cash flow patterns. In conjunction with the credit component of the project, it is hoped that this will stimulate sales enough to allow the dealers to attain economies of scale. The GEF subsidy also covers the costs of other "market conditioning activities." This includes business planning assistance for dealers and lenders, training for the BPPT to establish a domestic equipment testing and certification capability, and technical assistance to the Directorate General of Electricity and Energy Development (DGEED) for the development of a least cost decentralized rural electrification plan.

An expanded focus on consumer protection: Consumer acceptance is the most vital ingredient to establish a rural SHS market. The project approaches this from a number of angles. First, there are equipment and energy service standards for participating dealers, including returns policies, warranties, adequate after-sales service and certification. To protect against sub-standard performance, the GEF co-payment to the dealers is deposited into an escrow account, which is used to assist customers that receive unsatisfactory service.[180] When the project concludes, the dealers gain access to these funds, so they have an incentive to take steps to conserve them in the meantime. There are also sanctions, which vary according to the severity and frequency of the violation. PFIs must agree not lend to dealers with severe violations. The GEF grant also promotes customer initiative by supporting information interchange among existing and prospective users with regard to the quality of the SHS and the service. Finally, by providing technical assistance for the establishment of an ISO 25 accredited product certification laboratory within the BPPT's Technical Implementation Unit and Energy Technology Laboratory (LSDE), the project will begin to build the necessary regulatory framework. Although some of these measures will expire with the project, it is hoped that there will be base upon which to build more permanent arrangements that complement a market-based approach.

Training and technical assistance: Training and technical assistance will focus primarily on dealers and public agencies. For dealers this will include business planning, financial management and accounting. The LSDE will receive training and technical assistance to institute a product testing and certification laboratory, which it is hoped will eventually qualify for an ISO 25 rating.[181] Finally, the DGEED will receive technical assistance to help it develop a least cost decentralized rural electrification plan, with a focus on SHS.

Strong government support: The GOI recognizes rural electrification as a key element of it rural development strategy. It is also a signatory of the UNFCCC and is pursuing opportunities for mitigation. The GOI supports the development of renewable energy as a means of diversifying its energy sources to slow the transition to status as a net oil importer.[182] It has directly supported solar rural electrification since 1987, and there is a well-developed set of official institutions. The Agency for the Assessment and Application of Technology (BPPT) is in charge of implementing

180 *Ibid.* 33.

181 *Ibid.* 23.

182 *Ibid.* 1.

the long term to install a million SHS, known as the "50 MWp" program.[183] However, power supply is not a monopoly of the state utility, and private sector participation under BOO schemes is permitted. The law also permits cooperatives and other legal entities to generate, transmit and distribute power for public use." The GOI is gradually moving toward a more market-based approach, and the Indonesia SHS project is the most advanced expression of this transition.

Constraints

Asian Currency Crisis: Indonesia's stand-by agreement with the IMF in response to the 1997 currency crisis included provisions for temporarily halting all lending by domestic banks. This effectively postponed the start-up date for the Solar Home Systems project.

Extra demands on household liquidity: Battery replacements have not been factored into the five-year lease. Since households will already be making regular lease payments, the extra cash required to do this every two to three years may be beyond the means of many rural family budgets. This translates into the possibility that the systems may not perform as foreseen due to battery deterioration.

Fee-for-Service: SOLUZ, Inc.

Richard Hansen, the head of *SOLUZ, Inc.* and its Dominican subsidiary *Soluz Dominicana* started the company in 1993. Soluz benefited from the market-seeding activities carried out by Enersol and ADESOL, such that when it began operating there was already 1 percent market penetration through cash and credit sales. It bought the operations of an existing service and supply business, *Industrias Eléctricas Bella Vista, C.A (IEBV)*, which had been one of the most active members of the network of small businesses collaborating with the CF operations of ADESOL. Soluz Dominicana joined its activities with the fee-for-service operation known as Solar Electric Energy Delivery (SEED™). The head office is located in Chelmsford, Massachusetts in the United States, and the Dominican subsidiary is located in Sosúa, in the former offices of IEBV. In December 1997 Soluz completed the prototype 1,000 unit stage.[184] In 1997, Soluz also commenced operating in Honduras, under its subsidiary *Soluz Honduras, Inc.*[185] As of June 1999 the joint operations are providing service to roughly 2000 households, 1600 located in the Dominican Republic, in the provinces of Puerto Plata and Espaillat, and 400 in Honduras.

Expanded Coverage and Greater Affordability: Soluz was conceived as a means of reaching a larger segment of the rural population than possible through the NGO/microenterprise consumer financing (CF) approach. Two elements were particularly important. First, the fee-for-service approach provides a more satisfactory means of overcoming the first-cost barrier faced by rural households. Second, it also attempts to overcome the capital constraints faced by the NGO financing programs that were trying to expand their lending activities based primarily on official development assistance.

Purchasing energy services from one of the four Soluz energy service plans is more affordable than buying a SHS from on credit using an ADESOL consumer loan through one of the

[183] *Ibid.* 3.

[184] "1000 Rental PV Systems." *PV Power: News in PV Commerce, Industry and Research.* 3.

[185] NRB Microenterprise draft , 46.

collaborating microenterprises. In contrast to the 25 percent down payment required under the CF plans, Soluz requires a less demanding series of connection fees. Since the company maintains the SHS, there is no need to use the down payment as a filter to eliminate those clients who would be unable to replace the battery. Furthermore, the periodic payment, which ranges up to US$20 is also lower under the Soluz service plan the NGO consumer loan. For example the monthly payment for plan that offers 6.5 kWh per month is roughly US$20.[186] The monthly payment for the same 50-watt SHS under an ADESOL consumer loan is approximately $42.[187] The interest portion alone of this payment is just slightly smaller than the monthly payment for a Soluz 6.5 kWh service plan (50-watt SHS). These individual advantages add up to a significant reduction in the liquidity demands on household incomes, when compared to CF. By making energy service more affordable SEED significantly expands the potential market.

Soluz also represents a response to the capital constraints facing developers trying to scale-up NGO consumer credit operations. ODA has been a shrinking and uncertain means of capitalizing portfolios. Some grants are also subject to high transaction costs due to complicated qualification and reporting requirements. Finally, grassroots NGOs have only been able to raise commercial debt financing based on specialized funds that provide loan guarantees such as Enersol's *Fondo Solar* (or ACCION's *Bridge Fund* in microenterprise lending). Soluz was formed as a private commercial firm, since its founders viewed this as a more appropriate vehicle for raising large amounts of long-term debt and equity financing requiring more sophisticated financial and operational management.[188] While the Dominican NGO CF operation has raised approximately US$100,000 in loan capital, to date Soluz' Dominican subsidiary has raised just under US$1.3 million in debt and equity financing (see Table 4.1.2) in half the time. Soluz Dominicana started operations in 1993, at which time 10 microenterprises collaborating with ADESOL had sold roughly 4,000 SHS on a cash and credit basis over a ten-year period. In four and a half years, the fee-for-service operation has reached roughly 2,000 rural households.

Table 4.1.2: Capitalization of Soluz Dominicana

Date	*Amount (US$)*	*Source*
October 1993	100,000	Rockefeller Foundation
December 1993	200,000	Rockefeller Foundation
June 1995	200,000	Environmental Enterprises Assistance Fund (EEAF) / USAID
April 1997	75,000	EEAF / IFC
	75,000	
July & September 1997	75,000	E&Co. (IDB)
September 1997	150,000	Calvert Group
March - October 1998	500,000	Sunlight Power

Source: Village Power '98, "Solar Electric Energy Delivery: A Business Model."

186 Sustainable Energy Solutions. *Guidebook for Financing New and Renewable Energy Projects*. Prepared for the Asia Pacific Economic Cooperation (APEC) Energy Working Group, Group on New and Renewable Energy Technologies. (Japan: New Energy and Industrial Technology Development Organization, August 1998) 3–14.

187 This uses an exchange rate of US$1 = RD$15, which was roughly the rate in mid-1998 when the APEC publication from which the service tariff for the 50 watt SHS was taken. The monthly interest rate for the consumer loan is 2.5 percent flatline balance.

188 Sustainable Energy Solutions. 3–13.

Flexible and Customer-oriented Service: Soluz serves the need for power and lighting primarily from rural households, though it has also included the needs of rural small businesses with productive loads. It has successfully included options to help rural entrepreneurs provide more varied and higher quality services and to increase their productivity. Examples include powering small and medium-scale electronic equipment to offer music and/or news in small country stores and *discotecas*, as well as food and beverage preparation using DC blenders. It has also started to test-market PV-powered refrigeration packages aimed at these businesses.[189] On a limited basis Soluz PV systems are also supporting a slow expansion of cellular phones to rural households and businesses.

Appropriate Credit Methodology: Since the SEED customer never takes ownership of the SHS, many techniques for establishing customer creditworthiness and securing the transaction are less necessary. Soluz customers only need to show limited repayment capacity since they can cancel service by giving advance notice. Instead of the 25 percent down payment that NGO consumer financing plans use to filter out risky clients (inadequate cash flow), Soluz clients pay a several more economical connection fees. Furthermore, since Soluz maintains ownership of the SHS there is no need for formal collateral. If payment is discontinued, a Soluz technician can transfer the SHS to another customer. The customer contributes those components that cannot be removed on disconnection. While NGO CF operations have innovated on traditional lending techniques to work with rural households and businesses, fee-for-service operations such as Soluz have reduced the need for them altogether. In a country, with an often-unpredictable legal system, the SEED approach is advantageous because it reduces the need to use expensive techniques to ensure revenue security.

Like other fee-for-service operations, Soluz innovates by offering itself as a creditworthy borrower in capital markets. This is an advantage over the CF models wherein the rural borrower has to qualify for the loan. In contrast to this individual borrower, Soluz maintains GAAP-compliant financial records, and can provide collateral to secure debt financing. This approach locates the credit transaction where it is most appropriate.

Effective Payment and Service Channels: Soluz Dominicana relies on local businesses to serve as collection points for customer payments and channels their requests for system repairs. There is one collection point for every 50 households served.[190] Eventually one technician is supposed to cover 20 collection points and service 1,000 systems. Currently this is limited to 16 collection points and 800 systems.[191] Though the operation is currently at a level of roughly 1,600 systems, the near term objective is to cover five technician territories of 1,000 systems with one solar service center providing centralized management.[192]

Generally the SEED program offers more convenient and continuous service than if the SHS is marketed by individual microenterprises cooperating with ADESOL. SEED customers can make monthly lease payments and request service without leaving the community. Furthermore, system maintenance and repairs are bundled with the energy service. This is a fundamental improvement over the CF approach, where end users are responsible for routine maintenance and

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189 NRB microenterprise draft, page 46.

190 Hansen, Richard. 11.

191 Foster, Robert. 97.

192 Hansen, Richard. 14.

contract for repairs as needed. Many of the microenterprises that work with ADESOL also provide high-quality customer service. However, as volume increases the Soluz approach will be more responsive due to the centralized inventory and general operational management provided by the Service Center. Ultimately, it is the bundling of expert maintenance and repair with the energy service agreement that provides more convenience and promises greater sustainability through optimized lifetime system performance and greater customer satisfaction.

"Business as Usual" Equipment Supply and Service: In contrast to the one-time centralized public procurement characteristic of many official solar electrification efforts, Soluz procures and supplies equipment based on estimated customer demand per period. Soluz purchases batteries in the local markets where it operates, and assembles lamp ballasts and charge controllers locally from imported components.[193] This reduces labor costs for system assembly somewhat. PV modules are procured fully assembled from U.S.-based companies. Soluz Dominicana pays 18 percent in value-added (known as the ITBIS) and import taxes on all foreign components. Due to the "business-as-usual" approach to equipment supply and service, the prices that SEED customers pay are subject to less variation than in markets characterized by one-time volume discounts and tax exonerations.

Sustainability: Full cost recovery: As a commercial operator Soluz does not subsidize the cost of providing energy service to the rural household. Nonetheless, as indicated in the section on affordability, the cost to the household is lower than under a CF approach. Even customs and value-added taxes are accounted for in the cost-structure and Soluz has made no efforts to obtain a tax exoneration from the Dominican government.

High quality training and technical assistance: Soluz has been able to capitalize on the extensive practical training experience of Enersol. As a result its technicians have participated in numerous hands-on training courses in basic and advanced PV design and installation. In contrast to the situation generally faced by individual entrepreneurs, Soluz has the ability to contract for specialized training and technical assistance, which is viewed as an operational cost. Thus, while Soluz may have benefit from special circumstances due to its affiliation with Enersol within the Global Transition Group (GTG), fee-for-service operations may be more able to continually update technician skills due to greater cash flow.

Limited role for the government: Neither of the two Soluz subsidiaries has focussed on the centralized government procurement market to any great degree. In the Dominican Republic Soluz operates in the same policy vacuum that all PV enterprises face. Both subsidiaries have concentrated on their core activities of fee-for-service, although Soluz Dominicana has collaborated with the NGO community occasionally to pursue rural water projects based on PV and on wind energy.

Constraints to the Fee-for-Service Model

Current Limited Access to Capital: Despite having overcome the constraints faced by NGO CF operations in raising private capital, Soluz is still unable to raise enough capital to meet the demand it faces from rural Dominican and Honduran households. As is the case with all SPs or project developers, commercial banks and equity investors still view Soluz as operating in a high risk market because they question the creditworthiness of rural customers or the "appeal of the

193 Sustainable Energy Solutions. 3–14.

technology."[194] Furthermore, fee-for-service operations (or ESCOs as they are known) are small in relation to the stakes that conventional investors are accustomed to taking, while the cost for closing and managing the transaction are roughly the same as for larger investments. At present Soluz Dominicana has raised roughly 50 percent of the necessary capital to build up to the minimum business unit serving 5,000 rural households (estimated US$2.5 million at $500 per household).

Limited Ability to Cover Isolated Systems: Soluz provides cost-effective service by concentrating its customers geographically, which may mean that some households that are able to afford service cannot obtain it. Typically rural families are placed on a waiting list until the minimum concentration is reached, whereon a collection point is set up, and the demand is met. In isolated communities there may not be sufficient demand to warrant setting up a collection point. Individual microenterprises may be willing to venture farther afield, though credit sales also suffer from this drawback to some degree. Thus the only option available to distant households may be to purchase their SHS with cash or to pursue special credit terms that permit irregular payments.

Fee-for-Service and Leasing: Philippine Rural Electric Cooperatives (RECs)

While REC activity does not preclude private PV dealers from selling to rural households, much PV electrification has occurred under public-private initiatives run through the RECs. Roughly 2,750 of the estimated 5,000 SHS installed through 1997 fall into this category. The primary on-going effort dates from the *Rural Photovoltaic Electrification* (RPE) Program (1993–99), as part of the *Philippine-German Special Energy Program* (SEP) implemented between the NEA and the German Agency for Technical Cooperation (GTZ) from 1986 to 1995.[195] Under RPE, solar PV is a pre-electrification option for remote barangays that will eventually receive grid service. A follow-up phase to SEP runs through 1999. It has been planned that activities will continue as part of the Estrada administration's *Energy Resources for the Alleviation of Poverty* (ERAP) Program.[196]

The RECs, supported by NEA and GTZ, have employed both leasing and fee-for-service models. While progress has been slower than envisioned, RPE offers a potentially useful model. As privately owned institutions, the RECs are an alternative to the Rural Energy Services Companies, which may more effectively complement a country's institutional structure. The financial and operational constraints that have limited progress do not indicate that the model is not viable. Rather, the experience highlights obstacles that must be overcome if PV electrification is pursued using primarily public funding. The Philippine experience is not described in detail here, due to the familiarity of the ESMAP report audience with this experience.

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194 Flavin & O-Meara. 8.

195 Hernandez, Noel. "Rural Photovoltaic Electrification: Experience of the National Electrification Administration (NEA) with the Electric Cooperatives." Alternative Energy Department, NEA. Presentation at Workshop *Private Sector Roles in Rural Renewable Energy Services Delivery in the Philippines*. (Quezon City, Metro Manila: March 17–18, 1999).

196 Yeneza, Grace. Manager, PEI/Winrock International REPSO.

Mixed Approach (Consumer Finance and Leasing): Solar Electric Light Company India (SELCO-India)

With 962 million citizens, India is the world's second most populous country. Roughly 63 percent of the population is rural. The Indian government (GOI) has actively pursued grid electrification and officially almost 87 percent of its 587,258 villages already receive service. However, due to the parameters used by the Ministry of Power (MOP) for categorizing a village as electrified, actual household coverage is only 31 percent.[197] According to the Indian Renewable Energy Development Agency (IREDA) electrification via SHS becomes the most cost-effective solution for villages located three to four kilometers or more from the nearest 11 kV grid.[198] Some 50,000 villages of 80 households each fall into this category.

SELCO Photovoltaic Electrification Pvt. Ltd., is a private company started up in 1995 to provide energy services to rural communities in Southern India. Its head office is in Bangalore. Its market encompasses 290,000 rural households in the states of Karnataka, Andhra Pradesh, northern Kerala and Tamil Nadu.[199] It is a wholly owned subsidiary of SELCO International. SELCO India's (SI) Director and founder is Dr. Harish Hande. He has a doctorate from the University of Massachusetts in Energy Engineering (solar energy),[200] and has received training from Enersol Associates. Through 1998 SI has served over 2,500 households.[201]

Controlling Costs by Working through Local Institutions: SELCO takes different approaches to financing the end user's purchase. Where solid financial institutions are engaged in consumer lending at the village level, the company prefers to collaborate with them. It has reached agreements with national banks as well as the Grameen bank to provide three to five year consumer loans to SI's creditworthy customers. It also works through other local institutions such as agricultural cooperatives and plantation companies that provide financial services to their rural members. Where local institutions are weak, SI itself provides three-year lease plans using IREDA soft loans. By collaborating with local institutions with established processes and knowledge of local economies SI can confidently outsource payment, collection, and credit analysis. This helps to minimize the costs of providing financing to both lender and customer.

Appropriate Credit Methodology: SI facilitates access to capital on the part of rural households that have the ability and willingness to pay for a SHS. It is currently estimated that the average rural household in Southern India spends roughly US$9/month[202] on lighting and batteries. SI will on-lend third party funds itself or facilitate relationships between customers and local institutions offering financial services.

SI has facilitated medium-term third-party consumer financing for its customers. Though it works with traditional partner organizations such as the Malaprabha Grameen Bank, the company has also facilitated individual SHS loans from the banking sector. These state-owned banks have access to capital at preferential rates, which are transferred at 12–12.5 percent to

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197 Winrock International/Renewable Energy Project Support Office (REPSO) India. "SELCO—A Success Story in Solar Energy."

198 Bhargava, B. "Economics of Photovoltaic Applications." *IREDA News*. IREDA, 2.

199 E&Co. "India: SELCO Photovoltaic Electrification Pvt. Ltd." http://www.energyhouse.com

200 Winrock International/REPSO India, 2.

201 Arora, Rahul. PV Project Officer. Winrock International REPSO India.

202 Rs.43.5=US$1

borrowers. Affordability is enhanced because loans range from three to five years, and restricting the down payment to 10 percent of the SHS price. Consequently, monthly payments fall within the range of affordability for rural households.

In other cases SI serves as an intermediary using appropriate credit practices to allow rural households to access additional funding at an affordable cost. In some areas of Karnataka it offers three-year lease plans capitalized by an eight-year loan at 2.5 percent annually from IREDA/World Bank facilities. The leases carry a financing cost of 13 percent. SI's plans avoid expensive banking sector methods for establishing borrower creditworthiness and for securing loans. The transaction is secured by the primary components of the SHS. Customers also make a 25 percent down payment, which serves to filter out the most risky transactions. As a result, it is more affordable for a customer to qualify for SHS financing. In to a monthly payment ranging from US$8 to US$12, minimizing transaction costs keeps the arrangement within the range of affordability. Finally, SI also offers a plan with a 50 percent down payment, and the balance payable 90 days after the installation for rural households with short-term financing needs.

Expanded Coverage and Greater Affordability: SELCO India's activities build upon the experiences of the Solar Electric Light Fund (SELF), a U.S based NGO, in providing consumer credit on a pilot basis in collaboration with Indian counterpart organizations. However, while SELCO benefited from SELF's experience, SI's founders decided to scale up activities via a private commercial company rather than a nonprofit vehicle. Increased growth prospects could translate into economies of scale and greater affordability. SI has generally not had access to grants; the Winrock "reimbursable grant" was effectively a loan. Its commercial status has allowed it to tap international capital markets. Recently SELCO International raised US$2.5 million, largely on the strength of SI's operating record.[203] (See Table 4.1.3.)

Table 4.1.3: Capitalization of SELCO India

Date	*Amount (US$)*	*Source*	*Type*
September 1995	30,000	Rockefeller Foundation	Grant
1995	50,000	E&Co.	Equity
November 1996	150,000	Winrock Intl. REPSO India	Reimbursable grant/loan
June 1995	~50,000	IREDA	Concessional loan with E&Co. guarantee
	2.5 million	Diverse Investment Funds	Equity

Sources: National Renewable Energy Laboratory (NREL), E&Co., REPSO India.

Equipment Supply and Service Network: End users that deal with SI obtain their SHS through a commercial distribution chain much like other consumer durable goods. This is in contrast to many activities carried out by the State-Owned Nodal Energy Development Agencies (NEDA). SELCO purchases from reputable suppliers such as Tata BP Solar and Siemens.[204] This allows it to offer its customers a reliable in-country manufacturers warranty, in addition to a proprietary one-year guarantee on the SHS. It uses locally made batteries. SI's business approach to solar electrification stands in contrast to traditional governmental efforts that have concentrated on

203 Winrock International/REPSO India, 4.

204 Aroral, Rahul.

fulfilling targets rather than on providing high quality service. Although SI has taken advantage of the financial incentives available through different official and multilateral initiatives, its revenues come from closing sales to individual households. This connection fosters a view of their activities as providing an energy *service* more than equipment, and is reflected in the company's customer support activities. SI's ninety-day credit sales are conditional, offer a money-back guarantee if the customer is not satisfied, and installations come with a one-year maintenance contract. Maintenance and spare parts are also built into the three-year leasing contracts. SI provides decentralized service for its customers' installations through a network of seven offices located in the states of Karnataka and Andhra Pradesh.

Sustainability: High Cost Recovery: SELCO India (SI) stands out because it does not subsidize equipment or O&M costs. The financial subsidies that SI channels to its customers do not appear to distort the market since they are a routine part of wider government support for PV. SI's strategy is sustainable for primarily two reasons. First, by recovering its equipment and O&M costs, the company can provide consistent, high-quality customer service. This has been shown to be critical to cost recovery. Secondly, as mentioned earlier in this paper, greater cost recovery provides the necessary information to SI's investor's on the viability of the venture and on the end users' willingness to pay. An indication of this is that SELCO International was able to raise US$2.5 million based substantially on SI's record of profitability.

High quality training: SI's technicians undergo a rigorous week-long course teaching technical and business skills, which is conducted by the Bhartiya Vikas Trust in Manipal.[205]

Supportive role for the government: The Government of India (GOI) has a history of support for renewable energy technologies channeled through different official agencies. Since 1992 it has reoriented its role to focus on market development, with an increasing use for targeted incentives. One expression of this trend is the GOI's growing support for IREDA, which is its renewable energy financing arm. The GOI has taken out US$1.5 million WB grant to capitalize IREDA's activities, and has supported additional debt financing.

Constraints

Prevalence of Subsidized Alternatives: While the government's strategy has shifted toward market friendly approaches, capital subsidies continue to be used to some extent. The State Nodal Energy Development Agency (NEDA) in Karnataka is inactive and the grid is erratic and unreliable, which has favored SI's growth. IT has sold over 2,500 SHS there. However, in other states NEDAs are more actively constraining the germination of SELCO-like companies.[206]

Capitalizing Rural Energy Service Delivery Operations

The rural energy service delivery options presented in the foregoing sections offer the possibility of reducing the heavy drain on government resources posed by many public sector programs. At the same time governments can target a limited amount of funding to leverage private capital to address the need for light and power in rural areas. The options available to off-grid developers to capitalize their operations are growing and becoming more diverse. The following is a brief

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205 Arora, Rahul.

206 *Ibid.*

description of some of these options, as well as activities that governments may undertake to facilitate capitalization.

Micro Credit

Micro-credit operations have become profitable and established options for serving the working poor. Their ability to raise capital from different sources, including the banking sector, has grown. They have evolved methods suitable for working with clients not traditionally served by the commercial banks. By following this strategy they are able to profitably disburse many smaller-sized loans, which benefits their clients by minimizing the transaction costs of qualifying for and servicing the loan. It is this combination of increasing access to capital and cost-effective lending methodologies, that has led the Grameen Bank to set up a rural power subsidiary, known as Grameen Shakti (GS) to market solar home systems (SHS) and other alternatives. Over roughly two years, which included the planning stage, GS *solarized* 430 rural households.[207] In 1997 it raised US$750,000 from the IFC. It anticipates that by 2001 up to 5,000 households will gain access to dependable electrical services. One drawback is that many micro-credit organizations, with important exceptions, do not have extensive rural outreach.

Rural Savings and Loans (S&L) Cooperatives

While their financial health varies by country, rural S&L cooperatives may be able to provide the capital for rural energy service ventures. In some places they are increasingly taking a business-like approach to rural banking. Where they manage to project an image of security, these community banks are mobilizing growing amounts of capital from rural households. However, there is a need to identify profitable lending opportunities. For example, in the Dominican Republic some reformed rural S&L cooperatives exceed the reserve requirements by 10 percent. Solar electrification operations with a proven track record can offer a secure opportunity to place this capital. S&L cooperatives are in theory well suited for collaborating in consumer financing (CF) operations since they have traditionally focused on such lending. Moreover, they are familiar with local economies and have evolved methodologies suitable for rural areas.[208] A beneficial use of government subsidies would be to support efforts by third parties to train qualified cooperatives in lending for solar electrification. However, one obstacle that may arise as these organizations come under formal regulation is a restriction of their ability to adopt innovative credit practices.

Commercial Clean Energy Investment Funds

Over the last several years specialized investment funds have sprung up to provide commercial financing for environmental business ventures. They provide debt or equity financing, or both. Their activities include support for renewable energy projects, both on and off-grid, in various places. These organizations range from private sector initiatives such as the Triodos Bank in the Netherlands[209] to the public-private partnerships such as the upcoming Renewable Energy and Efficiency Fund (REEF), which involves the International Finance Corporation. There are also

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[207] Chandra Barua, Dipal. "Energy's Role in the Rural Income Generation: The Grameen Strategy." Grameen Shakti. Presentation at *Village Power '98 Conference*. Washington, DC: National Renewable Energy Laboratory (NREL), October 1998.

[208] Sustainable Energy Solutions, 3–6.

[209] *Ibid.*, 3–10.

nonprofit organizations such as Environmental Enterprises Assistance Fund (EEAF) that function as venture capital funds. What they have in common is that they provide capital at commercial rates. Some of them offer limited grants for technical assistance activities. All stages of business development are targeted, although support is limited for start-up ventures.

Multilateral and Official Institutions

In addition to collaborating with the private sector in developing environmental venture capital funds, the multilateral development banks are increasing their support for renewable energy ventures. The trend is to support pre-commercial and commercial operations, but in many instances nonprofit organizations can also qualify. The World Bank has been trying to mainstream lending for renewable energy into its portfolio. To date the most active efforts have occurred through the Asia Alternative Energy (ASTAE) program, which has committed over US$1 billion for 31 renewable energy and energy efficiency projects in Asia since 1992. Bilateral donors are beginning to offer financing mechanisms that could serve to capitalize a rural energy service operation, including the U.S. Agency for International Development's (USAID) Development Credit Authority (DCA), the German Investment and Development Company (DEG) long-term project finance basis, and the Netherlands Development Finance Company (FMO), which is establishing an environmental fund that will include financing of renewable energy projects.[210]

Loan Guarantees

Until now the most innovative uses of loan guarantee funds have occurred in the nonprofit sector. The oldest example is that of Accion, a U.S.-based nongovernmental organization (NGO) that support micro-enterprise lending programs, which has used its *Bridge Fund* to enable its affiliates to capitalize their loan portfolios. Enersol Associates, Inc. used grant funding from the Rockefeller Brothers' Fund to set up a similar guarantee fund known as Fondo Solar. Through this mechanism five NGOs in the Dominican Republic and Honduras were able to capitalize loan portfolios using roughly US$140,000 in funding from the commercial banking sector. Another NGO, the Solar Electric Light Fund, provided the guarantees to allow the initial capitalization of its for-profit affiliate in India, the Solar Electric Light Company India Ltd. Despite the fact that solar electrification has established a record as the most cost-effective option for serving many off-grid markets, conventional lenders continue to perceive such transactions as excessively risky. Government funds that currently subsidize the equipment cost of SHS could instead be reoriented to provide guarantees for loans to rural developers. The commitments could then be gradually reduced as the borrowers establish a credit history. The underlying assumption is that these operations are profitable, and that lenders will recover their funds without accessing the guarantee.

210 Winrock International, "Global Financiers of Renewable Energy Enterprises" *REPSOurce*. Volume 3, No. 1, 1998.

Annex 4.2: The Argentina Off-Grid Rural Electrification Project: An Example of the Concession System Approach

Project Objectives: The main objectives of the proposed loan are to (a) provide rural areas with reliable electric supply in a sustainable manner, using renewable sources where feasible; (b) support and consolidate the power sector reform strategy of the Government of Argentina (GOA), (c) support the government strategy to expand private sector participation in the provision of electricity in rural areas; and (d) promote environmentally sound energy resource development in Argentina.

Global GEF objectives are to (a) remove market barriers to the development and application, of renewable energy sources; and (b) reduce GHG emissions that would be produced otherwise by thermal generation of electricity (using diesel), and by burning candles and kerosene for lighting and other domestic uses.

Project Description: The project will consist of (a) installation and operation in about eight provinces, by private concessionaires of (i) solar home systems in about 70,000 dispersed rural households; (ii) small decentralized power supply units, (range 3 kW to 10 kW each), based on renewable energy systems (RES), namely photovoltaics, small wind turbines, and mini hydro plants) and diesel units to provide electricity to about 3,500 households living in agglomerated village; and (iii) about 1,100 RES to provide electricity to provincial public institutions (schools, medical centers, police stations); (b) installation of pilot wind home systems in two (2) communities; and (c) a capacity building program consisting of technical assistance to facilitate (i) the implementation of the program; (ii) the consolidation of power sector reforms in the country; (iii) the development of the technical and institutional capabilities required for broader adoption of RES; and a training program to strengthen the capability of the Secretariat of Energy (SE) and the provincial regulatory agencies.

Project Financing: On a preliminary basis, it is estimated that the total cost of the project will be about US$120 million, of which US$30 million would be financed by IBRD, US$10 million would be financed by a GEF grant, and the balance (US$90 million) by customers, concessionaires, and the provincial governments through the Electricity Funds.

Project Sustainability: Sustainability of the proposed project would be assured by strengthening the provincial regulatory functions and institutions, and by providing appropriate incentives and returns for the concessionaires. The financing of individual systems is structured (a mix of GEF grant for incremental costs, GOA lifeline tariffs/connection fee assistance, and consumer payments), so that full cost recovery is assured from those customers who sign up for services during the project life. In other words, the sustainability of systems installed with project support is assured for the 15-year concession period. Beyond the project life, it is expected that new customers would sign up, even in the absence of the GEF grant, because expansion of the customer base during the project life and achievement of economies of scale would have reduced operational costs by at least the amount of the initial GEF assistance. Project sustainability will be supported through agreed monitoring and implementation actions. A Mid-term Review will be scheduled by about June 2001 to allow mid-course corrections if necessary. The Bank will monitor project implementation on the basis of quarterly progress reports from the SE, by accounting auditors, and through Bank supervision missions.

Project Implementation: The SE will provide the policy framework for rural energy development and overall guidance to the project. A Project Coordination Unit has been set up in the SE responsible for general project coordination. An administrative Unit (AU) located within the SE would be responsible for record keeping, reporting functions, and processing disbursement requests for Bank loan and GEF grant. UNDP would assist the SE in handling the hiring of consultants. The GOA will transfer the Bank loan and GEF grant to the provincial governments as a grant. The provincial governments, through a project implementation unit, will be in charge of the local coordination and project supervision and monitoring. The provincial regulatory agencies will supervise concession contract compliance. Existing or new concessionaires will implement the project. Existing concessionaires will purchase equipment following the Bank's procurement guidelines. New concessionaires selected through international competitive bidding, will purchase equipment following their own procurement rules. It is expected that new and existing concessionaires will finance the cost of equipment and its installation using own resources, i.e., before claiming any eligible customer subsidy from the provincial government. Two pilot concessions for dispersed rural areas, which were a condition for the Bank to launch a preparation mission, have been in place since November 1996. These concessions, which also supply power to the concentrated market (urban areas), have already initiated the installation of RES in public buildings located in the dispersed rural areas. Consultants financed by France under GEF are already carrying out market studies in four provinces.

Environmental Aspects: The project would reduce environmental impacts by shifting supply from conventional fuel sources to non-polluting energy sources. The renewable energy technologies most likely to be used in the project are solar PV, wind turbine, and mini-hydro power units. The project also supports the GEF Climate Change Operational Program titled "Promoting the adoption of renewable energy by removing barriers and reducing implementation costs." These technologies are environmentally clean and are not expected to pose significant environmental or resettlement problems. The project is classified as "B." The concessionaires during the installation operation and maintenance of the RES will comply with national environmental regulations (as well as specific conditions in the concession contract documents) to qualify for disbursement of Bank and GEF funds.

Table 4.2.1: Financing Plan

Funding Source	*US$ million*
Private Concessionaires	43.2
IBRD	30.0
Government (National and Provincial)	26.5
Customers	10.8
GEF	10.0
Total	120.5

Figure 4.2.1: Argentina Off-Grid Rural Electrification Project: The Concession System

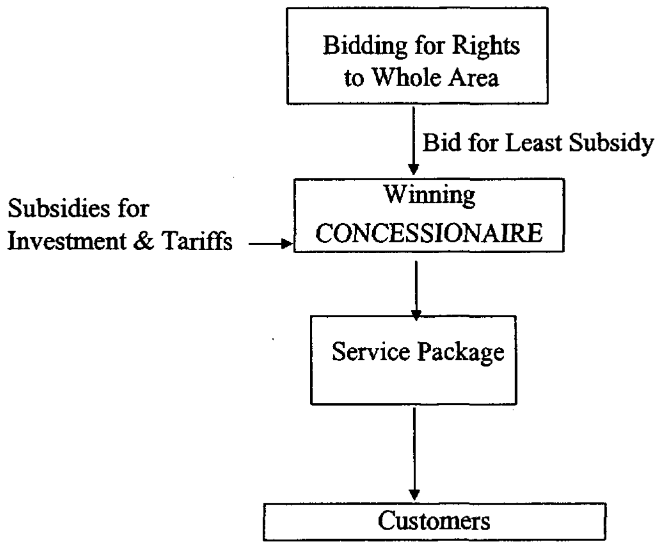

Table 4.2.2: Technical Assistance Activities Grant-Financed by the GEF (US$ million)

Activity	*Total*	*Gov't*	*GEF*
Capacity Building on Renewable Energy	3.20	1.05	2.15
Detailed market studies	0.40	0.10	0.30
Standards and Certification for SHS	0.30	0.10	0.20
Promotion and Public Education Campaign	0.75	0.25	0.50
Feasibility Studies for Centralized Renewable	0.40	0.10	0.30
Database to Improving Solar Resource Information	0.20	0.05	0.15
Database to Improve Wind Resource Information	0.25	0.05	0.20
Study to Match Direct Current Appliances to SHS	0.20	0.00	0.20
Workshops for Concessionaires and Suppliers	0.70	0.40	0.30
Total	6.40	2.10	4.30

Annex 4.3: Off-Grid Electrification in the Philippines: Barangay Sampling Design Issues

The goal of the survey on the potential for renewable energy in the Philippines is to determine the potential market, willingness to pay for electricity services, and the existing barriers to adopting renewable energy.[211] Most of the previous energy surveys have been based on national sample surveys. The national sample surveys in the Philippines are based on a stratified random sample of households throughout the country. By contrast, the survey of off-grid households requires a different approach, because the study requires a representative sample of barangays as well as the households.

The design a sample plan for households without grid electricity service in the Philippines will be quite different from previous energy surveys carried out in the country. The population sample frame involves households without electricity in regions where access to electricity service is a problem. In many regions, people do not adopt electricity for because their income is too low or they perceive that electricity is too expensive for them. Thus the development of the sample must be based on the populations that will not have access to electricity for years to come.

The Department of Energy already has identified barangays without electricity in the Philippines. In addition, the barangays without electricity that will not receive any service in the near future from the rural electric cooperatives also have already been identified. As a consequence, the goals of the study will be to determine the new and renewable energy resources typical in such barangays, the socioeconomic conditions of the regions, the existing energy consumption patterns, and any other factors such ability to pay for energy services.

Sample Design Issues

A total of 10,439 barangays have been identified that are not in the short-term electrification plans of the electricity distribution companies. Of these barangays, about 5,985 barangays and/or island barangays are considered to be feasible for NRE applications. The barangays have been identified based on the records of the National Electrification Administration (NEA) and other private utilities. NEA's definition of barangay electrification is whether one household in a barangay has adopted electricity. This means that lines have been run to the village and there is at least one transformer in the barangay. However, this generally means that people in the area have access to electricity service, and it may not be likely that they would adopt renewable energy systems that are more expensive than obtaining electricity from the grid. The typical case as reported by the rural electric cooperatives is that about twenty to twenty-five household adopt electricity, but there is significant variation throughout the country depending on local conditions.

The barangays without electricity (10,939) are widely scattered in different regions of the country. The regions with a high number of barangays without electricity are in ARMM and other regions identified in Table 4.3.1. The peace and order situation in ARMM makes electricity

[211] This annex is by Douglas Barnes (May, 1999).

connection very difficult to undertake. The other barangays without electricity are located in quite remote regions, hinterlands, and isolated islands, where extension of transmission/ distribution lines is not technically and economically feasible.

Table 4.3.1: Regions Containing a High Number of Barangays without Electricity

Region	*Potential Connections (Barangay Level)*	*Total Connections (Barangay Level)*	*Percentage of Electrification*
ARMM	2121	978	46.11
IX	2082	1150	55.24
VIII	4355	2783	63.90
XII	924	628	67.97
XI	1216	863	70.97
VI	3860	2762	71.55
CAR	1070	784	73.27
V	3380	2486	73.55
II	2371	1769	74.61
VII	2711	2098	77.39
CARAGA	1280	1006	78.59
IV	3356	2727	81.26
X	1428	1197	83.82
III	2064	1979	95.88
I	2995	2908	97.10

Source: DOE Estimates, 1999.

According to the Department of Energy, there are about five thousand barangays without electricity service that would be a possible market for renewable energy systems, and there are an additional five thousand barangays that do not have electricity, but may have service in the near future. The idea is to determine the potential market for renewable energy in barangays that do not have service today, but and will not likely have it in the near future.

In designing the survey and the sample design, there are several issues that have emerged concerning the design of the sample. They are as follows:

- The surveys should give an indication of the resource availability in the 5,000 barangays without electricity. This might include such resources as microhydro, wind, geothermal, and solar energy.
- It is important to know the ability or willingness to pay for electricity services for individuals or income groups in the communities.
- The sample should be representative of the 5,000 barangays that are the basis of the possible plans for adopting renewable or local energy systems for providing electricity to rural consumers.

- The main goal of the survey is to identify the characteristics of the barangays and households without near term possibilities to obtain electricity from the grid system maintained by the rural electric cooperatives.
- The surveys should not be considered as a tool for identifying specific barangays for renewable energy projects, but rather they will be the basis for identifying the characteristics for such identification in later project planning. The surveys will identify in general the potential market for remote barangays in the Philippines.

Sample Design and Confidence Levels

Information for Assessing Potential for Renewable Energy

In satisfying the above issues, several different types of information are necessary. In order to obtain information on the socioeconomic issues, it will be necessary to conduct a household survey. The household survey will obtain information such as household income, education, occupation, and family size. The household survey will contain a section on the awareness of household about renewable energy systems. For instance, the will be asked whether they have head, seen or seen a solar PV system. In addition, information will be collected on the existing budget expenditures of households on common activities that might benefit from electrification, such as kerosene for lighting, and batteries for radio listening and/or watching television. The survey will also ask some questions about experience with credit, and whether households are comfortable in purchasing appliances or other major items with cash or credit. Access to energy services also will be an issue explored in the survey.

The barangay also is a unit of analysis for the survey. The type of information that will be necessary to obtain from the barangay will be the total population and number of household, the main crops grown in the village, the local businesses and industries that potentially could use electricity. In addition to these common sources of information, the more difficult task of collecting resource data for the village would be necessary to understand the geographic and potential for renewable energy. The later information will be quite a bit more difficult to obtain. However, it would be possible to do this through both geographic information systems and field visits by staff that are familiar with renewable energy resource assessment.

Electricity from renewable energy sources is expensive. Thus, for a community that is likely to get electricity from the grid in the near future to make extensive investments in renewable energy systems is not likely, mainly because of the expense. This is not true for barangays distant from the grid, as their expectation of getting electricity from the grid are lower. Therefore, they may be quite willing to pay for alternative sources of electricity. Thus, it these communities are the sample frame for the market study.

The Sample Design

In this case, to satisfy the requirements that market assessment involve both supply and demand, and based on the policy and information needs of the study, two units of analysis are necessary for the study—the household and the barangay. However, given the remoteness many of the barangays, the collecting of information on all of them would result both a superficial information base because of the high costs in collecting original information and significant errors because of the high number of barangays without electricity. The solution to both of these problems is to draw as sample that is representative of the 5,000 barangays.

The simplest and probably most efficient design of the sample for the survey involves the two stage-random selection process. The first stage would involve a simple random selection of barangays from the 5,000 potential barangays that have been identified as possible candidates for off-grid electrification. The second stage would involve the random selection of households within the selected barangays.

The reason for applying a simple random sample at the barangay sampling stage is due to the issues identified as important for the study. The goal of the study is to determine not only the market characteristics for decentralized rural electrification, but also the potential for various forms of energy supply. If the study were for market characteristics of the households regardless of the supply, then the sample would be structured differently. The main reason for insuring that the barangay selection is based on a high enough number for generalized conclusions is because the study must assess the potential for renewable energy supply. To obtain a representative sample for the energy supply situation in the barangays, the barangay level information required will be an assessment of the potential for renewable and other forms of energy.

The DOE has already assembled a list of the barangays that will not have electricity in the near future. The figures in Table 4.3.2 indicate the number of cases that would be necessary to achieve an error of plus and minus 5 percent and 10 percent with a confidence level of 95 percent. The confidence level of 95 percent means that the sample is likely to be within the allowable error 19 out of 20 times, which is a very high degree of certainty.

Table 4.3.2: Representativeness of Barangays Under Different Scenarios (at 95-Percent Confidence Level)

Allowable Error Plus/Minus	*Proportion of Barangays with Certain Characteristic*				
	.1	.2	.5	.8	.9
5%	144	256	400	256	144
10%	36	64	100	64	36

Note: Figures based on simple random sample.

The implication of these results for the ideal barangay selection is that to achieve the number of sample barangays necessary to obtain a representative sample of the 5,000 barangays would be 400. *However, in the table it is evident that for all practical purposes a sample of 250 would be quite acceptable.* For the variables that have a particular characteristic about one-half of the time, the error of the mean would be somewhere between 5 and 10 percent, which would be quite reasonable for the study. It should also be noted that it does not matter much whether the population for the study is 5,000 or 10,000 barangays, as the sample figures cited above would be almost identical for either case (but of course the barangay lists for drawing the random sample would be different).

The second stage of the sample design would involve interviewing about 15–20 households per barangay. The bulk of the cost will be getting to the barangays. Interviewing 20 households can be easily accomplished in one day, by a team of 5 or 6 enumerators and one supervisor. Because the study requires information at the barangay level, the first stage of the sample design is determined by these requirements. The barangays represent the primary sampling units. The estimation precision for the household level sample will be quite high because of the unique requirements to sample a high number of barangays in the first stage. Table 4.3.3 indicates the resulting level of confidence for varying number of households per barangay.

Table 4.3.3: Number of Households Required per Barangay (Assumes 250 Barangays and 95% Confidence Level)

Allowable Error at 95% Confidence Level (Mean Plus/Minus)	*Level of Possible Variation For Between Barangays in Standard Deviations (based on 1–10 units)*		
	1	*2*	*3*
1%	12	25	35
5%	4	5	6

Note: Figures have been adjusted for the sample design effect of stratification.

One caution is that in order to estimate the number of cases needed for a stratified survey design, it is necessary to make assumptions concerning characteristics of the sample population. When these characteristics are not known, then one has to make the best guess concerning variation within the sample. Therefore, the table above indicates the possible variation (standard deviations among the barangays), and also gives an idea of the possible combination of outcomes. In addition, it should be recognized that in the analysis of the household survey, there would be many circumstances in which the sample will be subdivided into strata for analysis. This will mean fewer cases, which has an impact on the level of significant for the averages within the strata. In such a case, it is better to err on the side of a larger rather than a smaller sample in the design of the survey sampling plan.

Conclusion

The cost of surveying such remote areas may be a significant concern for selecting the sample. If the travel costs to the region are quite high, then the costs can be reduced with greater stratification of the sample. Since we do not have costs at the present time, it would premature to incorporate this aspect formally into the sample design. However, sending survey teams to all 5,000 barangays would be prohibitively expensive, and the compromise of assembling secondary information would not generate enough information to assess the market for renewable energy systems. Thus, obtaining a sample of 250 barangays and about 15–20 households per barangay would significantly reduce costs and improve the quality of information collected in the survey.

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Joint UNDP/World Bank

ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

LIST OF REPORTS ON COMPLETED ACTIVITIES

Region/Country	*Activity/Report Title*	*Date*	*Number*
	SUB-SAHARAN AFRICA (AFR)		
Africa Regional	Anglophone Africa Household Energy Workshop (English)	07/88	085/88
	Regional Power Seminar on Reducing Electric Power System Losses in Africa (English)	08/88	087/88
	Institutional Evaluation of EGL (English)	02/89	098/89
	Biomass Mapping Regional Workshops (English)	05/89	--
	Francophone Household Energy Workshop (French)	08/89	--
	Interafrican Electrical Engineering College: Proposals for Short- and Long-Term Development (English)	03/90	112/90
	Biomass Assessment and Mapping (English)	03/90	--
	Symposium on Power Sector Reform and Efficiency Improvement in Sub-Saharan Africa (English)	06/96	182/96
	Commercialization of Marginal Gas Fields (English)	12/97	201/97
	Commercilizing Natural Gas: Lessons from the Seminar in Nairobi for Sub-Saharan Africa and Beyond	01/00	225/00
	Africa Gas Initiative – Main Report: Volume I	02/01	240/01
Angola	Energy Assessment (English and Portuguese)	05/89	4708-ANG
	Power Rehabilitation and Technical Assistance (English)	10/91	142/91
	Africa Gas Initiative – Angola: Volume II	02/01	240/01
Benin	Energy Assessment (English and French)	06/85	5222-BEN
Botswana	Energy Assessment (English)	09/84	4998-BT
	Pump Electrification Prefeasibility Study (English)	01/86	047/86
	Review of Electricity Service Connection Policy (English)	07/87	071/87
	Tuli Block Farms Electrification Study (English)	07/87	072/87
	Household Energy Issues Study (English)	02/88	--
	Urban Household Energy Strategy Study (English)	05/91	132/91
Burkina Faso	Energy Assessment (English and French)	01/86	5730-BUR
	Technical Assistance Program (English)	03/86	052/86
	Urban Household Energy Strategy Study (English and French)	06/91	134/91
Burundi	Energy Assessment (English)	06/82	3778-BU
	Petroleum Supply Management (English)	01/84	012/84
	Status Report (English and French)	02/84	011/84
	Presentation of Energy Projects for the Fourth Five-Year Plan (1983-1987) (English and French)	05/85	036/85
	Improved Charcoal Cookstove Strategy (English and French)	09/85	042/85
	Peat Utilization Project (English)	11/85	046/85
	Energy Assessment (English and French)	01/92	9215-BU
Cameroon	Africa Gas Initiative – Cameroon: Volume III	02/01	240/01
Cape Verde	Energy Assessment (English and Portuguese)	08/84	5073-CV
	Household Energy Strategy Study (English)	02/90	110/90
Central African Republic	Energy Assessement (French)	08/92	9898-CAR
Chad	Elements of Strategy for Urban Household Energy The Case of N'djamena (French)	12/93	160/94
Comoros	Energy Assessment (English and French)	01/88	7104-COM
	In Search of Better Ways to Develop Solar Markets: The Case of Comoros	05/00	230/00
Congo	Energy Assessment (English)	01/88	6420-COB

Region/Country	*Activity/Report Title*	*Date*	*Number*
Congo	Power Development Plan (English and French)	03/90	106/90
	Africa Gas Initiative – Congo: Volume IV	02/01	240/01
Côte d'Ivoire	Energy Assessment (English and French)	04/85	5250-IVC
	Improved Biomass Utilization (English and French)	04/87	069/87
	Power System Efficiency Study (English)	12/87	--
	Power Sector Efficiency Study (French)	02/92	140/91
	Project of Energy Efficiency in Buildings (English)	09/95	175/95
	Africa Gas Initiative – Côte d'Ivoire: Volume V	02/01	240/01
Ethiopia	Energy Assessment (English)	07/84	4741-ET
	Power System Efficiency Study (English)	10/85	045/85
	Agricultural Residue Briquetting Pilot Project (English)	12/86	062/86
	Bagasse Study (English)	12/86	063/86
	Cooking Efficiency Project (English)	12/87	--
	Energy Assessment (English)	02/96	179/96
Gabon	Energy Assessment (English)	07/88	6915-GA
	Africa Gas Initiative – Gabon: Volume VI	02/01	240/01
The Gambia	Energy Assessment (English)	11/83	4743-GM
	Solar Water Heating Retrofit Project (English)	02/85	030/85
	Solar Photovoltaic Applications (English)	03/85	032/85
	Petroleum Supply Management Assistance (English)	04/85	035/85
Ghana	Energy Assessment (English)	11/86	6234-GH
	Energy Rationalization in the Industrial Sector (English)	06/88	084/88
	Sawmill Residues Utilization Study (English)	11/88	074/87
	Industrial Energy Efficiency (English)	11/92	148/92
Guinea	Energy Assessment (English)	11/86	6137-GUI
	Household Energy Strategy (English and French)	01/94	163/94
Guinea-Bissau	Energy Assessment (English and Portuguese)	08/84	5083-GUB
	Recommended Technical Assistance Projects (English & Portuguese)	04/85	033/85
	Management Options for the Electric Power and Water Supply Subsectors (English)	02/90	100/90
	Power and Water Institutional Restructuring (French)	04/91	118/91
Kenya	Energy Assessment (English)	05/82	3800-KE
	Power System Efficiency Study (English)	03/84	014/84
	Status Report (English)	05/84	016/84
	Coal Conversion Action Plan (English)	02/87	--
	Solar Water Heating Study (English)	02/87	066/87
	Peri-Urban Woodfuel Development (English)	10/87	076/87
	Power Master Plan (English)	11/87	--
	Power Loss Reduction Study (English)	09/96	186/96
	Implementation Manual: Financing Mechanisms for Solar Electric Equipment	07/00	231/00
Lesotho	Energy Assessment (English)	01/84	4676-LSO
Liberia	Energy Assessment (English)	12/84	5279-LBR
	Recommended Technical Assistance Projects (English)	06/85	038/85
	Power System Efficiency Study (English)	12/87	081/87
Madagascar	Energy Assessment (English)	01/87	5700-MAG
	Power System Efficiency Study (English and French)	12/87	075/87
	Environmental Impact of Woodfuels (French)	10/95	176/95
Malawi	Energy Assessment (English)	08/82	3903-MAL
	Technical Assistance to Improve the Efficiency of Fuelwood Use in the Tobacco Industry (English)	11/83	009/83

Region/Country	Activity/Report Title	Date	Number
Malawi	Status Report (English)	01/84	013/84
Mali	Energy Assessment (English and French)	11/91	8423-MLI
	Household Energy Strategy (English and French)	03/92	147/92
Islamic Republic of Mauritania	Energy Assessment (English and French)	04/85	5224-MAU
	Household Energy Strategy Study (English and French)	07/90	123/90
Mauritius	Energy Assessment (English)	12/81	3510-MAS
	Status Report (English)	10/83	008/83
	Power System Efficiency Audit (English)	05/87	070/87
	Bagasse Power Potential (English)	10/87	077/87
	Energy Sector Review (English)	12/94	3643-MAS
Mozambique	Energy Assessment (English)	01/87	6128-MOZ
	Household Electricity Utilization Study (English)	03/90	113/90
	Electricity Tariffs Study (English)	06/96	181/96
	Sample Survey of Low Voltage Electricity Customers	06/97	195/97
Namibia	Energy Assessment (English)	03/93	11320-NAM
Niger	Energy Assessment (French)	05/84	4642-NIR
	Status Report (English and French)	02/86	051/86
	Improved Stoves Project (English and French)	12/87	080/87
	Household Energy Conservation and Substitution (English and French)	01/88	082/88
Nigeria	Energy Assessment (English)	08/83	4440-UNI
	Energy Assessment (English)	07/93	11672-UNI
Rwanda	Energy Assessment (English)	06/82	3779-RW
	Status Report (English and French)	05/84	017/84
	Improved Charcoal Cookstove Strategy (English and French)	08/86	059/86
	Improved Charcoal Production Techniques (English and French)	02/87	065/87
	Energy Assessment (English and French)	07/91	8017-RW
	Commercialization of Improved Charcoal Stoves and Carbonization Techniques Mid-Term Progress Report (English and French)	12/91	141/91
SADC	SADC Regional Power Interconnection Study, Vols. I-IV (English)	12/93	--
SADCC	SADCC Regional Sector: Regional Capacity-Building Program for Energy Surveys and Policy Analysis (English)	11/91	--
Sao Tome and Principe	Energy Assessment (English)	10/85	5803-STP
Senegal	Energy Assessment (English)	07/83	4182-SE
	Status Report (English and French)	10/84	025/84
	Industrial Energy Conservation Study (English)	05/85	037/85
	Preparatory Assistance for Donor Meeting (English and French)	04/86	056/86
	Urban Household Energy Strategy (English)	02/89	096/89
	Industrial Energy Conservation Program (English)	05/94	165/94
Seychelles	Energy Assessment (English)	01/84	4693-SEY
	Electric Power System Efficiency Study (English)	08/84	021/84
Sierra Leone	Energy Assessment (English)	10/87	6597-SL
Somalia	Energy Assessment (English)	12/85	5796-SO
Republic of South Africa	Options for the Structure and Regulation of Natural Gas Industry (English)	05/95	172/95
Sudan	Management Assistance to the Ministry of Energy and Mining	05/83	003/83
	Energy Assessment (English)	07/83	4511-SU
	Power System Efficiency Study (English)	06/84	018/84
	Status Report (English)	11/84	026/84

Region/Country	*Activity/Report Title*	*Date*	*Number*
Sudan	Wood Energy/Forestry Feasibility (English)	07/87	073/87
Swaziland	Energy Assessment (English)	02/87	6262-SW
	Household Energy Strategy Study	10/97	198/97
Tanzania	Energy Assessment (English)	11/84	4969-TA
	Peri-Urban Woodfuels Feasibility Study (English)	08/88	086/88
	Tobacco Curing Efficiency Study (English)	05/89	102/89
	Remote Sensing and Mapping of Woodlands (English)	06/90	--
	Industrial Energy Efficiency Technical Assistance (English)	08/90	122/90
	Power Loss Reduction Volume 1: Transmission and Distribution SystemTechnical Loss Reduction and Network Development (English)	06/98	204A/98
	Power Loss Reduction Volume 2: Reduction of Non-Technical Losses (English)	06/98	204B/98
Togo	Energy Assessment (English)	06/85	5221-TO
	Wood Recovery in the Nangbeto Lake (English and French)	04/86	055/86
	Power Efficiency Improvement (English and French)	12/87	078/87
Uganda	Energy Assessment (English)	07/83	4453-UG
	Status Report (English)	08/84	020/84
	Institutional Review of the Energy Sector (English)	01/85	029/85
	Energy Efficiency in Tobacco Curing Industry (English)	02/86	049/86
	Fuelwood/Forestry Feasibility Study (English)	03/86	053/86
	Power System Efficiency Study (English)	12/88	092/88
	Energy Efficiency Improvement in the Brick and Tile Industry (English)	02/89	097/89
	Tobacco Curing Pilot Project (English)	03/89	UNDP Terminal Report
	Energy Assessment (English)	12/96	193/96
	Rural Electrification Strategy Study	09/99	221/99
Zaire	Energy Assessment (English)	05/86	5837-ZR
Zambia	Energy Assessment (English)	01/83	4110-ZA
	Status Report (English)	08/85	039/85
	Energy Sector Institutional Review (English)	11/86	060/86
	Power Subsector Efficiency Study (English)	02/89	093/88
	Energy Strategy Study (English)	02/89	094/88
	Urban Household Energy Strategy Study (English)	08/90	121/90
Zimbabwe	Energy Assessment (English)	06/82	3765-ZIM
	Power System Efficiency Study (English)	06/83	005/83
	Status Report (English)	08/84	019/84
	Power Sector Management Assistance Project (English)	04/85	034/85
	Power Sector Management Institution Building (English)	09/89	--
	Petroleum Management Assistance (English)	12/89	109/89
	Charcoal Utilization Prefeasibility Study (English)	06/90	119/90
	Integrated Energy Strategy Evaluation (English)	01/92	8768-ZIM
	Energy Efficiency Technical Assistance Project: Strategic Framework for a National Energy Efficiency Improvement Program (English)	04/94	--
	Capacity Building for the National Energy Efficiency Improvement Programme (NEEIP) (English)	12/94	--
	Rural Electrification Study	03/00	228/00

Region/Country	*Activity/Report Title*	*Date*	*Number*
	EAST ASIA AND PACIFIC (EAP)		
Asia Regional	Pacific Household and Rural Energy Seminar (English)	11/90	--
China	County-Level Rural Energy Assessments (English)	05/89	101/89
	Fuelwood Forestry Preinvestment Study (English)	12/89	105/89
	Strategic Options for Power Sector Reform in China (English)	07/93	156/93
	Energy Efficiency and Pollution Control in Township and Village Enterprises (TVE) Industry (English)	11/94	168/94
	Energy for Rural Development in China: An Assessment Based on a Joint Chinese/ESMAP Study in Six Counties (English)	06/96	183/96
	Improving the Technical Efficiency of Decentralized Power Companies	09/99	222/999
Fiji	Energy Assessment (English)	06/83	4462-FIJ
Indonesia	Energy Assessment (English)	11/81	3543-IND
	Status Report (English)	09/84	022/84
	Power Generation Efficiency Study (English)	02/86	050/86
	Energy Efficiency in the Brick, Tile and Lime Industries (English)	04/87	067/87
	Diesel Generating Plant Efficiency Study (English)	12/88	095/88
	Urban Household Energy Strategy Study (English)	02/90	107/90
	Biomass Gasifier Preinvestment Study Vols. I & II (English)	12/90	124/90
	Prospects for Biomass Power Generation with Emphasis on Palm Oil, Sugar, Rubberwood and Plywood Residues (English)	11/94	167/94
Lao PDR	Urban Electricity Demand Assessment Study (English)	03/93	154/93
	Institutional Development for Off-Grid Electrification	06/99	215/99
Malaysia	Sabah Power System Efficiency Study (English)	03/87	068/87
	Gas Utilization Study (English)	09/91	9645-MA
Myanmar	Energy Assessment (English)	06/85	5416-BA
Papua New Guinea	Energy Assessment (English)	06/82	3882-PNG
	Status Report (English)	07/83	006/83
	Energy Strategy Paper (English)	--	--
	Institutional Review in the Energy Sector (English)	10/84	023/84
	Power Tariff Study (English)	10/84	024/84
Philippines	Commercial Potential for Power Production from Agricultural Residues (English)	12/93	157/93
	Energy Conservation Study (English)	08/94	--
	Strengthening the Non-Conventional and Rural Energy Development Program in the Philippines: A Policy Framework and Action Plan	08/01	243/01
Solomon Islands	Energy Assessment (English)	06/83	4404-SOL
	Energy Assessment (English)	01/92	979-SOL
South Pacific	Petroleum Transport in the South Pacific (English)	05/86	--
Thailand	Energy Assessment (English)	09/85	5793-TH
	Rural Energy Issues and Options (English)	09/85	044/85
	Accelerated Dissemination of Improved Stoves and Charcoal Kilns (English)	09/87	079/87
	Northeast Region Village Forestry and Woodfuels Preinvestment Study (English)	02/88	083/88
	Impact of Lower Oil Prices (English)	08/88	--
	Coal Development and Utilization Study (English)	10/89	--
Tonga	Energy Assessment (English)	06/85	5498-TON

Region/Country	*Activity/Report Title*	*Date*	*Number*
Vanuatu	Energy Assessment (English)	06/85	5577-VA
Vietnam	Rural and Household Energy-Issues and Options (English)	01/94	161/94
	Power Sector Reform and Restructuring in Vietnam: Final Report to the Steering Committee (English and Vietnamese)	09/95	174/95
	Household Energy Technical Assistance: Improved Coal Briquetting and Commercialized Dissemination of Higher Efficiency Biomass and Coal Stoves (English)	01/96	178/96
	Petroleum Fiscal Issues and Policies for Fluctuating Oil Prices In Vietnam	02/01	236/01
Western Samoa	Energy Assessment (English)	06/85	5497-WSO

SOUTH ASIA (SAS)

Bangladesh	Energy Assessment (English)	10/82	3873-BD
	Priority Investment Program (English)	05/83	002/83
	Status Report (English)	04/84	015/84
	Power System Efficiency Study (English)	02/85	031/85
	Small Scale Uses of Gas Prefeasibility Study (English)	12/88	--
India	Opportunities for Commercialization of Nonconventional Energy Systems (English)	11/88	091/88
	Maharashtra Bagasse Energy Efficiency Project (English)	07/90	120/90
	Mini-Hydro Development on Irrigation Dams and Canal Drops Vols. I, II and III (English)	07/91	139/91
	WindFarm Pre-Investment Study (English)	12/92	150/92
	Power Sector Reform Seminar (English)	04/94	166/94
	Environmental Issues in the Power Sector (English)	06/98	205/98
	Environmental Issues in the Power Sector: Manual for Environmental Decision Making (English)	06/99	213/99
	Household Energy Strategies for Urban India: The Case of Hyderabad	06/99	214/99
	Greenhouse Gas Mitigation In the Power Sector: Case Studies From India	02/01	237/01
Nepal	Energy Assessment (English)	08/83	4474-NEP
	Status Report (English)	01/85	028/84
	Energy Efficiency & Fuel Substitution in Industries (English)	06/93	158/93
Pakistan	Household Energy Assessment (English)	05/88	--
	Assessment of Photovoltaic Programs, Applications, and Markets (English)	10/89	103/89
	National Household Energy Survey and Strategy Formulation Study: Project Terminal Report (English)	03/94	--
	Managing the Energy Transition (English)	10/94	--
	Lighting Efficiency Improvement Program Phase 1: Commercial Buildings Five Year Plan (English)	10/94	--
Sri Lanka	Energy Assessment (English)	05/82	3792-CE
	Power System Loss Reduction Study (English)	07/83	007/83
	Status Report (English)	01/84	010/84
	Industrial Energy Conservation Study (English)	03/86	054/86

EUROPE AND CENTRAL ASIA (ECA)

Bulgaria	Natural Gas Policies and Issues (English)	10/96	188/96

Region/Country	*Activity/Report Title*	*Date*	*Number*
Central Asia and The Caucasus	Cleaner Transport Fuels in Central Asia and the Caucasus	08/01	242/01
Central and Eastern Europe	Power Sector Reform in Selected Countries	07/97	196/97
	Increasing the Efficiency of Heating Systems in Central and Eastern Europe and the Former Soviet Union	08/00	234/00
	The Future of Natural Gas in Eastern Europe (English)	08/92	149/92
Kazakhstan	Natural Gas Investment Study, Volumes 1, 2 & 3	12/97	199/97
Kazakhstan & Kyrgyzstan	Opportunities for Renewable Energy Development	11/97	16855-KAZ
Poland	Energy Sector Restructuring Program Vols. I-V (English)	01/93	153/93
	Natural Gas Upstream Policy (English and Polish)	08/98	206/98
	Energy Sector Restructuring Program: Establishing the Energy Regulation Authority	10/98	208/98
Portugal	Energy Assessment (English)	04/84	4824-PO
Romania	Natural Gas Development Strategy (English)	12/96	192/96
Slovenia	Workshop on Private Participation in the Power Sector (English)	02/99	211/99
Turkey	Energy Assessment (English)	03/83	3877-TU
	Energy and the Environment: Issues and Options Paper	04/00	229/00

MIDDLE EAST AND NORTH AFRICA (MNA)

Arab Republic of Egypt	Energy Assessment (English)	10/96	189/96
	Energy Assessment (English and French)	03/84	4157-MOR
	Status Report (English and French)	01/86	048/86
Morocco	Energy Sector Institutional Development Study (English and French)	07/95	173/95
	Natural Gas Pricing Study (French)	10/98	209/98
	Gas Development Plan Phase II (French)	02/99	210/99
Syria	Energy Assessment (English)	05/86	5822-SYR
	Electric Power Efficiency Study (English)	09/88	089/88
	Energy Efficiency Improvement in the Cement Sector (English)	04/89	099/89
	Energy Efficiency Improvement in the Fertilizer Sector (English)	06/90	115/90
Tunisia	Fuel Substitution (English and French)	03/90	--
	Power Efficiency Study (English and French)	02/92	136/91
	Energy Management Strategy in the Residential and Tertiary Sectors (English)	04/92	146/92
	Renewable Energy Strategy Study, Volume I (French)	11/96	190A/96
	Renewable Energy Strategy Study, Volume II (French)	11/96	190B/96
Yemen	Energy Assessment (English)	12/84	4892-YAR
	Energy Investment Priorities (English)	02/87	6376-YAR
	Household Energy Strategy Study Phase I (English)	03/91	126/91

LATIN AMERICA AND THE CARIBBEAN (LAC)

LAC Regional	Regional Seminar on Electric Power System Loss Reduction in the Caribbean (English)	07/89	--
	Elimination of Lead in Gasoline in Latin America and the Caribbean (English and Spanish)	04/97	194/97

Region/Country	***Activity/Report Title***	***Date***	***Number***
LAC Regional	Elimination of Lead in Gasoline in Latin America and the Caribbean - Status Report (English and Spanish)	12/97	200/97
	Harmonization of Fuels Specifications in Latin America and the Caribbean (English and Spanish)	06/98	203/98
Bolivia	Energy Assessment (English)	04/83	4213-BO
	National Energy Plan (English)	12/87	--
	La Paz Private Power Technical Assistance (English)	11/90	111/90
	Prefeasibility Evaluation Rural Electrification and Demand Assessment (English and Spanish)	04/91	129/91
	National Energy Plan (Spanish)	08/91	131/91
	Private Power Generation and Transmission (English)	01/92	137/91
	Natural Gas Distribution: Economics and Regulation (English)	03/92	125/92
	Natural Gas Sector Policies and Issues (English and Spanish)	12/93	164/93
	Household Rural Energy Strategy (English and Spanish)	01/94	162/94
	Preparation of Capitalization of the Hydrocarbon Sector	12/96	191/96
	Introducing Competition into the Electricity Supply Industry in Developing Countries: Lessons from Bolivia	08/00	233/00
	Final Report on Operational Activities Rural Energy and Energy Efficiency	08/00	235/00
Brazil	Energy Efficiency & Conservation: Strategic Partnership for Energy Efficiency in Brazil (English)	01/95	170/95
	Hydro and Thermal Power Sector Study	09/97	197/97
	Rural Electrification with Renewable Energy Systems in the Northeast: A Preinvestment Study	07/00	232/00
Chile	Energy Sector Review (English)	08/88	7129-CH
Colombia	Energy Strategy Paper (English)	12/86	--
	Power Sector Restructuring (English)	11/94	169/94
	Energy Efficiency Report for the Commercial and Public Sector (English)	06/96	184/96
Costa Rica	Energy Assessment (English and Spanish)	01/84	4655-CR
	Recommended Technical Assistance Projects (English)	11/84	027/84
	Forest Residues Utilization Study (English and Spanish)	02/90	108/90
Dominican Republic	Energy Assessment (English)	05/91	8234-DO
Ecuador	Energy Assessment (Spanish)	12/85	5865-EC
	Energy Strategy Phase I (Spanish)	07/88	--
	Energy Strategy (English)	04/91	--
	Private Minihydropower Development Study (English)	11/92	--
	Energy Pricing Subsidies and Interfuel Substitution (English)	08/94	11798-EC
	Energy Pricing, Poverty and Social Mitigation (English)	08/94	12831-EC
Guatemala	Issues and Options in the Energy Sector (English)	09/93	12160-GU
Haiti	Energy Assessment (English and French)	06/82	3672-HA
	Status Report (English and French)	08/85	041/85
	Household Energy Strategy (English and French)	12/91	143/91
Honduras	Energy Assessment (English)	08/87	6476-HO
	Petroleum Supply Management (English)	03/91	128/91
Jamaica	Energy Assessment (English)	04/85	5466-JM
	Petroleum Procurement, Refining, and Distribution Study (English)	11/86	061/86
	Energy Efficiency Building Code Phase I (English)	03/88	--
	Energy Efficiency Standards and Labels Phase I (English)	03/88	--
	Management Information System Phase I (English)	03/88	--

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Jamaica	Charcoal Production Project (English)	09/88	090/88
	FIDCO Sawmill Residues Utilization Study (English)	09/88	088/88
	Energy Sector Strategy and Investment Planning Study (English)	07/92	135/92
Mexico	Improved Charcoal Production Within Forest Management for the State of Veracruz (English and Spanish)	08/91	138/91
	Energy Efficiency Management Technical Assistance to the Comision Nacional para el Ahorro de Energia (CONAE) (English)	04/96	180/96
	Energy Environment Review	05/01	241/01
Panama	Power System Efficiency Study (English)	06/83	004/83
Paraguay	Energy Assessment (English)	10/84	5145-PA
	Recommended Technical Assistance Projects (English)	09/85	--
	Status Report (English and Spanish)	09/85	043/85
Peru	Energy Assessment (English)	01/84	4677-PE
	Status Report (English)	08/85	040/85
	Proposal for a Stove Dissemination Program in the Sierra (English and Spanish)	02/87	064/87
	Energy Strategy (English and Spanish)	12/90	--
	Study of Energy Taxation and Liberalization of the Hydrocarbons Sector (English and Spanish)	120/93	159/93
	Reform and Privatization in the Hydrocarbon Sector (English and Spanish)	07/99	216/99
	Rural Electrification	02/01	238/01
Saint Lucia	Energy Assessment (English)	09/84	5111-SLU
St. Vincent and the Grenadines	Energy Assessment (English)	09/84	5103-STV
Sub Andean	Environmental and Social Regulation of Oil and Gas Operations in Sensitive Areas of the Sub-Andean Basin (English and Spanish)	07/99	217/99
Trinidad and Tobago	Energy Assessment (English)	12/85	5930-TR

GLOBAL

	Energy End Use Efficiency: Research and Strategy (English)	11/89	--
	Women and Energy--A Resource Guide The International Network: Policies and Experience (English)	04/90	--
	Guidelines for Utility Customer Management and Metering (English and Spanish)	07/91	--
	Assessment of Personal Computer Models for Energy Planning in Developing Countries (English)	10/91	--
	Long-Term Gas Contracts Principles and Applications (English)	02/93	152/93
	Comparative Behavior of Firms Under Public and Private Ownership (English)	05/93	155/93
	Development of Regional Electric Power Networks (English)	10/94	--
	Roundtable on Energy Efficiency (English)	02/95	171/95
	Assessing Pollution Abatement Policies with a Case Study of Ankara (English)	11/95	177/95
	A Synopsis of the Third Annual Roundtable on Independent Power Projects: Rhetoric and Reality (English)	08/96	187/96
	Rural Energy and Development Roundtable (English)	05/98	202/98

Region/Country	***Activity/Report Title***	***Date***	***Number***
Global	A Synopsis of the Second Roundtable on Energy Efficiency: Institutional and Financial Delivery Mechanisms (English)	09/98	207/98
	The Effect of a Shadow Price on Carbon Emission in the Energy Portfolio of the World Bank: A Carbon Backcasting Exercise (English)	02/99	212/99
	Increasing the Efficiency of Gas Distribution Phase 1: Case Studies and Thematic Data Sheets	07/99	218/99
	Global Energy Sector Reform in Developing Countries: A Scorecard	07/99	219/99
	Global Lighting Services for the Poor Phase II: Text Marketing of Small "Solar" Batteries for Rural Electrification Purposes	08/99	220/99
	A Review of the Renewable Energy Activities of the UNDP/ World Bank Energy Sector Management Assistance Programme 1993 to 1998	11/99	223/99
	Energy, Transportation and Environment: Policy Options for Environmental Improvement	12/99	224/99
	Privatization, Competition and Regulation in the British Electricity Industry, With Implications for Developing Countries	02/00	226/00
	Reducing the Cost of Grid Extension for Rural Electrification	02/00	227/00
	Undeveloped Oil and Gas Fields in the Industrializing World	02/01	239/01

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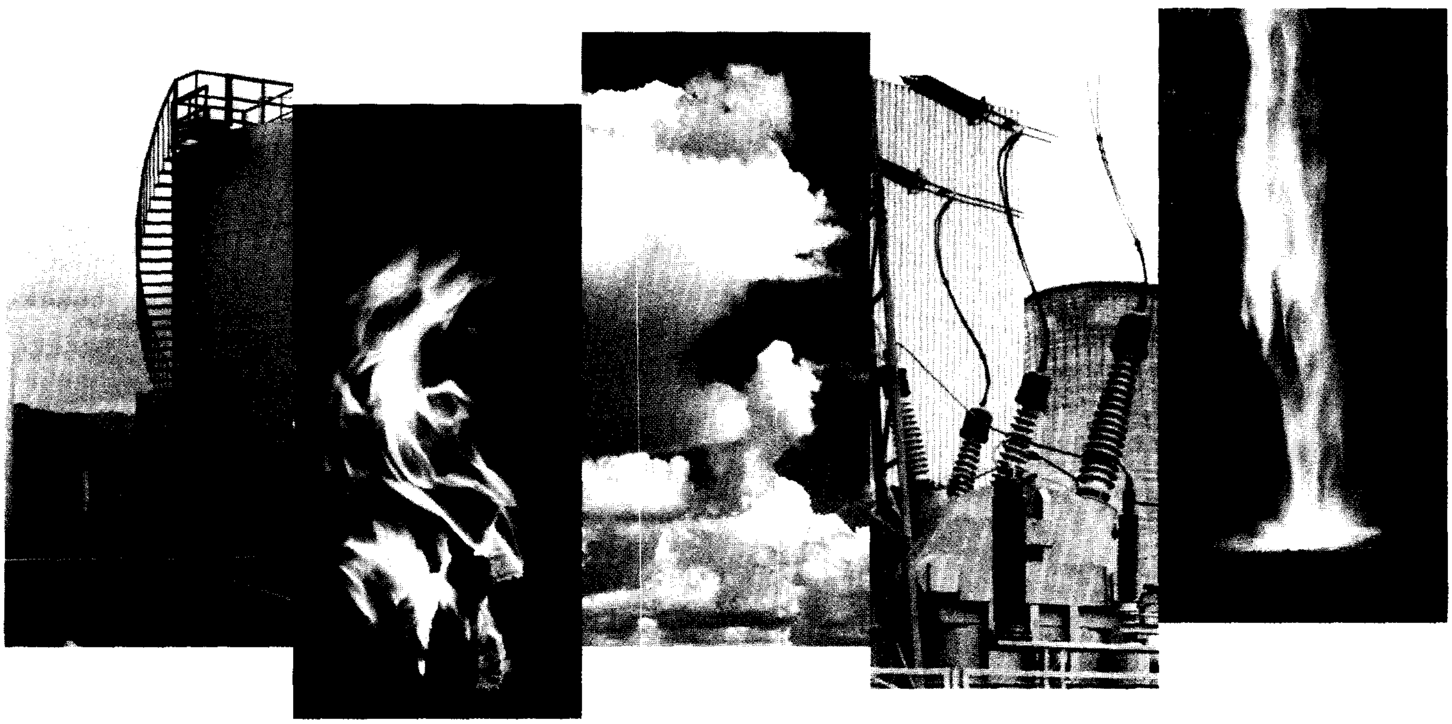

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