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ESMAP TECHNICAL PAPER
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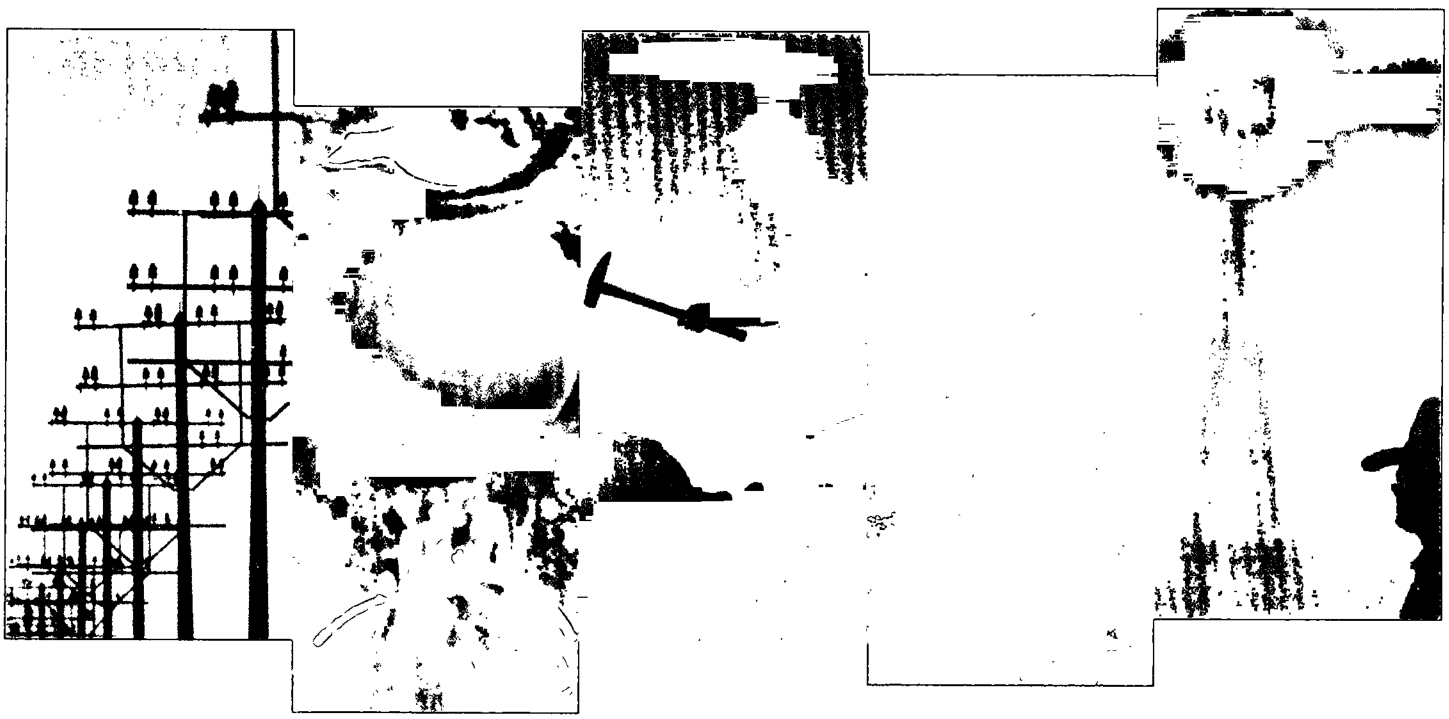
Vietnam —Renewable Energy Action Plan



Energy

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March 2002

ESMAP

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ENERGY SECTOR MANAGEMENT ASSISTANCE PROGRAMME (ESMAP)

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The Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP) is a special global technical assistance partnership sponsored by the UNDP, the World Bank and bi-lateral official donors. Established with the support of UNDP and bilateral official donors in 1983, ESMAP is managed by the World Bank. ESMAP's mission is to promote the role of energy in poverty reduction and economic growth in an environmentally responsible manner. Its work applies to low-income, emerging, and transition economies and contributes to the achievement of internationally agreed development goals. ESMAP interventions are knowledge products including free technical assistance, specific studies, advisory services, pilot projects, knowledge generation and dissemination, trainings, workshops and seminars, conferences and roundtables, and publications. ESMAP work is focused on three priority areas: access to modern energy for the poorest, the development of sustainable energy markets, and the promotion of environmentally sustainable energy practices.

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ASTAE/ESMAP

MOI

EVN

Vietnam: Renewable Energy Action Plan

Providing clean, cost-effective electricity
to help rural people improve their
standard of living and increase their income

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First printing March 2002

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ESMAP Management"

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Currency Equivalents and Units of Measure

Currency Unit = Vietnamese Dong (VND)
VND 1,000 = US$0.06
US$1 = VND 14,522

GW	Gigawatt
GWh	Gigawatt-hour
kg	Kilogram
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt peak
m	Meter
m/s	Meter per second
m^2	Square meter
MW	Megawatt
MWh	Megawatt-hour
MWp	Megawatt peak
tcpd	Ton cane per day
ton	Metric ton
W	Watt
Wp	Watt peak

Acronyms and Abbreviations

ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
ASTAE	Asia Alternative Energy Program
BOT	Build-operate-transfer
BST	Bulk supply tariff
CDM	Clean Development Mechanism
CEB	Ceylon Electricity Board
CEMMA	Committee for Ethnic Minorities and Mountainous Areas
DANIDA	Danish Ministry of Foreign Affairs
EGAT	Electricity Generating Authority of Thailand
EIRR	Economic internal rate of return
ESMAP	Energy Sector Management Assistance Programme
EU	European Union
EVN	Electricity of Vietnam
FIRR	Financial internal rate of return
GEF	Global Environment Facility
GHG	Greenhouse gas
GOV	Government of Vietnam
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
HCM	Ho Chi Minh
hh	Household
HPC	Hydro Power Center
HV	High voltage
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IE	Institute of Energy of Vietnam
IFC	International Finance Corporation
IMH	Institute for Meteorology and Hydrology
IPP	Independent power producer
IREDA	Indian Renewable Energy Development Agency
JBIC	Japan Bank for Internation Cooperation
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt für Wiederaufbau
LRMC	Long-run marginal cost
LV	Low voltage
M&E	Monitoring and Evaluation Program
MARD	Ministry of Agriculture and Rural Development
MNES	Ministry of Non-Conventional Energy Sources
MOF	Ministry of Finance
MOI	Ministry of Industry
MOSTE	Ministry of Science, Technology and Environment
MPI	Ministry of Planning and Investment
MV	Medium voltage
NEDO	New Energy and Industrial Technology Development Organization (Japan)
NPV	Net present value

NGO	Nongovernmental organization
ODA	Official Development Assistance
OECF	Overseas Economic Cooperation Fund
O&M	Operation and maintenance
PCF	Prototype Carbon Fund
PPA	Power Purchase Agreement
PPC	Provincial People's Committee
PV	Photovoltaic
RE	Rural electrification
REAP	Renewable Energy Action Plan
RECTERE	Research Center for Thermal Equipment and Renewable Energy of the Ho Chi Minh City University of Technology
RERC	Renewable Energy Research Center of the Hanoi University of Technology
RPMD	REAP Program Management Board
SEIER	System Efficiency Improvement, Equitization and Renewables Project
SHS	Solar home system
SIDA	Swedish International Development Agency
SPP	Small Power Producer
SPPA	Standardized Small Power Purchase Agreement
TA	Technical assistance
UNDP	United Nations Development Programme
UNFCC	United Nations Framework Convention on Climate Change
US$	U.S. dollar
VAT	Value added tax
VBARD	Vietnam Bank for Agriculture and Rural Development
VND	Vietnamese Dong
VWU	Vietnam Women's Union

Foreword

Vietnam has made remarkable progress in poverty reduction and economic development over the past decade. Nevertheless, the country remains poor with 78 percent of its population and 90 percent of the poor living in rural areas. Rural poverty reduction is a high priority in the Government's 5-year plan and 10-year strategy.

The Government recognizes that electricity service is an important tool to help rural people improve their standard of living and increase their incomes. Today, 75 percent of rural households have electricity service and the Government intends to provide electricity to 90 percent of rural households by 2005.

It is estimated that about 1 million households in isolated and remote rural areas will not be able to receive electricity from the national grid. For these households, alternative ways to provide electricity service must be utilized, especially renewable energy systems like hydro, wind and solar systems.

The Ministry of Industry and the World Bank, together with Electricity of Vietnam, are honored to present to you this *Renewable Energy Action Plan*, which we have been working on for the last 18 months. The Plan aims to support an acceleration of renewable electricity production, to meet the needs of isolated households and communities that can not receive electricity services from the national grid, and to supplement grid supply, cost effectively in remote areas.

The proposed ten-year program laid out in the Plan is ambitious, but achievable if Vietnam establishes a supportive policy framework, builds the necessary capacity, and financing is made available.

Vietnam is richly endowed with renewable energy resources. We are convinced that these resources can be used to meet the growing needs of rural people in an economic and environmentally sound manner.

We invite our multilateral and bilateral parners to joint and support Vietnam in its efforts to develop renewable energy resources so that our combined efforts has a far greater impact.

Hoang Trung Hai
Vice Minister
Ministry of Industry

Andrew Steer
Country Director
The World Bank

Acknowledgements

Valuable input to the report was provided by representatives of more than 20 Vietnamese organizations that attended the two participatory workshops that were held in Hanoi (see Annex 1). In the June 1999 workshop, they provided knowledge on the potential of different technology options, the main barriers to accelerated development, and ways to overcome the barriers. In the October 2000 workshop, the participants provided invaluable information on the REAP goals, the activities to be undertaken and the organizational models to implement the activities. Without their participation, it would not have been possible to produce this report. The Institute of Energy team, under the leadership of Dr. Pham Khanh Toan, is recognized for its excellent organization of the workshops and coordination of REAP activities on behalf of EVN.

The report originated with the request of EVN for an action plan for renewable energy development. EVN requested not another master plan, but an output-oriented study that would lead to results on the ground in a relatively short time. Under the insightful guidance and professional expertise of Mr. Pham Van Vy and Mr. Trinh Ngoc Khanh of EVN, the study team worked with national and international consultants to do the background work needed to complete the report. This summary report is built on a number of extensive studies commissioned as part of this study and for the Rural Energy Project. These include the following:

ASTAE. 2000. *Options for Renewable Energy in Vietnam, a Report on the June 15–16, 1999 Two-Day Participatory Workshop, Hanoi.* ESMAP Technical Paper 001, World Bank, Washington, D.C.

COWI. 1998. *Rural Electrification Master Plan Study—Vietnam.* Consultant Report to EVN, Hanoi.

Entec. 2000a. *Investment and Business Plan for Setting Up a Micro Hydro Turbine Manufacturing Business in Vietnam.* Consultant Report for the World Bank, Washington, D.C.

Entec. 2000b. *Package C: Techno-Economic Assessment Model.* Consultant Report to World Bank, Washington, D.C.

Fichtner and Colenco. 1999. *Technical Assistance for Preparation of Proposed Rural Energy Project, Package 2: Pricing Policy for Rural Electrification.* Consultant Report for EVN, Hanoi.

Fichtner and Colenco. 2000. *Technical Assistance for Preparation of Proposed Rural Energy Project, Package 7: Pipeline Developmemt Rehabilitation and Upgrade of Grid Connected Renewable Energy Projects.* Consultant Report for EVN, Hanoi.

Finucane, J., et.al. 2000. *REAP Package D: Program Design for Isolated Households Segment.* Consultant Report for the World Bank, Washington, D.C.

Hydro Power Center. 2000. *Package B: Collection of Basic Information and Mapping Information for Vietnam.* Consultant Report for the World Bank, Washington, D.C.

Meritec. 1999. *Vietnam Renewable Energy Small Power Purchase Agreement.* Consultant Report for EVN, Hanoi.

Meritec. 2000a. *REAP Package E: Feasibility Study of a Program to Develop and/or Rehabilitate Community-Scale Hydro-Based Mini Grids.* Consultant Report for EVN, Hanoi.

Meritec. 2000b. *Turn-Key Micro Hydro-Diesel Hybrid and Battery Charging Station Pilot Project.* Consultant Report for EVN, Hanoi.

Meritec. 2000c. *Vietnam Rural Energy Project Pre-Investment Study Report for Pipeline Development of New Small Hydro Projects.* Consultant Report for EVN, Hanoi.

Pham Nguyet Anh. 2000. *Background Information for Institutional and Policy Aspects of Renewable Energy Development.* Consultant Report for World Bank, Washington, D.C.

World Bank. 2000. *Project Appraisal Document for Vietnam Rural Energy Project.* World Bank, Washington, D.C.

Substantial funding for the REAP was provided by the World Bank's Energy Sector Management Assistance Programme (ESMAP) and the Asia Alternative Energy Program (ASTAE).[1,2] Additional funds were provided by Japan, New Zealand, and Switzerland. Funds were used to conduct consultant studies, organize participatory workshops, and to analyze and to formulate this 10-year strategic Action Plan.

The REAP team would like to acknowledge the leadership and guidance provided throughout the course of the study by Mr. Anil Malhotra, the World Bank's Regional Energy Adviser, and the assistance of his team in Hanoi (especially Mr. Van Tien Hung, and Ms. Nguyen Thuy Anh). The World Bank is supporting renewable energy development in Vietnam on a programmatic basis in three parts: (a) support for preparation of the REAP under the Rural Energy 1 Project, through support for studies and the draft report, the Rural Electrification Policy, and inclusion of covenants with EVN as part of the Project agreements; (b) financing of part of Phase 1 of the REAP under the proposed System Efficiency Improvement, Equitization and Renewables (SEIER) Project planned for FY02; and (c) financing of Phase 2 under the proposed Rural Energy 2 Project in FY04.

The report was prepared as a team effort by Ms. Susan Bogach (Task Team Leader), Mr. Anil Cabraal, Mr. Jon Exel, and Ms. Pham Nguyet Anh. Ms. Cristina Hernandez was responsible for word processing of the report. Ms. Rebecca Kary edited the final report.

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[1] For more information on ESMAP go to http://www.worldbank.org/esmap.
[2] For more information on ASTAE go to http://www.worldbank.org/astae.

Executive Summary

A. Background

Introduction. At the request of EVN, the World Bank has assisted in preparing a plan for international assistance for development of renewable electricity in Vietnam, the Renewable Energy Action Plan (REAP). The REAP presents a 10-year program to accelerate large-scale development of renewable energy for rural electrification and grid supply in Vietnam.[3] It will be implemented in two phases: a five-year capacity building phase followed by a five-year implementation phase. The REAP will be used as a framework for coordination of activities by the Government of Vietnam (GOV) agencies, and mobilization of resources from all entities, including international agencies.

The REAP was prepared in a series of steps: (a) a participatory workshop with stakeholders in June 1999 to discuss renewable energy potential, problems and solutions; (b) preparation of more than 10 consulting studies by teams of national and international consultants; (c) synthesis of the study results into a draft action plan report; (d) presentation of the draft report at a two day participatory workshop with stakeholders and discussion with international agencies in October 2000; and (e) revision of the report to take into account all comments received.

The REAP was endorsed by participants during the Workshop held in October 2000. Subsequently, MOI and EVN agreed that the REAP report would provide a framework for implementation of a program to be led and coordinated by MOI.

International Context. Renewable development is expected to surge internationally over the next decade, in both industrial and developing countries. Many countries are introducing strong policies to promote renewable electricity, which are justified by social and economic benefits, including (a) environmental protection, (b) provision of electricity on a least-cost basis to remote areas, (c) suitability for financing by local businesses and banks, and (d) creation of economic activity and employment in rural areas.[4] Europe leads in renewable electricity development where installed capacity of renewable electricity is expected to increase by 50 GW by 2010.

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[3] The REAP focuses only on the power sector because (a) EVN was the main counterpart; (b) providing electricity service is a high priority for GOV, as shown by the rural electrification program; and (c) the opportunities for grid-connected renewable electricity are significant.

[4] These countries include Australia, Belgium, Brazil, China, Denmark, France, Germany, India, Italy, Netherlands, Poland, Spain, and the United Kingdom, as well as seven U.S. states, including Texas.

China has already installed 23 GW of small hydropower (4–5 times Vietnam's total electricity generating capacity), mainly in rural county grids. Both China and India are introducing policies to scale up their renewable energy programs, each aiming at increases of more than 10 GW in grid-connected capacity over the next 10 years. Both countries are also preparing large renewable-based rural electrification programs, as are Argentina, Brazil, Cambodia, Laos, the Philippines, Sri Lanka, and Uganda. Many of these countries are receiving assistance from the World Bank/Global Environment Facility (GEF), which recently began to make funding available on a longer-term, programmatic basis.

Renewable Energy in Vietnam to Date

Potential. Vietnam has a fast-growing power sector and rich renewable energy resources, which could be used to generate electricity. Small hydropower potential (under 10 MW per site) is estimated at 800 - 1,400 MW, while biomass cogeneration could supply an additional 250 - 400 MW.

Renewable electricity also has considerable potential to supply isolated rural households and villages. Even with a fast-growing power sector and an aggressive grid extension program, more than 1,100 remote or mountainous communes or villages, representing about 750,000 households and 3 million people, are outside EVN's plans for connection to the grid by 2010.[5] There are almost an equal number of households in electrified communes that cannot be economically connected to the grid. A substantial share of these households or communities could be served at a cost similar to current costs for grid connection (US$400–500 per household), using renewable resources. Early results from a feasibility study indicate that small isolated hydro-based mini-grids could supply several hundred thousand households in the north and center with electricity. Improved pico-hydro systems have the potential to supply a similar number of households in the north, while solar photovoltaic (PV) systems could serve about 50,000 households in the south and center, if they could be made affordable. Wind resources, while poorly identified, could play a role on coastal areas in the central regions. Experience has been gained with these technologies in Vietnam, at least at the demonstration scale.

Barriers. While potential is significant, challenges in developing renewable energy are also significant. A two-day participatory workshop, in June 1999, discussed the barriers to large-scale renewable energy development and the possible solutions.[6] The workshop was attended by 32 representatives of stakeholder organizations. The major barriers identified are (a) inadequate policy and regulatory framework to encourage renewable electricity; (b) inadequate awareness about the technologies, their costs, and performance in Vietnam; (c) lack of commercial businesses to provide renewable electricity equipment and services; (d) lack of access to financing for consumers, businesses, and project developers; (e) high-quality technology is not available at affordable prices; and (f) inadequate resource data to plan a major program.

Since the workshop, steps have been taken toward a policy framework for large-scale renewable electricity development. Decision No.22-1999/CP-TTg by the Prime Minister (Decision 22) and the Rural Elec-

[5] Hydro Power Center 2000.
[6] ASTAE 2000.

trification Policy adopted by the MOI provide a foundation for renewable electricity development in Vietnam, but the remaining challenges are large. The REAP is proposed to address these challenges.

B. The Renewable Energy Action Plan

Objective. The objective of the REAP is that renewable energy will provide cost-effective and reliable electricity to help rural people improve their standard of living and increase their income. Renewable electricity will (a) supply isolated households and communities that cannot be reached economically by the grid and (b) augment grid supply in remote areas.

Strategy and Phasing. MOI, with support from national and international agencies, will facilitate and coordinate the implementation of the REAP. Priority will be given to providing energy services in poor isolated communes and villages, with particular attention to stimulating income-generating activities through electricity services. The program will be carried out in two five-year phases, a capacity building phase and an implementation phase. The capacity building phase would put in place the decrees, regulations and incentives needed to create a positive environment for renewable electricity activities to expand. It would also build capacity at all levels, while carrying out pilot activities in particular provinces, to test the proposed implementation arrangements. Phase 2 would scale up implementation.

REAP is based on the following strategic principles:[7] (a) renewable electricity will be used where it is least cost and economically viable; (b) renewable electricity will be supplied on a commercial basis, using businesses with all ownership forms; (c) communities, individual consumers and investors will actively contribute to and participate in the program; (d) government will act as a market enabler, putting in place the laws, decrees, regulations, and building capacity for large-scale use of renewable electricity; (e) access to long-term credit and other financial incentives will be increased to improve financial viability of businesses and affordability to consumers; and (f) limited grant assistance will be provided in recognition of social and environmental benefits, but grants will be used carefully to support sustainability.

Components. MOI and EVN agreed to five components for the capacity-building phase, which would be scaled up in the implementation phase. Following are the components in the first phase:

(a) *Renewable Energy Policy and Institutional Development (TA: US$3 million).* Building on the Rural Electrification Policy, technical assistance (TA) will be provided to (i) prepare decrees and regulations needed to encourage off-grid rural electrification and small power producers to sell to the grid, (ii) improve access to financing, (iii) investigate tax incentives, and (iv) provide training and business development assistance to businesses and government at all levels.

(b) *Individual Household/Institutional Renewable Energy Systems (TA: US$3–5 million Investment: US$3.5–10 million).* The aim will be to support the sale and after-sales service and support of 25,000–50,000 systems (improved pico-hydro

[7] Developed from Ministry of Industry (2000b).

and solar PV) for use by individual households, schools, and other institutions that cannot be connected to the grid. The program would support the development of commercial businesses to supply high-quality equipment and services.

(c) *Community Isolated Hydro Grids (TA: US$1–3 million; Investment US$4.5–18 million).*[8] Support will be provided to 20–80 communes in northern provinces to build and operate mini-grids based on hydro-hybrid plants. These grids will serve 10,000–40,000 households, as well as productive loads, which are essential for viability. TA will be provided to develop community electricity cooperatives or mini-utility businesses, as well as stimulate income-generating activities.

(d) *Grid-Connected Renewable Electricity.* There will be two subcomponents under this component:
   (i) *Renewable Energy Small Power Producers (TA: US$1–3 million; Investment US$18–30 million).* TA and investment support will be provided to encourage nonutility small power producers to invest in 15–25 MW of renewable electricity for grid supply, from small hydro, bagasse, or rice husk cogeneration. EVN will purchase the power under a Standardized Small Power Purchase Agreement (SPPA) and associated tariff. Long-term financing will be facilitated for these investments.
   (ii) *EVN Rehabilitation of Small Hydropower Plants (TA: US$0.5–1 million; Investment US$12 million).* Technical assistance and investment support will be provided to EVN to rehabilitate up to 13 economically viable small hydro plants, with an aggregate capacity of 26 MW. EVN will later consider equitization of these plants.

(e) *Technology/Market Development and Resource Assessment (TA: US$5 million).* Other activities will be supported to strengthen capacity for scale-up, including activities to support other technologies, such as wind power. Indicative activities are technology improvement of locally manufactured products, acceleration of institutional markets for renewable energy, and creation of a public database on renewable energy resources.

Program Cost and Results. Total cost of the program is estimated to be US$46–US$69 million in Phase 1. The results would be provision of electricity to 35,000–90,000 households off the national grid, and installation and operation of 41–50 MW of renewable electricity generators connected to the national grid. The results depend on the commitment and resources put into the program by the GOV, as well as support from international agencies. If the results of the first phase are successful, Phase 2 could scale up the above activities by a factor five or more. Preliminary estimates of potential scale for Phase 1 and the total program are given in Table 1.

Management and Coordination. There will be a Program Management Unit or Management Board at the MOI that will coordinate and promote the REAP. An advisory committee will be set up comprised

[8] The number of the small hydro-based grids for isolated commune electrification in the first phase of the REAP was increased from the level discussed during the workshop in October because of knowledge gained about the interest and planned activities of other international agencies (see details in main report).

of representatives of key GOV agencies, including the Ministry of Planning and Investment (MPI), Ministry of Finance (MOF); and Ministry of Science, Technology and Environment (MOSTE) as well as provincial governments, the financial community and private sector. This committee will advise on sector development issues and assist in coordination. Coordination with other rural infrastructure programs being implemented by the GOV will be particularly important.

Financing Strategy. A significant part of the financing for REAP would be provided by households and communities using the decentralized systems and by developers of grid-connected projects that would invest in the facilities. Grant financing will be sought from the GEF, to the extent that incremental costs result in reduction in greenhouse gas emissions. The creation of a Renewable Energy Fund at national and provincial level is proposed. The proposed Renewable Energy Fund could be financed by the GOV and bilateral donors in recognition of social development benefits, and from payments from communities that have renewable energy grids.

International Assistance. Assistance from international agencies will be actively sought by MOI during planning and implementation of the REAP. To date, staff of the Japan International Cooperation Agency (JICA) and Swedish International Develop-

Table 1:
Indicative Physical Achievements and Costs of REAP Program

REAP Component	Phase 1 (0–5 years)		
	Physical Targets		Estimated Cost
	Households (000)	MW	Million US$
Policy and Institutional Development	-	-	3
Individual Household and Institutional	25–50	-	7–15
Community Isolated Hydro Grids	10–40	-	6–21
Grid-connected Renewable Energy	-	25–51	25–47
Technology Improvement/Resource Assessment	-	-	5
Subtotal	35–90	25–51	46–91

	Total Program (0–10 years)		
	Physical Targets		Total Cost
	Households (000)	MW	Million US$
Policy and Institutional Development		-	6
Individual Household and Institutional	85–150	-	18–39
Community Isolated Hydro Grids	90–150	-	45–74
Grid-connected Renewable Energy	-	175–251	206–289
Technology Improvement/Resource Assessment	-		10
Total	175–300	175–251	285–418

ment Agency (SIDA) have expressed interest in implementing projects within the framework of the REAP. The World Bank plans to continue to support REAP by assisting in implementation, in two further phases:

- The proposed SEIER Project (FY02) will include a renewable energy component to support some components of Phase 1.
- The proposed Rural Energy 2 Project (FY04) will support large-scale implementation in Phase 2.

Risk and Sustainability. There are substantial risks in any renewable energy program, because the technologies are new and lesser known. Additional risks in carrying out the REAP include (a) the barriers to business, especially private business, in Vietnam, including discrimination with respect to approvals, licensing, and access to financing; and (b) the fact that renewable technologies are directed to isolated communities in Vietnam, which are also the poorest and least skilled in terms of management. Failures with existing commune hydro facilities highlight the risks.

Nevertheless, the sustainability of the program is considered strong, despite these risks, because of the commitment of the GOV to providing rural electricity service to all communities, and the step-by-step approach being taken. The phased approach allows for learning through pilots, before scaling up. Sustainability will also be addressed in the design of each component. For example, the individual household component would focus on supporting improved pico-hydro systems, the most affordable off-grid electricity supply sources. For the commune-based hydro systems, the approach taken will build on the successes and lessons learned from existing projects. Special attention will be given to the organizational set-up and financial sustainability. For the grid-connected projects, an SPPA is to be adopted by EVN-experience from other countries show that this approach reduces transactions costs and risks to investors. This will provide an ongoing market for electricity from independent producers. A temporary support unit will support EVN, financial institutions, investors and project developers. In the long run, similar to the off-grid systems, market forces will enhance sustainability.

In designing the REAP, lessons learned from the experience of the World Bank and other international agencies have been used. These lessons include the need

- for ensuring a policy and legal framework to guide private sector involvement;
- to first build capacity and support strong institutional set-up before developing larger-scale investments;
- for understanding the market characteristics, including willingness and capability of consumers to pay, before implementing an enterprise-driven energy project;
- to support development of commercial renewable energy businesses, which are the engine for implementing the projects; and
- for financial intermediation, including microfinance.

A.

Overview of the Renewable Energy Action Plan in Vietnam

1. Background

Renewable energy could play a significant role in providing electricity services to rural people in Vietnam. In 2000, about 3.9 million households and about 18 million people in rural areas of Vietnam had no access to electricity. To improve this situation, the GOV is carrying out an ambitious rural electrification program that aims to extend the national grid to 90 percent of rural households by 2005.[9] Decentralized sources of electricity, especially those based on renewable energy, offer the remaining households the only opportunity to experience the benefits of modern lighting, communication, and appliances. Renewable electricity plants connected to the grid could cost-effectively supplement grid electricity, reducing losses and improving grid stability by providing generation at the far reaches of the grid.

At the request of EVN, the World Bank assisted in preparing the Renewable Energy Action Plan (REAP). The REAP is a framework for international assistance to scale up renewable electricity development in Vietnam for rural electrification and grid supply. It proposes a 10-year program with two 5-year phases: Phase 1, an institutional and capacity building phase, and Phase 2, an implementation phase. For the first phase, the REAP details the activities, TA, and institutional and financial requirements. For the second phase, the REAP provides only a broad outline for the scale and scope of implementation because it depends on the achievements of Phase 1.

The REAP was prepared in a series of steps: (a) a participatory workshop with stakeholders in June 1999 to discuss renewable energy potential, problems, and solutions; (b) preparation of more than 10 consulting studies by teams of national and international consultants; (c) synthesis of the study results into a draft action plan report; (d) presentation of the draft report at a two-day participatory workshop with stakeholders and discussion with other international agencies in October 2000; and (e) revision of the report to take into account all comments received.

After the October workshop endorsed the REAP, EVN and MOI agreed that MOI will act as the coordinating agency for implementing the REAP. It will use the REAP as a framework for efforts by international agen-

[9] As one element of this program, the GOV, with World Bank assistance, has initiated the Rural Energy I Project, with a total cost of US$201.3 million, to extend the grid to about 430,000 rural households in 32 provinces.

cies, thereby creating synergy. MOI and EVN will open discussions with other interested international agencies that may be interested in renewable electricity development. It is hoped that other agencies will find the framework useful and will participate in its implementation.

The report is in two parts. Part A gives an overview of the REAP, while Part B provides details on each component. The overview contains (a) this introduction; (b) a summary of international developments in renewable electricity; (c) an analysis of the potential for renewable electricity in Vietnam; (d) an analysis of the barriers to its development; and (e) an outline of the proposed action plan.

1.1 International Context

In a growing number of countries, governments are introducing strong policies and programs to promote renewable energy, especially for electricity generation. Policies to promote renewable electricity are justified by the social and economic benefits, including (a) environmental protection; (b) provision of electricity on a least-cost basis to remote areas; (c) creation of economic activity and employment in remote areas; and (d) diversification of energy supply.

In industrial countries, mature renewable energy technologies are often supported through a legal requirement that utilities purchase renewable energy if it is offered below a certain price. In the United States, this price is the minimum, the avoided cost of conventional electricity production. In other countries, the stipulated price is higher than the price of conventional electricity, reflecting the environmental benefits of renewable electricity. Many countries, including Germany, Japan, Netherlands, and the United States, also provide direct subsidies on capital costs for less mature technologies like solar PV. Finally, most countries support renewable energy through the tax system, using such measures as lower VAT, tax credits, and lower rates of income tax, and increasingly taxing use of thermal energy.

In the last few years, even stronger "mandated market" mechanisms are being introduced to promote renewable electricity. The European Union (EU) has set a target that 12 percent of all energy should come from renewable energy, and is negotiating with member countries on compliance. A number of countries have introduced a legal requirement on suppliers that a certain share of electricity should come from renewable electricity.[10] This requirement is justified by the failure of the market to recognize the environmental benefits of renewable energy.

China has an impressive history of use of renewable energy for rural development, with some of the world's largest programs on small hydropower, biogas, and efficient woodstoves. The experience in small hydropower is especially significant for Vietnam. China has constructed more than 23 GW of small hydropower. These stations supply about 800 of China's 1,800 counties and 300 million people with most of their electricity. Electricity from small hydro plants made an important contribution to the growth of industries in rural China. Most of these stations were built on isolated grids; now 64 percent are connected to the main provincial grids. Small hydro plants were installed with TA from the Ministry of Water Resources and financed by grants and loans from government, loans from local banks, and commu-

[10] Including Australia, Belgium, Denmark, Italy, Netherlands (voluntary), the United Kingdom, and seven U.S. states, including Texas

nity labor and resources. Governments also supported small hydro through exemptions from income tax; VAT reduction from 17 percent to 6 percent; and provision of a subsidy to buy down the interest rate on a certain amount of the loans by 1–2 percent.

China is initiating new programs to accelerate renewable electricity. The World Bank/GEF have approved a project to support installation of 300,000–400,000 solar home systems (SHSs) in Northwest China, and 20 MW of grid-connected wind farms, as well as to improve local solar technology.[11] China is also developing, with World Bank/GEF support, a major initiative to introduce a legal requirement on suppliers that a certain share of all electricity will come from renewable sources. It is expected to aim to increase installed capacity of renewable electricity by 5–10 GW over the business-as-usual case by 2010. The Asian Development Bank (ADB) and the United Nations Development Programme (UNDP) are also supporting renewable projects in China, along with many bilateral donors.

India also has strong achievements, including the fourth largest installed wind power capacity in the world. India's policies to promote renewable energy include 100 percent depreciation of the investment in the first year;[12] reduction of custom duties; sales tax exemptions in some states; five-year tax holiday for independent power producers (IPPs); assured power purchase at fixed rates by some state utilities (about US$0.06 per kWh); facilities for wheeling, banking, and third party sale of power; 10-year financing; grant assistance; and low interest loans for PV. Using these policies, India has installed more than 1,175 MW of wind power, 235 MW of biomass cogeneration, 1,160 MW of small hydropower, and 750,000 solar PV systems with a total capacity of 58 MWp.[13] India had a World Bank/GEF Project, which installed to date 44 MW of grid-connected small hydropower, 50 MW of wind farms, and 4.2 MWp systems of solar PV for household and institutional use. A second World Bank/GEF project has been approved, aiming to install an additional 200 MW of small hydro capacity, with special attention to serving rural communities in hilly areas.

Like China, India is embarking on a major new policy initiative. While the policy is not yet finalized, current information suggests that 10 percent of all new power generation capacity will be based on renewable energy (about 12 GW new capacity by 2012), and that renewable electricity will supply 4,500 remote villages and 2 million additional isolated households by 2012. India expects that electricity from wind, bagasse cogeneration, and small hydropower will be fully competitive with conventional electricity by 2012.

Sri Lanka is new in supporting renewable energy development, comparable to Vietnam. The first large-scale initiative was the World Bank/GEF Energy Services Delivery (ESD) Project.[14] In 1997 the US$55.4 million project began with 3 components: (a) US$49 million for private sector companies and community organizations that sell PV systems or develop grid-connected mini-hydro or village hydro plants; (b) a pilot wind farm for US$3.8 million; and (c) capacity building for US$2.6 million. Today nearly 25 MW in mini hydro projects are commissioned or under construction, and another 12 MW are under review by banks; 8 village hydro systems have been financed and 3 are under consideration;

[11] China Renewable Energy Development Program Web site: http://setc-gef.newenergy.org.cn

[12] Accelerated depreciation is also applicable for some conventional investments.

[13] Ministry of Non-Conventional Energy Sources Web site: http://mnes.nic.in/so3.htm.

[14] Sri Lanka ESD Project Web site: http://www.energyservice.lk.

and loans for 7,200 PV systems have been approved. Shell Solar has entered the solar systems market.The project has catalyzed involvement of microfinance institutions. By developing an SPPA, the project has created the framework for sustained mini-hydro.

*Uganda.*Today less than 1 percent of the rural population has access to grid-supplied electricity. The Government has enacted a new Electricity Law, which encourages private participation in the power market. In rural electrification, the government is encouraging a commercial approach, with the government playing the role of market enabler. The main elements of the approach are (a) a level playing field for private and public sector participants; (b) enabling regulatory framework; (c) cost recovery and cost-based tariffs; and (d) a transparent subsidy transfer and financing mechanism.The Government has requested World Bank/GEF assistance for a large-scale rural electrification program (US$375 million).The main investment components include support for grid-connected renewable generation; isolated renewable facilities; individual and institutional solar PV systems, for relatively dispersed areas where even isolated grids are not viable; and pilots, such as efficient use of wood fuels by rural small and medium enterprises. Capacity building supports sector reform, project development, low-cost rural electrification designs, and light-handed regulation at the local level.

Table 2 summarizes the information presented above for selected countries.

1.2 Renewable Electricity in Vietnam to Date

Overview of the Power Sector

Vietnam is well endowed with energy resources, creating the opportunity to provide local industries and households with electricity, and export electricity to neighboring countries. Nevertheless, current per capita use of electricity is one of the lowest in the world, at 309 kWh per year or less than 26 kWh per month. In 1999, the power sector had an installed capacity of 5,765 MW, of which hy-

Table 2
Summary of Selected Major Renewable Electricity Initiatives

Region	Grid-connected target (MW)	Rural Electrification Target (000 households)	World Bank/GEF Support	Status
Europe	50,000	-	No	Preparation
China				
– Renewable Energy Development Project	20 (Revised)	300–400	Yes	Approved
– Renewable Energy Scale-up Program	10,000 additional MW by 2010	n.a.	Yes	Preparation
India-				
- RRDP Project	150		Yes	Implementation
- Proposed Policy	12,000 by 2012	4,500 villages and 2 million households	Requested	Approved by Cabinet of Secretaries
Sri Lanka	26	32	Yes	Implementation
Uganda	70	100–300	Yes	Preparation

n.a Not applicable
Source: Team estimates

dro plants accounted for 53 percent, thermal power plants 22 percent, gas turbines 20 percent and diesel 5 percent. Power consumption has been growing rapidly over the last decade at 11.8 percent per year. According to EVN's forecast, this growth rate will continue until 2010, when electricity consumption per capita is forecast to more than double to 734 kWh per year. Installed capacity is expected to triple, to about 16 GW, straining the ability of the power sector to finance plants. Hydro is expected to remain dominant, although its share will drop to 40 percent. Coal will play an increasing role in the north, and gas resources in the south.

The key organizations in the power sector are MOI and EVN. MOI is responsible for energy policy and planning. EVN is a state-owned utility responsible for production, transmission, distribution and supply of electricity. Under EVN, the seven regional power companies in charge of power distribution and retailing through the country are Power Company (PC) Hanoi, PC Ho Chi Minh (HCM) City, PC1 (North), PC2 (South), PC3 (Central), PC Dong Nai and PC Hai Phong. In several provinces, especially in the south, electricity distribution companies exist at provincial and district level.

Tariffs are currently set at only about two thirds of the long-run marginal cost (LRMC), indicating that long-term financial situation may not be sustainable. For example, the average retail tariff, excluding VAT, in 1999 was VND 662 (US$0.047) per kWh. This compares to an estimated LRMC including generation, transmission and distribution, of about VND 980–1,120 (US$0.07–0.08). It is planned to increase the average tariff, excluding VAT, to VND 896 (US$0.064) in 2001.[15]

A new electricity law is under preparation. Main objectives of the new law are to (a) attract domestic and foreign investors; (b) ensure equality, fairness and competition in power production and trading; and (c) protect legal rights and the interests of consumers.[16] The law is expected to make EVN the sole buyer of electricity. Competition will be encouraged in generation, with a 20 percent target for private sector generation in the medium term. The electricity law is not expected to be in place until 2003, and implementing decrees will be issued only after the law is passed. Until then, there is considerable uncertainty as a result of conflicting interim regulations, as well as uncertainty about future policies.

The GOV plans to encourage private investment in infrastructure using the build-operate-transfer (BOT) model, to avoid using budget resources or sovereign debt to finance all expansion in the power grid. Nevertheless, the private investor in a power plant faces several difficulties: (a) procedures for initiating and operating a private sector business in Vietnam are lengthy, complicated, and not transparent; (b) the legal system remains undeveloped, creating uncertainty about the legal force of contracts, business procedures and agreements; (c) there is not a level playing field, private domestic and foreign investors are at a disadvantage compared to publicly owned entities in obtaining contracts, licenses and approvals, and even bank financing; and (d) the fact that EVN and its subsidiaries are monopoly buyers places them in a strong position when determining tariffs.

EVN and its subsidiaries are making substantial progress in rural electrification. In 2000, 81 percent of the communes (7,245) and 71

[15] GOV has agreed with the World Bank and other international agencies to increase the average tariff to VND 896 (see Country Assistance Strategy).
[16] *Ibid.*

percent of rural households (9.3 million) had electricity service from the grid. GOV aims to provide electricity to 90 percent of rural households by 2005. Responsibility for implementing rural electrification is as follows:[17] (a) MOI manages overall planning, provides guidance and supervises implementation; (b) MPI, together with MOF, prepares an annual investment plan (from State Budget, concessional credit, and Official Development Assistance (ODA) funds); (c) MOF defines the State Budget, mobilizes and provides concessional credits; (d) Provincial People's Committees (PPCs) prepare investment plans and manage rural electrification programs in their territories; and (e) State Bank instructs commercial banks to provide concessional loans for poorest households.

There is a uniform national rural residential retail tariff of VND 700 per kWh for communes connected to the grid. On an exceptional basis, the GOV allows flexibility in rural tariffs, to allow the recovery of distribution costs by the local authorities selling power. This has been allowed under a GOV decree that permits people's committees to decide on exceptions to the VND 700 per kWh rural residential tariff rule. In 1997, the average rural tariff was VND 670 per kWh. Nevertheless, about 7 percent of consumers paid more than VND 900, 32 percent paid VND 700–900, and 61 percent paid VND 450–700 per kWh. The PCs sell electricity to the local rural distribution company at a wholesale price approved by the GOV, VND 360 per kWh (US$0.026), which is less than the cost of generation. This implies that there is a cross-subsidy to rural consumers from other consumers.

Renewable Resources and the Status of Different Technologies

The potential of renewable energy for electricity has been recognized in Vietnam, though its promise has not yet been realized. The first step in the REAP study was a two day participatory workshop with 32 representatives of agencies and organizations involved in the energy sector, in June 1999.[18] The objectives of the workshop were (a) to identify the most promising options for renewable energy development; (b) to develop a common understanding of the main barriers for renewable energy development, and ways to address these barriers; and (c) to provide a basis for defining the studies to be conducted under the REAP.

The workshop identified the options with the most potential as the following:

- Grid connected mini hydro and biomass systems
- Mini hydro for isolated community grids, alone or in hybrid systems with diesel
- Household scale pico-hydro systems.
- Household scale solar electricity systems

Assessment by the REAP team confirmed that these are the main opportunities in the near to medium term, as discussed below. For a summary of the potential and current use of renewable energy in Vietnam, see Table 3 below.

Small Hydropower. Vietnam is rich in hydropower resources. Technical potential for small hydro power (<10 MW per site) is 800–1,400 MW.[19] The hydro resources are mainly in the north and central areas, near the bor-

[17] Nguyet Anh Pham. 2000. Background Information for Institutional and Policy Aspects of Renewable Energy Development. Consultant report to World Bank, Washington, D.C.
[18] ASTAE. 2000. *Options for Renewable Energy in Vietnam*, report on the June 15–16, 1999, two-day participatory workshop in Hanoi. ESMAP Technical Paper 001. World Bank, Washington, D.C.
[19] Estimated by Hydropower Department of the Institute of Energy.

Table 3
Potential and Current Use of Renewable Energy in Vietnam

Resource	Potential		Current Usage		Geographical potential
	MW	Thousand hh served	MW	Thousand hh served	
Hydro power	800–1,400		110–155		North and center
- pico-hydro	90–150	200–250	30–75	100	North and center
- isolated mini-grids	300–600	300	20	n a.	North and center
- grid connected mini hydro	400–600	n.a.	60	n a	North and center
Off-grid solar PV systems	2	50	0 6	5	South and center
Biomass bagasse, rice husks, and so forth	250–400	n.a	50	n a	South and center
Geothermal	~50–200	n a	0	n a	Center
Wind power	TBD	TBD	0 2	1	Central coastal region
Total	**1,100–1,900**	**500–600**	**160–215**	**106**	

n.a Not applicable.
TBD = to be determined.

der with Laos and Cambodia. About 70–75 percent of the annual runoff is generated in three to four months. There are now about 60 MW of grid-connected mini hydro installed at 48 sites, ranging from 100 to 7,500 kW capacity (see Section B4 for details).[20] Only six out of the 48 have been reported as not in operation (13 percent) due to equipment failure. Though most of the systems are functioning, there is substantial scope to increase capacity and generation through rehabilitation. All the grid-connected systems were government financed, either directly or through international aid. There are estimated to be 400–600 MW of grid-connected mini-hydro potential (see Table 3).

More than 300 *commune based small hydro systems* have been installed. The total installed capacity of these systems is about 70 MW, with individual systems ranging from 5 to 200 kW. Most of the systems are installed in north and central Vietnam (see Section B3 for details). The quality of the community systems is poor and about 200 of them are not operating. Commercially operated small hydro-power-based grids have a much lower failure rate than community operated ones. For example, in Dong Nai, of 19 remote area installations, the 10 community-operated systems failed while nine commercially operated systems were working. According to estimates above, there are 300–600 MW of small hydropower that could be developed for community use.

A *pico-hydro system* is a small family scale generator consisting of a propeller turbine, (100–1,000 W) generator, wires and switches. It is placed in a stream or river near the home. It is estimated that about 100,000–150,000 pico-hydro systems have been sold in open

[20] Hydro Power Center. 2000. *Package B· Collection of Basic Information and Mapping Information for Vietnam.* Consultant report to World Bank, Washington, D.C.

markets on a commercial basis (see Section B2 for details). The further potential for use of these systems is considerable.

Solar Electricity. Vietnam has good constant solar resources in the south and center but substantial seasonal fluctuations in the north. Solar radiation levels in the south and central regions average just below 5 kWh per m^2 and are almost constant during the year, ranging from 4.0 to 5.9 kWh per m^2. The solar regime in the north exhibits averages around 4 kWh per m^2, but has wide variation ranging from 2.4 to 5.6. Installations in the north would be more expensive as they must include extra capacity to compensate for cloudier winter months. Therefore, priority for solar development will be in the center and southern part of the country, where rural electrification is very advanced using grid extension. Vietnam has approximately 650 kW[21] or about 5,000 installed solar PV systems divided over three market segments: professional applications (50 percent), institutional systems like hospitals, community centers and battery charging centers (30 percent), and household systems (20 percent). Most of the systems installed in Vietnam are in operation and of good quality. Almost all of the panels are imported.

Biomass Cogeneration. The main biomass sources that can be used to generate electricity are sugarcane bagasse, cane trash, and rice husks. An estimated 2.5 million tons of bagasse (1999) and 3.8 million tons of rice husks (1996) are available.[22] Most of the 43 existing sugar mills are located from Da Nang southward. Only three sugar mills supply power to the grid: Son La sugar mill in the North, La Nga sugar mill, and Sucrerie de Bourbon–Tay Ninh, both in the South. The accumulated capacity of larger industrial sugar mills (>1,000 cane tons per day) was expected to increase from 20,500 TCD in 1997 to 98,000 TCD in 2005 according to government plans. This was to be achieved by modernization and expansion of at least seven plants and construction of 12 new ones. Initial estimates show that these modern industrial mills could generate about 120 MW of excess power that could be sold to the grid (an estimated 434 million kWh). The expansion of sugar mills has halted because of a current surplus of sugar. However, even without new mills, an opportunity exists as only 3 out of 43 facilities sell electricity to EVN. There is substantial scope for updating the technology and creating excess generation. Production of electricity from rice husks is also an important but untapped resource.

Other Renewable Resources. With more than 3,000 km of seashore and 70 percent of the country mountainous, there is likely to be potential for wind power. The potential cannot be quantified as no systematic wind resource measurements are available. Data from meteorological stations is of limited use as the measurement sites are not appropriate for wind farms and meters are not calibrated regularly. The data show averages recorded of about 5 m/s (at a 10-meter height). A study by the Institute of Energy of Vietnam (IE) on nine islands shows average annual wind speeds ranging from 4.1 to 7.1 m/s. Potential is indicated by the results of a macro wind mapping study of Vietnam and neiboring countries, showing several pockets of wind speeds higher than 6 m/s, in the mountainous areas that border Laos, and coastal provinces south of Da Nang and north of HCM City.[23] (See Annex 2, Macro-Level Wind Map of Vietnam and neiboring countries). While there

[21] Institute of Energy estimate.

[22] *Ibid.*

[23] Truewind Solutions. 2001. *Wind Resource Atlas of Southeast Asia.* Consultant report to World Bank.

are no grid-connected wind energy systems in Vietnam, the Research Center for Thermal Equipment and Renewable Energy of the HCM City University of Technology (RECTERE) has developed and installed household wind power home systems. IE has also been involved in government supported household scale pilot projects and research and development.

No information is available about the geothermal resource potential in Vietnam. One developer has estimated that about 200 MW is available in Central Vietnam. Based on their initial assessment they are pursuing a prefeasibility study for three plants generating at least 50 MW of power. Six sites have been identified with total potential capacity estimated at about 100 MW.[24]

International Assistance for Renewable Electricity Development

Support for renewable electricity development has been provided to the GOV by international agencies, such as the World Bank, UNDP, JICA, and SIDA. The World Bank Group has supported the following activities (see also Annex 3).

- REAP. Background studies included creation of a data base on more than 1,100 communes that will not be electrified by EVN in the next five years;[25] a feasibility study for individual systems for households and institutions; a feasibility study for community isolated hydro grids; an institutional and policy background study; and a techno-economic analysis of options.
- Renewable Energy activities as part of the preparation of the Rural Energy 1 Project, included a commune based micro-hydro-diesel pilot project in Son La Province; identification of an investment pipeline of 15 projects to rehabilitate grid connected hydro facilities; development of an SPPA and tariff; and a visit of the main Vietnamese stakeholders to village hydro, solar and grid connected renewable projects in Sri Lanka.
- Projects with support from IFC and Trust Fund resources that resulted in a Master Plan for Rural Electrification for Vietnam (Danish Consultant Trust Fund); preparation of an investment pipeline for new small hydro sites (New Zealand Government); a macro level wind resource map for Vietnam and neiboring countries. (Netherlands Partnership Program); renewable energy training and awareness material for communes (Netherlands Partnership Program); investment and business plan for micro hydro manufacturing business (Swiss Consultant Trust Fund); and IFC support for a commercial solar company that is selling PV systems.

Other renewable energy research and development projects have been supported by international agencies (see Annex 4).

In particular, the Government of Japan has provided assistance for renewable energy activities including a demonstration project of a hybrid system of PV micro-hydro-power in Gia Lai Province through the New Energy and Industrial Technology Development Organization (NEDO); and a rural electrification plan for 265 communes of 17 provinces in the north through the use of renewable resources, such as micro-hydro, solar or wind energy (JICA).

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[24] Informal communication with ORMAT, USA.

[25] Data includes population, number of households, per capita income, village spacing, access to seasonal road, perennial road, health center, school, market, and small hydro potential.

Sweden (SIDA) has provided support for a Regional Research and Dissemination Program on Renewable Energy Technology for Asia to promote dissemination of technologies through adaptation to local conditions. This program is coordinated by the Asian Institute of Technology and implemented by research agencies in 6 countries. SIDA will consider rural electrification using renewable energy technologies in their assistance program during 2001–2003.

Barriers to Renewable Electricity Development

Despite the work that is going on, considerable barriers and challenges to developing renewable energy in Vietnam remain. During the participatory workshop referred to earlier, a brainstorming session was held to identify these barriers. More than 100 perceived barriers were identified by the participants (see Annex 5). The main barriers were identified as the following:

- Lack of an adequate policy and regulatory framework that encourages renewable electricity where it is least cost. Policies, regulations and procedures are required to level the playing field with conventional generation. For rural electrification, a mechanism is required to determine and channel an appropriate subsidy to rural communities.
- Inadequate information about the technologies, their costs and effectiveness, for the potential investors in grid-connected plants, community and household systems, for financing agencies, and for government officials at all levels.[26]
- Lack of commercial businesses to provide renewable electricity equipment and services. More transparency is required on the implementation of the business licensing and regulatory frameworks, to encourage formation of such businesses. Publicly and privately owned businesses need to be treated equally with respect to project approvals and access to financing.
- Lack of financing for consumers, businesses and developers. Consumer credit is needed for solar PV household units. Credit is also required for many of the small and medium companies that might be renewable energy suppliers. Long-term financing is needed for community mini-grids and developers of grid-connected projects.
- Local technology is not yet available. Pico-hydro and small hydro generators and controls are of lesser quality than systems available internationally. Import of high quality equipment or the introduction of joint venture investment to improve local quality of equipment is needed to support a major program.[27]
- Inadequate resource and market data to plan a major program and to develop projects. For small hydro, a number of sites have been identified, but the level of detail is not adequate for planning a detailed program. Data is scant and inconsistent for wind energy.

Studies were undertaken as part of the REAP to identify a framework for how to address these barriers. The resulting Action Plan is described below.

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[26] A start has been made by preparing renewable energy training material for communes through the Renewable Energy for Rural Infrastructure Development project (RERID, see also Annex 1).

[27] A start has been made on this through twinning of a Swiss company with RERC. See Annex 1, and Entec, 2000. *Investment and Business Plan for Setting up a Micro Hydro Turbine Manufacturing Business in Vietnam*. Consultant report for World Bank, Washington, D.C.

2. Renewable Energy Action Plan

2.1 Objective and Indicators

The objective of the REAP is that renewable energy will provide electricity for economic and social development in remote areas by (a) supplying isolated households and communities that cannot be reached economically by the grid; and (b) augmenting grid supply in remote areas. Private and public sector companies, as well as nongovernmental organizations (NGOs), will supply cost-effective, reliable renewable electricity equipment and services, on a commercial basis, to households and communities.

Success in reaching this objective will be measured by the following indicators:

- the number of renewable electricity systems operated by households and institutions;
- the number of isolated grids installed with renewable electricity, the number of households served and the MWh generated and sold in such grids;
- electricity use per household with renewable electricity;
- productive usage of electricity in communities with isolated grids;
- the number of renewable electricity facilities selling electricity to the grid and the MWh sold.

2.2 Strategy and Principles

The GOV, in partnership with international agencies, will carry out a 10-year program that will enable large-scale supply of clean, reliable electricity from renewable energy to rural communities. Priority will be given to providing energy services in poorer isolated communes and villages, with particular attention to supporting productive uses and social development through electricity services.

The REAP will be carried out in two phases, an institutional and capacity building phase and an implementation phase, each about five years long. The institutional and capacity building phase will allow time to put in place the necessary policy, legislative and regulatory base for renewable energy activities to expand. It would also allow trial activities that would be focused on particular provinces, which could test the proposed implementation activities and arrangements.

The program would follow six strategic principles:

(a) Renewable electricity will be used when it is least cost and economically viable. There are two areas where decentralized renewable electricity systems are cost-effective in Vietnam:

- To provide electricity services to remote consumers who will not be reached by extension of the grid. These include households in communes too far away to be reached by the grid, or households in electrified communes that cannot be economically connected.
- To augment electricity supply to the grid, especially in outlying areas. This will help improve grid stability and reduce transmission losses, increasingly important considerations as the grid network expands.

(b) Renewable electricity will be supplied on a commercial basis, by all types of businesses. Renewable electricity equipment and services will be supplied by a variety of private and public sector companies, cooperatives and NGOs, on a commercial basis. The new Company Law issued in 2000 is supportive of companies, but the program will also build on Vietnam's strong base of local community electricity units and cooperatives. The private sector will be encouraged.

(c) *Communities, individual consumers and investors will actively contribute to and participate in the program* All stakeholders will participate actively in program design and implementation and invest their own funds in the proposed activities and installations. The government and international agencies will contribute, but there must be a concept of local community and investor cost sharing, ownership and participation in the choice of technology and management approach.

(d) *Government will act as a market enabler.* Building on the principles in MOI's Rural Electrification Policy (see Section B1), the GOV will issue policies and establish the legislation and regulation to support commercial development of renewable electricity. Government assistance will be provided for capacity building in design, engineering, business and finance to support the renewable energy sector and management of the renewable facilities in rural communities. The Government will play an important role in assuring quality and safety, as well as increasing awareness.

(e) *Access to long-term credit will be increased to improve financial viability of businesses and affordability of services.* Financing will be needed by renewable energy businesses for investment in facilities and distribution networks and for working capital. The program will facilitate provision of credit by commercial banks, so that they gain experience with the renewable electricity business and take it on it's financing as a normal activity. The REAP will facilitate access to credit for individual households to purchase systems or for communities or developers to finance larger scale plants.

(f) *Limited grant assistance will be provided in recognition of the social and environmental benefits, but will be used carefully.* Grant funding is needed to build the capacity for large-scale renewable electricity development in government, business and communities. Grant funding is also needed to buy down the costs of preinvestment activities and, and to some extent, renewable electricity facilities for rural electrification. For grid-connected investment, an effective role for subsidy or grant funds is to cover higher risk preinvestment costs, such as feasibility and prefeasibility studies, information collection, resource assessment, training and capacity building. For off-grid facilities, consideration will be given to subsidizing part of the capital costs of the facilities, as is now done with grid extension. Grants will be sought from the GEF and others for global environmental benefits, and from the GOV and international agencies for local social and environmental benefits.

2.3 Program Components

The program will focus on three potential markets segments for renewable energy: individual and institutional consumers that will use stand alone systems; communities that could benefit from isolated grids; and supply to the national grid. The program has five main components, which are described briefly below for Phase 1:[28]

(a) *Renewable Energy Policy and Institutional Development (TA: US$3 million)* Building on the Rural Electrification Policy, TA will be provided to (i) prepare decrees and regulations needed to encourage off-grid rural electrification and small power producers to sell to the grid; (ii) improve access to financing; (iii) investigate tax in-

[28] The five main components were derived from the workshop with the main stakeholders and the analysis of potential for expansion (see section 1.3.2)

centives; (iv) develop the concept of a Renewable Energy Fund; and (v) and provide training and business development assistance to businesses and government at all levels

(b) *Individual Household/Institutional Systems (TA: US$3–5 million; Investment: US$3.5–10 million)* The aim will be to support businesses to sell and provide after-sales service and support for 25,000–50,000 systems, (improved pico-hydro and solar PV) for use by individual households, schools, and other institutions that cannot be connected to the grid. The program would provide training, technical and financial support for the development of commercial businesses to supply good quality equipment and services.

(c) *Community Isolated Hydro Grids (TA: US$1–3 million; Investment US$4.5–18 million)*[29] TA and investment support will be provided to 20–80 communes in northern provinces to build and operate mini-grids based on hydro-hybrid plants. These grids will serve 10,000–40,000 households, as well as productive loads, which are essential for viability. TA will be provided to develop community electricity cooperatives or mini-utility businesses, as well as stimulate income-generating activities.

(d) *Grid-Connected Renewable Electricity.* There will be two subcomponents under this component:
   (i) *Renewable Energy Small Power Producers (TA: US$1–3 million; Investment US$18–30 million)* Small power producers will invest in 15–25 MW of renewable electricity for grid supply, from small hydro, bagasse or rice husk cogeneration. EVN will purchase the power under an SPPA and associated tariff. Long-term financing will be required for these investments.
   (ii) *EVN Rehabilitation of Small Hydropower Plants (TA: US$0.5–1 million; Investment US$12 million)* EVN will rehabilitate up to 13 economically viable small hydro plants with an aggregate capacity of 26 MW. EVN may later consider equitization of these plants.

(e) *Technology/Market Development and Resource Assessment (TA US$5 million).* Other activities will be supported to strengthen capacity for scale-up. Indicative activities are technology improvement of locally manufactured products; acceleration of institutional markets for renewable energy; and creation of a public data base on renewable energy resources.

Each component will be discussed in detail in Section B of the report.

2.4 Expected Results and Costs

Total cost of the program is estimated to be US$46–91 million in Phase 1. The result would be provision of electricity to 35,000–90,000 households off the national grid, and installation and operation of 41–50 MW of renewable electricity generation by small power producers connected to the national grid. The results depend on the commitment and resources put into the program by the GOV, as well as support from international agencies. If the results of the first phase are successful, Phase 2 could involve a scale-up of the above activities by a factor five or more. Preliminary estimates of potential scale for Phase 2 are given in Table 4.

[29] The number of the small hydro-based grids for isolated commune electrification was increased because interest and planned activities of other international agencies.

2.5 Financing Plan

Indicative sources of financing for the above investment and TA program are given below in Table 5. A significant part of the financing would be provided by investors themselves, households, communities and developers of grid-connected projects in the form of equity. Loans will be made by commercial banks, but financing to be onlent could be sought from multilateral banks, which are increasingly interested in supporting renewable energy. Grants would also be sought from the GOV and bilateral agencies in recognition of local social and environmental benefits that are not recognized in the market. Grant financing will also be sought from the GEF, Prototype Carbon Fund (PCF) and the Clean Development Mechanism (CDM) to the extent that activities result in reduced green-

Table 4:
Indicative Physical Achievements and Costs of REAP Program

REAP Component	Phase 1		
	Physical Targets		Estimated Cost
	Households (000)	MW	Million US$
Policy and Institutional Development	-.	-	3
Individual Household and Institutional	25–50	-	7–15
Community Isolated Hydro Grids	10–40	-	6–21
Grid-connected Renewable Energy	-	25–51	25–47
EVN Mini-Hydro Rehabilitation	-	10–26	5–12
Small Power Producers	-	15–25	18–30
TA	-	-	2–4
Technology Improvement/Resource Assessment	-	-	5
Total	**35–90**	**25–51**	**45–91**
REAP Component	**Phases I & II (0–10 years)**		
	Physical Targets		**Total Cost**
	Households (000)	**MW**	**Million US$**
Policy and Institutional Development	-	-	6
Individual Household and Institutional	85–150	-	18–39
Hydro-based Commune Electricity	90–150	-	45–74
Grid-connected Renewable Energy	-	-	206–289
EVN Mini-Hydro Rehabilitation	-	26	5–13
Small Power Producers	-	165–225	198–270
TA	-	-	3–6
Technology Improvement/Resource Assessment	-	-	10
Total	**175–300**	**175–251**	**285–418**

Source: Team estimates

house gas (GHG) emissions.

Renewable energy technologies are characterized by relatively high capital costs and low operating costs. Therefore, long-term credit (5–10 years, including 3-year grace) is needed to finance projects, such as mini-hydro power plants and mini-grid networks. For pico-hydro plants while credit sales are not anticipated, the supplier companies would need investment and working capital financing. Solar PV systems are likely to require financial assistance to permit some purchasers to pay for the systems over one or more years, in addition to investment and working capital credit for the supplier companies. Based on Table 5, about US$35–40 million in commercial loan financing may be required over the first five years, depending on the amount of grant assistance that would be available for the off-grid and mini-grid options. Over the next 5 years, an additional US$160–180 million in financing could be required.

Sources of debt financing could be *multilateral and bilateral loans* or funds mobilized in the *local capital markets*. It is recommended that credit obtained from multilateral sources, such as the World Bank or ADB, be made accessible through commercial or development banks rather than via specialized institutions. This permits the financial sector to gain experience in investing in the renewable energy sector and building greater confidence in such investments. As noted previously, mechanisms to permit microfinance institutions to access such funds is important in developing the market for off-grid systems. The approach of working through the formal financial sector helps in further mainstreaming of such investments and encourages greater efficiency.

While renewable energy options can be the least cost option on an economic basis, particularly for serving consumers not connected to the grid, their financial viability is constrained, especially in the early stages of business development. Rural consumers have a limited ability to pay the high up-front cost of renewable technologies. Suppliers find it difficult to mobilize adequate financing to produce quality products and offer necessary support services. In most countries, grant funds have been used to: overcome barriers and build the capacity of the public, private and nongovernmental sectors to deliver products and services; strengthen the capabilities of the financial sector to invest in renewable energy; improve quality of products and services; and increase access to information regarding technology and resources. Grant funds could also be used to create a guarantee fund to help reduce risks associated with factors beyond the developers control (such as water flow reductions, water diversions, and oil price fluctuations, which affect avoided cost-based tariffs). Finally, grants are justified for rural electrification on the same bases as grants are now given for grid extension, for social and economic development.

Based on experiences in other countries, GEF grant assistance for reducing the investment costs for off-grid and isolated grid applications and even grid-connected renewables could be justified for 5–25 percent of the investment cost on the basis of overcoming barriers to technologies that mitigate greenhouse gas emissions.[30] However, an argument must be made that the GEF subsidy contributes to the sustainability of the technology and application. Additional grant assistance, justified for social and economic development reasons, will be required. This would have to be mobilized from Government or bilateral sources.

The PCF is intended to invest in projects that will produce high quality greenhouse

[30] See the GEF Web site: http://www.gefweb.org/.

Table 5

Indicative 10-Year Financing Plan for REAP, Lower Boundary (Million US$)

Component	Phase I				Phase II			
	Grants	**Loans**	**Equity**	**Total**	**Grants**	**Loans**	**Equity**	**Total**
Policy and Institutional Development	3	-	-	3	3	-	-	3
Off-gnd Electnfication Program	4	1	2	7	3	3	6	11
Capacty Buildıng	3	-	-	3	2	-	-	2
Investments	1	1	2	4	1	3	6	9
Isolated Gnd Program	5	1	1	6	28	7	4	39
Capacty Building	1	-	-	1	3	-	-	3
Investments	4	1	1	5	25	7	4	36
Grid-Connected Program	2	17	6	25	1	135	45	181
Capacity Building	2	-	-	2	1	-	-	1
Investments*		17	6	23		135	45	180
Resource Assess/Technology	5	-	-	5	5	-	-	5
Total	**19**	**19**	**8**	**45**	**40**	**145**	**55**	**239**
Percentage	41	41	18	100	17	60	23	100
Total Government includıng EVN**	19	4	-	23	40	-	-	40
Total non-Government	-	14	8	22	-	145	55	200

* In Phase I, US$3.8 million of the loans are to EVN; ın Phase II, all investment loans are to nonutility commercial investors

** Government grants might be partially financed by several sources, for example, International Development Association (IDA) loan, bilateral support, GEF support and/or GHG reduction mechanisms induding the Prototype Carbon Fund (PCF) and carbon tradıng

Source: Team estimates

gas emission reductions that could be registered wıth the United Nations Framework Conventıon on Climate Change (UNFCC) for the purposes of the Kyoto Protocol.[31] The PCF will mobilize resources from both the public and private sectors in developed countries and invest in them ın projects in host developing countries designed to produce emissions reductions fully consistent with the Kyoto Protocol and the Joint Implementation Framework and the CDM. Half the funds will be spent in developing countries facilitating the CDM. The PCF is considering to not only invest in projects directly, but also to assist host countries ın setting up funds sponsored by commercial and development banks and other entities.

In order for Vietnam to be eligible to access PCF funds, and to implement PCF-assisted projects, the GOV needs to sign a Memorandum of Understanding and/or Letter of Endorsement with the PCF. This will allow Vietnam to become a member of the PCF Host

[31] See the PCF Web site: http://www.prototypecarbonfund.org/.

Country Committee. Subsequently, proponents in Vietnam with PCF eligible projects would need to submit their project proposals to the PCF for review and consideration.

If Vietnam were eligible to access PCF funds, renewable energy technology, such as, but not limited to, geothermal, wind, solar and small-scale hydro energy projects could be financed. No less than approximately 2 percent nor more than approximately 10 percent of the Fund's assets will be invested in any one Project. It is likely that initially, some of the grid-connected renewable energy projects (small hydro or biomass cogeneration) could receive PCF grant funds.

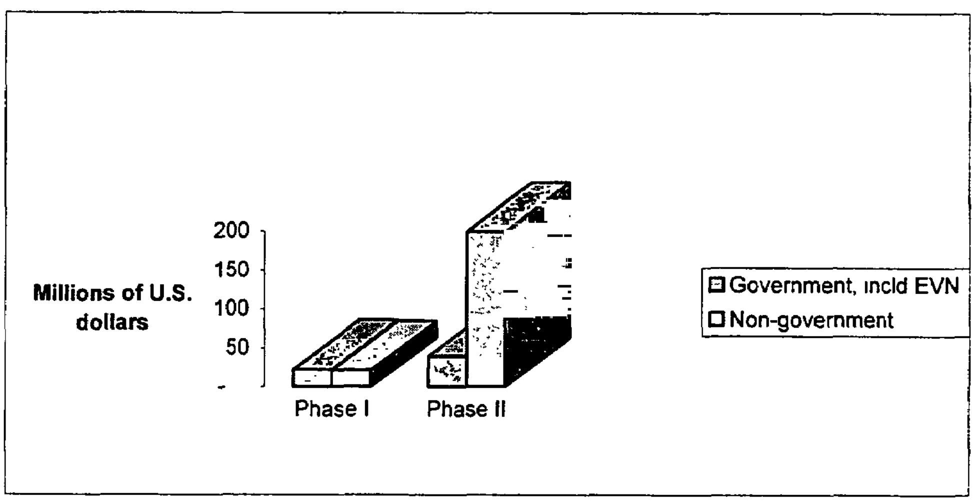
An indicative financing allocation is given in Figure 1 showing the share of government investment decreasing sharply in Phase 2.

2.6 Institutional Arrangements

The main project implementers are expected to be commercially oriented enterprises, the private sector, cooperatives and NGOs that have the primary role in delivering renewable energy products and services. The role of the government is that of market enabler and to help build the capacity of the entities delivering services. The government also has a fiduciary responsibility for proper use of grant or loan funds made available to it from bilateral and multilateral sources as well as from the government's own treasury to support the sector.

The proposed institutional arrangement for managing the Renewable Energy Program is outlined in Figure 2. The lead governmental responsibility will be delegated to a REAP Program Management Board (RPMB) at MOI. The Board will be responsible for overseeing and coordinating all activities under the program. There will be several groups under the RPMD, include off-grid and isolated grid program support group, small power producers support group, capacity building and information dissemination, resource mobilization and funds coordination (including management of Renewable Energy Fund, see below), and accounting and administration.

Figure 1:
Significant Decrease in Share of Government Investments in Phase II



An independent monitoring and evaluation unit would ensure that the program meets the government's development objectives.

An advisory committee will be set up comprised of representatives of key agencies from the government, financial community and private sector, at both national and provincial level, to advise MOI on sector development issues and assist in coordination and cooperation.

EVN will establish a group to oversee EVN-owned small hydropower plants power plant rehabilitation and to support interactions with nonutility small power producers.

It is planned to create a *Renewable Energy Fund*, that can be managed by one or more commercial banks, in order to assist in the provision of longer term credit. If necessary, partial credit guarantees could be considered to provide longer loan terms. The Renewable Energy Fund could also be used as a mechanism to provide subsidies. Such a fund could also be used to provide capital cost grants to communities for community isolated hydro facilities, in the poorer communities and in mountainous areas. It is recommended that such grant assistance be limited to buying down the investment costs but not to cover operating or replacement costs. The fund could be used to cofinance renewable energy isolated grids and off-grid options.

In the first five years, about US$5 million equivalent will be required if a fund like this would be established. This amount of funds is small. This fund could be established with budgetary contributions from the government, bilateral donor contributions and possibly a small surcharge on the urban electricity tariff. For example, the entire amount required for the first five years could be obtained by only a VND 0.5 per kWh surcharge (that is, 0.07 percent of the residential tariff), on electricity sales in Vietnam over the five-year period. Arrangements to pilot such a fund in one province are currently underway.

2.7 Sustainability and Risk Mitigation

There are substantial risks in any renewable energy program, because the technologies are lesser known than conventional ones. Special risks in carrying out the REAP program include (a) the remaining barriers to doing business, especially private business, in Vietnam, including difficulties with respect to approvals, licensing and access to financing; (b) the fact that renewable technologies are directed to isolated communities in Vietnam, which are also the poorest and least skilled in terms of management. Failures of many previous commune hydro plants highlight these risks.

Nevertheless, the sustainability of the program is considered to be strong, despite these risks. This is because of the strong commitment of the GOV to providing rural electricity service to all communities, as well as the step-by-step approach proposed. The phased approach allows for learning through pilots, before scaling up. Sustainability will also be addressed in the design of each component. For example, the individual household component would focus on supporting improved pico-hydro systems, which are among the lowest cost and most affordable sources of off-grid electricity supply. SHSs will also be supported, but with particular attention to financing mechanisms to increase affordability. For the commune based hydro systems a substantial amount of experience is available in Vietnam. The approach taken will build on the successes and lessons learned of these projects. It has been indicated that there are two main areas that need attention to enhance sustainability: the organizational set-up, and the financial sustainability. As part of a pilot and consultant studies these two areas have been focus of attention and will remain so during the implementation of the first phase of REAP. Successful models during the first phase will be replicated during Phase 2.

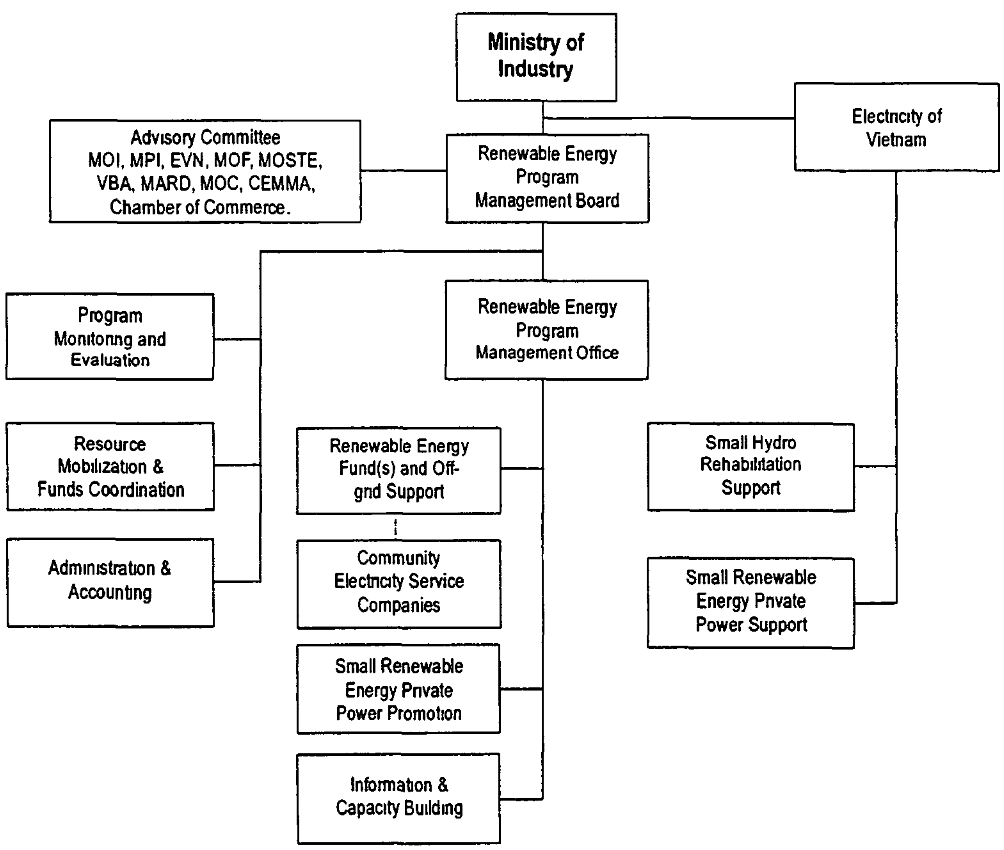
For the grid connected projects, an SPPA is to be adopted by EVN under a covenant of the Rural Energy 1 Project. This will provide an ongoing market for electricity from independent producers. To support the introduction of this market based standard agreement, there will be a temporary support unit. The unit will support EVN, finance institutions, investors and project developers on a demand basis to adopt the market driven approach. On the long run, similar to the off-grid systems, the market forces will enhance sustainability.

In designing the activities for GEF supp in Vietnam, lessons learned from the experience of the World Bank and other donors in supporting renewable energy technologies in countries of this region—for example, Cambodia, India, Indonesia, Laos, and Sri Lanka—have been taken into consideration. These lessons include the following:

- Need for ensuring a policy and legal framework to guide private sector involvement;
- Need to first build capacity and support strong institutional set up before developing larger scale investments;
- Need for understanding the market char-

Figure 2:

Significant Decrease in Share of Government Investments in Phase II



acteristics including willingness and capability of consumers to pay, before implementing an enterprise-driven energy project;

- Need to support development of commercial renewable energy businesses, which are the engine for implementing the projects; and
- Need for financial intermediation including providing microfinance options for technologies with high front-end costs like solar PV.

B.

Detailed Description of REAP Components

Each major component of the REAP will be described below. The description will begin with the objective; then background on international and Vietnamese experience; proposed activities; financial and economic viability of the activities; and the estimated cost in Phase 1. Following are descriptions of the components:

1. Renewable Energy Policy and Institutional Development;
2. Individual Household and Institutional Renewable Energy Systems;
3. Community Isolated Hydro Grids;
4. Grid-connected Renewable Electricity; and
5. Technology/Market Development and Resource Assessment

1. Renewable Energy Policy and Institutional Development Component

1.1 Objective

The objective of this component is to support (a) implementation of strong policies, programs and regulations to support renewable energy development on a large scale; (b) strengthening of leadership and implementation capacity at national, provincial and local level; and (c) development of mechanisms to mobilize investments through financial and fiscal incentives, improve access to financing and provide targeted subsidies.

1.2 Background

International Experience. As discussed in section A2, many countries have introduced strong policies to support renewable electricity development. These policies to promote renewable electricity are justified by the social and economic benefits, including (a) environmental protection; (b) provision of electricity on a least cost basis to remote areas; (b) creation of economic activity and employment in remote areas; and (d) diversification of energy supply. In order to carry out these policies, different countries have developed different instruments and institutional models. Examples of institutional models are given in section A2, and in more detail for India and China below.

India has a well-developed institutional structure for renewable energy with a Ministry of Non-Conventional Energy Sources (MNES) for policy and development at national level. MNES established the India Renewable Energy Development Agency (IREDA), to promote investment, and provide concessional loans and grants to developers. One notable feature of this structure is that IREDA has received substantial financing from the World Bank, ADB, Kreditanstalt für Wiederaufbau (KfW), Swiss Development Corporation, the Netherlands Government, and other international agencies. India also encourages investment through financial incentives for renewable energy at national level, including accelerated depreciation; subsidies for capital cost of PV for disadvantaged communities; low interest loans for PV and long-term loans for small hydro and wind projects; research and development expenditures. Several state (provincial) governments provide additional incentives—for example, lower sales taxes, provision for wheeling and banking of electricity, mandatory purchase of renewable electricity at set price (US$0.063 per kWh). A new policy is under development which proposes to require that 10 percent of all new electricity generating capacity should come from renewable sources, and that 4,500 remote villages and 2 million additional households will receive electricity service from renewable electricity by 2012.

China. The responsibility for planning for renewable energy development is shared between State Development Planning and State Economic and Trade Commissions. Ministries are active in implementation, especially Water Resources (small hydropower), Agriculture (biomass), and Science and Technology (PV and wind). The Government of China authorized a VAT reduction from 17 to 6 percent for small hydro and biomass. Provincial and local governments provide per system subsidies, as part of technology development and/or poverty alleviation efforts, especially for household solar PV and wind systems. For grid-connected small hydro and wind, local authorities forego income tax and encourage utilities to buy electricity from wind and small hydro at a higher tariff. A new market-based policy to accelerate renewable electricity is now under development, under the 10th Five Year Plan. This includes a proposed legal requirement on suppliers that a share of all electricity should come from renewable energy. The additional cost will be passed on to the consumer. Provinces are expected to prepare plans and receive TA from the national government. Assistance will also be provided to cost-share early investments in technology transfer and development. An expanded credit line for long-term credit, maybe concessional, is also under consideration.

Experience in Vietnam. The GOV has recently begun to put in place a policy framework for renewable electricity development, for rural electrification and grid supply. *Decision 22* sets the stage for using renewable energy by stating that rural electricity supply will utilize both grid and off-grid systems, based on least cost criteria. It states that the Provincial Planning Commission (PPC) is responsible for preparing power development plans and also for development and management of renewable energy. Also, the *Rural Energy I Credit* provided that EVN (a) review with the International Development Association (IDA) its action plan for renewable energy; and (b) encourage private sector investments in small scale grid-connected renewables through adoption of an SPPA and tariffs by December 31, 2000.

The *Rural Electrification Policy* adopted in early 2000 by MOI, sets the basic principles of diversifying ownership, providing incentives for local electricity supply businesses and encouraging decentralized power generation (see Annex 6).[32] It states that rural electricity supply will be based on both grid and off-grid systems, based on least cost criteria. Rural electricity companies should have adequate financial incentive to continue in business and maintain an acceptable level of service. Foreign and local investors are encouraged to invest in local electricity supply systems, especially in areas that cannot be reached by the grid. To encourage investment in decentralized plants, the PCs will offer capacity and/or energy payments equal to the investment and operating costs that are avoided by the purchase.

[32] Ministry of Industry 2000b.

By 2010, the draft *Master Plan of Power Development for 2001–2010* calls for 1,500 new communes to be electrified through grid extension and 400 remote communes, which cannot be economically connected to the grid, to be electrified through renewable energy technologies, such as micro hydro, together with solar, wind power or diesel. Northern Mountainous provinces and Central Highland are identified as regions for off-grid renewable energy development.[33]

According to Decision 22, financing for extending the grid is as follows: (a) the medium-voltage (MV) network is to be funded from State Budget, EVN Depreciation fund, GOV annual concessional credit and ODA funds; (b) low voltage network is to be constructed using local funding; (c) for the poorest areas, the GOV will supplement the local contributions; and (d) service drops to houses are to be funded by households.

The GOV is expected to announce a decree or decision on investment sources for decentralized grids soon.[34] It is expected that this decision will allow the tariff in such projects is to be decided by PPCs, to allow cost recovery and reasonable profits for distribution. The sources of funds for investment in decentralized grids are expected to be

- for the poorest communes, through national multipurpose investment programs, international support and contributions from economic sectors or other provinces. The contribution from local population is to be local available materials, labor, and so forth;
- for other mountainous communes, local network is to be funded by local government budget and other resources mobilized locally. The support from GOV budget is to be less than 30 percent of the project cost. Domestic investors in electricity network for communes in remote, mountainous or poor areas, including private investors, can borrow concessional credits from National Assistance Fund or other funds with interest rate reduced by 50 percent.

Approvals on isolated power systems are to be simplified and decentralized to provincial authority. All isolated power projects under 5,000 kW are proposed to be approved by PPC or lower levels, depending on scale of investment. If the project is to connect to the national grid, a Power Purchase Agreement (PPA) with EVN is also required.

While the Rural Electrification Policy and the Master Plan for Power Development for 2001–2010 state a clear intention to encourage off-grid electrification, there are not yet clear and detailed regulations on financing, management or operation of decentralized grids or off-grid supply. There are also no clear guidelines for transparent channeling of subsidies to rural communities for off-grid electrification.

Following are some key lessons that have been learned from different countries, including India and China:

1. Development of renewable energy requires a long-term, programmatic effort. Pilot and/or demonstration projects by themselves will not trigger market expansion. To support sustained market development, a long-term effort is needed that must be supported by all parties, including government, banks, private sector, research and development organizations, universities, NGOs, consumers, and the utility.

[33] See Chapter 2, Ministry of Industry (2000a).

[34] Draft Inter-ministerial Circular on Investment and Construction Management of Power Projects in Rural and Mountainous Areas. See page 13, Pham Nguyet Anh (2000).

2. Government involvement is essential. To support early development and overcome market failure (for example, externalities), the government has an important role to play as a market enabler. This includes setting appropriate policies; putting in place regulations, financial incentives, and targeted, transparent subsidies (justified by environmental and social benefits); and carrying out programs to create awareness and strengthen capacity.
3. Capacity building needs to be done in advance of market acceleration. Some important areas are (a) public awareness and knowledge; (b) market and resource information; (c) operational capacities of organizations and businesses; (d) finance mechanisms; (e) policy and legal framework; and (f) product quality and pricing policy. Capacity building must be closely related to investment opportunity, or it will be ineffective.
4. Renewable energy systems must first be financially viable, before meeting social objectives. Renewable energy systems should only be developed where they are financially least cost, or where financial incentives or other government policies make them affordable. Organizational set-up must be business-like, with accountability and good financial management.
5. Renewable energy benefits from joint international effort. Technology development or transfer is important. Also, while local production should be encouraged, the conditions to produce some of the high-technology components may not be favorable and it may be less costly to import these items (for example PV cells). Lessons learned from other countries can accelerate market penetration. Nevertheless, dumping of equipment to support international companies is detrimental to market development.

1.3 Technical Assistance Activities Proposed

The Policy and Institutional Development Component will provide TA to make recommendations to develop policy instruments, regulations, strengthen institutional capacity, and mobilize resources, especially within the first two years of the program. It will build on recently introduced policy and regulatory measures, especially the Rural Electrification Policy. The proposed TA activities are described below:

Assistance in Development of Policy Instruments, Decrees and Regulations. The Rural Electrification Policy states MOI's intention to support development of renewable electricity for off-grid rural electrification and for grid supply. It is necessary to develop a number of instruments to implement this intention. This TA activity will assist MOI in developing the necessary instruments, which will build on activities already underway.

Government has an important role to play in creating an enabling environment, because of the fact that the marketplace does not recognize fully the environmental and social benefits of renewable electricity. As with rural electrification, the government must facilitate investment in renewable electricity in a number of ways. Examples of key policy and regulatory requirements include decrees and regulations, which would set out the following:

Rural Electrification

- rights and responsibilities of national and local governments, service providers, communities, individuals with respect to rural electrification using renewable electricity,

- methodology for determining when renewable electricity is least cost;
- institutional models for community service provision and appropriate regulations developed for their operation;
- appropriate source, level, amount and mechanism for government subsidy of rural electrification with renewable electricity, for community grids and individual systems;
- appropriate design and quality standards and enforcement mechanisms for service, safety and reliability.

Nonutility Renewable Power Generation

- rights and responsibilities of governments, power companies, and project developers, owners and operators with respect to nonutility renewable electricity generation;[35]
- regulatory review and adjudication of the SPPA and tariff, so that implementation is satisfactory to both EVN and developers;
- a procedure for setting the tariff that recognizes avoided capacity, energy and T and D costs;
- targets for purchase of nonutility renewable electricity;
- appropriate design and quality standards and enforcement mechanisms for service, safety and reliability.

Facilitation of Investment. Under this activity, assistance will be provided to MOI for the following TA activities, to enable companies, communities and individuals to invest in renewable facilities:

- facilitation of access to commercial credit;
- assistance to create and operate a Renewable Electricity Fund to support such investments. As shown by IREDA in India, this can be a powerful magnet for funds, but requires clear operating rules, procedures for monitoring and evaluation, good staff capability for appraisal and supervision and accountability for management of funds;
- recommendations for fiscal incentives, such as VAT reduction and income tax benefits, such as accelerated depreciation, lower tax rates, or tax credits for such investments.

Strengthening Capacity for Implementation. Since the national and provincial power development and rural electrification plans have to be approved by MOI, MOI and PPCs will coordinate planning for grid-connected and off-grid electricity supply. For rural electrification, MOI needs to ensure that PPCs that have responsibility for planning rural electrification consider all least cost options prior to rural electrification network planning not only grid options. Since off-grid services would not be provided by EVN, it is important that planning be conducted in close cooperation with off-grid and isolated grid service providers. This cooperation occurred during preparation of the REAP where EVN shared data on communes to be electrified.

Each component of the REAP includes institutional strengthening for companies and

[35] Governments encourage renewable small power producers because the projects can be financed by local investors and save foreign exchange; create economic activity and employment in remote rural areas; create new industrial activity; and contribute to environment sustainability. However, power companies are often reluctant to buy renewable electricity from small power producers. Renewable electricity is seen as inconvenient because the facilities are small and dispersed, sometimes generation is intermittent, sometimes electricity is expensive, and the social and environmental benefits are not recognized in marketplace. The benefits are for the whole economy but the perceived inconvenience is for power companies. The interests of the nation must be balanced with those of power companies and project developers, owners and operators.

institutions that would be involved in implementation. Under this component, assistance will be provided to MOI for the following:

- targeted awareness creation and training of government officials (including MPI, MOI and EVN), the business and financial community, and the public about renewable electricity;
- simplifying approval procedures and ensuring that private and public sector companies are treated equally; and
- helping PPCs to carry out their task of planning renewable electricity provision as part of their rural electrification plans;
- support for a Program Management Unit to assist in implementing the REAP.

1.4 Component Costs

The estimated budget for this component is shown in Table 6 below.

2. Individual Household & Institutional Systems Component

2.1 Objective

Commercial enterprises will supply good quality renewable electricity systems (improved pico-hydro and solar PV), on an affordable basis, to isolated households and institutions. These enterprises could be cooperatives, or private or public companies.

2.2 Background

Individual renewable energy systems for households or institutions (for example, for schools, clinics) are needed when it is not economically possible to connect to the national grid or develop a local mini-grid, because the entities are too scattered and the loads are too small. Candidate technologies in Vietnam are pico-hydro units and solar PV systems. Potential customers for pico-hydro systems are scattered households and institutions in the North Mountainous and Central Coastal regions, while for PV, potential customers are scattered households and institutions in the Central Highlands and Mekong Delta areas.

Households will always prefer grid supply over individual systems for many reasons. The range of appliances that can be used is far grea ter. Electricity availability is not limited (if there are no supply constraints). Grid electricity cost to the rural consumer is low due to subsidized tariffs, householder investment required is far less. Specialized agencies, such as the PCs provide operation and maintenance (O&M) services. However, if grid electricity is not available, householders will prefer individual systems over kerosene lighting and battery charging services due to the improved quality of services and convenience.

International Experience. While there is little documented international experience

Table 6:
Estimated Cost of Policy and Institutional Development Component, Phase 1

Subcomponent	(million US$)
Development of Policy Instruments, Decrees and Regulations	0.50
Facilitation of Investment	0.50
Strengthening Capacity for Implementation	2.00
Total	**3.00**

Source. Team estimates

Table 7·

Examples of World Bank and GEF-Supported Solar Home System (SHS) Projects

Project Name	Bank/GEF funding & total project cost	SHS component description
India Renewable Resources Development Project (1992)	GEF: US$26 m Bank (IDA). US$115m. Bank (IBRD)· US$75m Total US$450 m (US$55 m for PV component)	2 5 MWp of PV for commercial use, water pumping and household use). Financing provided for sales of systems.
Small and Medium Scale Enterprise Program (1995)	GEF. Vietnam: US$0.75 m. Bangladesh. US$0.75 m Dominican Republic: US$75,000	Finance commercial SHS business ventures
Indonesia Solar Home Systems Project (1997)	GEF: US$24 m Bank (IBRD): US$20 m. Total: US$118 m.	200,000 SHS sold and installed on cash and credit terms by private dealers and entrepreneurs
Sri Lanka Energy Services Delivery Project (1997)	GEF: US$5 9 m. Bank (IDA)· US$24 m.	30,000 SHS sold and installed on credit through dealers and microfinance organizations
PV Market Transformation Initiative (1998)	GEF: US$30 m Total: US$90–120 m	Finance commercial SHS business ventures in India, Kenya and Morocco
Lao PDR Southern Provinces Rural Electrification Project (1998)	GEF: US$0 7 m. Bank (IDA)· US$1.5 m (for off-grid component only)	20 solar battery charging stations by national utility and village electricity associations as demonstrations
Argentina Renewable Energy in Rural Markets Project ((1999)	GEF: US$10 m Bank (IBRD)· US$30 m. Total: US$121 m	66,000 SHS in households through regulated energy-service concessions
Cape Verde Energy & Water Sector Reform and Development (1999)	GEF· US$4.7 m Bank (IDA). US$17.5 m Total: US$48 m.	4,000 SHS in households through regulated energy-service concessions
China Renewable Energy Development Project (1999)	GEF. US$35 m. Bank (IBRD). US$100m. Total: US$444 m.	300,000 to 400,000 (10 MWp) of SHS and PV-wind hybrid systems installed through private dealers—mainly cash sales
Benin Off-Grid Electrification/Traditional Energy (1998)	GEF: US$1.1 m. Bank· US$2.2 m Total US$5.7 m	5,000 SHS through regulated energy-service concessions

Source. Martinot, Cabraal, and Mathur 2000

with pico-hydro systems, there are now an estimated 1 million SHSs in use around the world and the number of installations is growing by about 15 percent per year.[36] Since 1992, the World Bank/GEF Group has approved 12 projects that provide basic "energy services" through the use of "solar home systems" (see Table 7).[37]

Three different types of implementation approaches have been used in World Bank/GEF–assisted projects, as described below:

Indonesia: Solar Home System Project. This Project supports companies to sell PV systems to rural households in three provinces. For every SHS sold, the company receives a grant of about US$100 per unit from the GEF. The project provides loans to dealers through commercial banks, to enable the dealers to finance credit sales or for working capital. The project also provides TA to dealers for business development and quality improvement. Under this project one company sells SHS (40Wp typically), on cash or 24-month credit terms to rural consumers. Credit sales require a 20 percent cash down payment (VND 800,000), and the balance is repaid monthly (VND~150,000 per month for 24 months.). The SHS products have to meet quality stan-

[36] Lorenzo 2000.

[37] Martinot, Cabraal, and Mathur 2000.

dards and the company has to provide warranties and service. To date, the company has set up 2 branch offices, 13 site offices to support sales, service and warranty requirements. This company is presently selling about 100–200 SHSs per month.

India: Renewable Resources Development Project. This Project provides low interest financing for companies and consumers who wish to sell or purchase PV systems. Eligible PV systems range from a solar lantern to grid-connected power plants. One PV system company, in association with a savings cooperative, has established a program to provide solar lanterns to coop members. The cooperative obtained a loan at 2.5 percent interest, repayable in 10 years from IREDA. It used the loan funds to purchase solar lanterns from the PV company and then lease the lanterns to its members. The members pay 10 percent down payment and Rs. 1 per day (VND 350 per day) for 10 years. Since the cooperative already collects Rs. 10 per day from its members as daily savings, the collection of an additional Rs. 1 per day is not burdensome. The cooperative also provides service and spare parts through technicians based in branch offices. The PV company supplies lanterns, trains technicians, gives warranty services. In order to meet project quality requirements, the PV company buys products from quality-certified manufacturers. The customers who lease lanterns are mainly traders who use the solar lanterns during peak sales hours of 6–9 P.M. Many of these customers have seen their daily income increase by 50–100 percent, as a result of lantern use. The cost of lighting is less than half that of using kerosene lanterns. The PV company has sold more than 3,000 lanterns and is establishing similar programs with several other cooperatives.

Argentina: Renewable Energy in Rural Markets. This Project expects to supply individual systems to 66,000 households and 1,100 public facilities; as well as supplying 3,500 households with village power systems (using mini-hydro or hybrids, such as wind-diesel) through province-level energy service concessions. Concessions are awarded to companies that agree to provide electricity services to rural consumers in their service territory for 15 years. Concessionaires can select the technology for any situation, including diesel village power systems. Customers who cannot be reached by any grid can be served with SHS. GEF grants are given when SHS systems are used. Concessions can be rebid every 15 years, and held for a total of 45 years. After 15 years, the government can modify the rules, or may even decide to abandon the concession system. During the 15-year period, the concessionaire, provincial government and provincial regulatory agency renegotiate the tariffs every 2 years.

Lessons Learned. A recently issued paper examined the experiences in World Bank/GEF-assisted SHS projects and drew a number of lessons applicable to future project designs.[38] This review suggests that projects need to do the following:

1. Use pilot private sector and NGO delivery models. Projects employ two basic models for delivery of SHSs: "dealer sales" and "energy-service company". Both approaches are difficult and require support. Dealers with rural experience and/or distribution infrastructure will do better. Most will benefit from training and support in obtaining business finance and other business skills. And all need flexibility to develop good business models. The "energy service company" approach requires substantial time and regulatory capacity for tariff-setting, bidding and supervision of operation.

[38] Martinot, Cabraal, and Mathur 2000.

2. Implement pilot consumer credit delivery mechanisms. For dealer sales, consumer credit makes systems more affordable to rural households. Credit risk is a serious concern of both bankers and dealers, making credit sales particularly challenging. Dealers are reluctant to extend credit to customers with little credit history, and administration may be costly. Partial credit guarantees, and microfinance lending may help reduce risks.
3. Pay first-cost subsidies and offer affordable systems. Per-system subsidies make systems more affordable and reduce initial and/or monthly payments by households. Using smaller system sizes or simpler components can improve affordability. Customers desire a range of component options and service levels and can benefit from even small systems.
4. Support policy development and capacity to implement policies. Assistance is needed to strengthen regulatory agencies; influence government policy related to rural electrification and power sector reform; facilitate industry participation in policy and planning; and reduce import duties for components. The link between rural grid extension and SHS demand must be recognized.
5. Enact codes and standards and establish certification, testing, and enforcement institutions. Establishing reasonable equipment standards and certification procedures for SHS components that ensure quality service while maintaining affordability is needed and is not difficult. Nevertheless, enforcement can be difficult.
6. Conduct consumer awareness and marketing programs. Simple consumer awareness is usually insufficient by itself. Dealers benefit from marketing assistance in early phases of new market development until a "critical mass" of customers develops that makes marketing easier.

Vietnam Experience. There is already substantial experience in Vietnam with pico-hydro and solar systems.

Pico-Hydro Household Systems. Vietnam has perhaps the largest market known for pico-hydro systems: 100,000–150,000 pico-hydro systems have been sold through commercial business channels. Annual sales are estimated at about 40,000 systems of which half are for replacement, the other 50 percent are new users. Most of the systems are being used and sold in the northern and central mountainous areas. Sixty thousand systems have been reported in the north, with lead provinces Yen Bai, Tyen Quang, Son La, Hoa Binh, and Lao Cai.[39] The total potential market for pico-hydro units in Vietnam is estimated to be about 200,000 systems.[40]

Pico-hydro unit capacities range from 100 to 1,000 W. Smaller units are used by households, while larger systems are used for productive activities and for multihousehold supply. Cheap, low quality systems from China dominate the market, with an estimated 90 percent market share. The retail price of a pico-hydro unit ranges from about VND 200,000–700,000 for 100–500W systems, respectively. With installed prices ranging from 0.7 million to VND 1.4 million (US$50–100), for systems ranging from 100-500 W, the systems

[39] Hydro Power Center. 2000. *Package B· Collection of Basic Information and Mapping Information for Vietnam.* Consultant report to World Bank, Washington, D.C.

[40] Finucane, J., et. al. 2000. *REAP Package D: Program Design for Isolated Households Segment.* Consultant report for World Bank, Washington, D.C.

Box 1

Mr. Hung's Pico-Hydro: Improving Quality of Life

Mr. Phung Sinh Hung lives in Na La village in Tuyen Quang province, with his wife and 3 children. His income comes from selling rice, maize, honey, plums, and coffee. He learned about the pico-hydro system from his neighbors and bought a system in 1993 from a shop in the district center for VND 180,000 (US$18). First, he used it only for lighting, then in 1995 added radio, and in 1997 TV. He says that the quality of the pico-hydro is not good. It has broken two times, but there is one young villager who can repair it. The power output is not stable, hence the light bulbs break often. Therefore, he has expenses to buy new light bulbs and repair the generator. However, the benefits are that he can now get more information and knows more about what is happening outside the village. He learned new agricultural production skills through radio and TV programs. His economic situation improved because he and his wife are applying new knowledge—for example, applying chemical fertilizers and feeding their pigs cooked food. Information on farm commodity prices lets him have more choices when buying piglets and buffalo, or selling maize or honey. Mr. Hung said that his sensitivity to women's issues increased after watching television programs. The children use one light bulb in the evening to study. Almost all the households in his village now have a pico-hydro system.

are affordable on a cash basis.[41] They provide sufficient power to meet needs for lighting, cassette-radios and low wattage televisions and fans (see Box 1). There is extensive commercial experience among wholesalers, traders, and local retailers in northern areas. Small blacksmiths provide support in installation and maintenance.

The use of pico-hydro systems is limited by several factors: (a) high maintenance costs, especially for bearing replacement for which the annual cost almost equals the initial cost of the unit; (b) inconvenience of having to walk to the stream several times a day to remove debris from the impeller chamber; and (c) need to be within 500–1,000 meters from a stream. The nameplate capacity rating is often over-rated. They have short life times of one to three years. They have no voltage regulation—voltage is only regulated by the load, which can result in appliance damage. Low quality wiring creates a risk of electrocution.

There are several Vietnamese institutes making pico-hydro units, which are reputed to be of higher quality. However, these institutes cannot compete with the low-cost products, which are coming across from China.

Solar photovoltaics. Vietnam began using PV systems in the mid-1980s when the National Center for Scientific Research led a project to set up PV systems around HCM City. Vietnam now has approximately 650 kW installed solar PV systems divided over three market segments: professional applications (50 percent), institutional systems like hospitals, community centers and battery charging centers (30 percent), and household systems (20 percent).[42] It is estimated that about 1,000 solar homes systems are in place, mostly installed in Southern Vietnam.

Some experience has been obtained in Vietnam (see Box 2). Design and installation expertise is available in Selco, SolarLab, and RERC. BP Solar, Siemens, and Solarex have sales offices or agents in the country. While

[41] Including distribution lines, indoor wires and switches.

[42] Communications with Solar Lab, October 2000

Box 2

Solar Electricity Service Models

Selco-Vietnam. Selco-Vietnam has received assistance from International Finance Corporation (IFC) under the IFC/GEF-assisted Small and Medium Enterprises Program. SELCO-Vietnam collaborates with the Vietnam Women's Union (VWU), and Vietnam Bank for Agriculture and Rural Development (VBARD). The project aims to install 12,000 solar home systems over two-years, through consumer credit sales. The company offers consumers 42–64 Wp systems. The 42 Wp system, sufficient for lighting, fans, and a black and white TV, costs VND 6.9 million ($493). Consumer credit is provided, through VBARD, to make the systems affordable. Consumers make a down payment of VND 1.7 million (US$123) and monthly payment of VND 141,000 (US$10) over 4 years for the 42 Wp system. VWU is responsible for marketing and providing support services. Selco-Vietnam is responsible for supplying products, installation, training technicians, and repossessing the PV module in case of default in payment. Recent reports indicate that sales are slower than expected, as VBARD has been reluctant to extend credit and the VWU's marketing efforts are encountering difficulty. Selco-Vietnam's experience to date points out the difficulties of using a commercially-oriented credit sales approach because of the reluctance of banks to lend to rural consumers for "consumer" products. Selco-Vietnam is proposing a concession agreement with EVN, based on providing electricity on a fee-for-service basis.

SolarLab Energy Solidarity Vietnam. The SolarLab, in association with FONDEM (Fondation Energies pour le Monde, France), began the Energy Solidarity Vietnam Program in 1991. This program has installed 400 systems (40 kWp) in 50 villages scattered throughout 19 provinces to provide electricity services to schools, health centers, collective services (such as cultural centers and telephone), forest stations, and private dwellings. About half the funding was provided by the Vietnamese partners, which, in addition to SolarLab, included the National Program of Science and Technology, MOSTE, Ministry of Emigration, and New Economic Zones of the Provinces, DOI of the provinces, CEMMA, and the Peoples Committees of the participating communes.

there are national capabilities to manufacture balance of system components, the limited demand makes such operations financially unsustainable at present.

Battery Charging Services. There is widespread use of rechargeable lead acid batteries for operating televisions, radios and lights. For example, in non-grid connected communes in Ha Tay province (70 Km south of Hanoi), Binh Long province (100 km west of HCM City), and Hoa Binh province (70 Km west of Hanoi), most families had radio, or radio recorder, or AC–DC televisions powered by rechargeable batteries or pico-hydro units. Pico-hydro units were used in some cases to charge batteries of neighbors. Pinaco Battery Company, has a 70–85 percent share of the battery market in general and a 50 percent market share of small batteries (20 Ah) for household use. It estimates that it sells about 20,000 batteries for household use per month. Battery charging prices currently are about VND 2,000–3,000 per charge. Batteries are recharged every 7–10 days.

SolarLab has installed 65 community operated battery charging stations in Vietnam. These are not commercial, since full costs are not recovered. SolarLab also has developed a solar PV battery charging station design that would be a possible option for community infrastructure investments under government supported programs. The installed costs of these systems are approximately VND 84 million (US$6,000) for a 500 Wp system and double that for a 1,000 Wp unit, not including batteries. The costs include training, a building and one-year warranty. On a per Wp basis, these are higher cost than the Selco units, which include deep discharge batteries.

2.3 Investment Subcomponent

The REAP proposes to mobilize commercial companies to provide stand-alone systems to (a) communes that are not to be served by the EVN grid within the next 10 years; and (b) isolated households in electrified communes. Eligible systems would include pico-hydro and solar PV. Preliminary market estimates show that of the 750,000 households that will not be connected to the grid, about 200,000 can best be served by isolated systems. Institutional users, such as schools, health centers, water supply, telephone services, would be additional.

Financial support would be provided to companies through provision of "smart" subsidies to companies for marketing outreach and development of after-sales service networks; and access to working capital. Subsidies would be provided to companies through mechanisms that are (a) transparent, rule-based and clear, (b) linked to commercial performance rather than cost (for example, a subsidy per unit sold); and (c) linked to adequate product quality to assure a reasonable level of consumer satisfaction. The subsidies would be gradually phased out, in line with expected in economies of scale, reductions in technology supply costs and rising consumer incomes.

The component will support installation of 25–50,000 units in the first five years (see Table 8). Most would likely be improved, locally made, pico-hydro units of which about 50 percent would replace cheap Chinese units. A smaller volume of PV systems would be sold. Aggregate capacity would be about 4 to 12 MW. In the subsequent 5 years, about 60-100,000 units may be installed with a corresponding capacity of 15–33 MW. It is expected that as rural incomes rise and product prices decline, consumers will seek larger capacity systems to provide higher levels of service.

The range of estimates reflects the uncertainties inherent in predicting markets. They are affected by the pace of adoption of commer-

Table 8:
Estimated Installations under the Individual Household/Institutional Systems Component

Thousands of Units	0–5 Years		5–10 Years	
	Low	High	Low	High
Individual Household/Institutional Systems	25	50	60	100
PV	5	10	10	20
Pico-Hydro	20	40	50	80
Total MW				
Individual Household/Institutional Systems	4.2	12.4	15.5	33.2
PV	0.2	0.4	0.5	1.2
Pico-Hydro	4	12	15	32

Assumes 30-40 Wp unit PV system and 200–300 W pico-hydro unit in Phase I. Unit sizes in Phase II are 50-60 Wp SHS and 300–500 W pico-hydro units.
Source: Finucane 2000

cial practices by Vietnamese companies, availability of commercial financing, donor support, and technology development and cost reduction trends.

The main implementers would be the enterprises that would develop the products, services and distribution networks to sell improved pico-hydro and solar PV systems, and possibly set up battery charging stations. The participating enterprises could be public or private sector companies or NGOs. The enterprises must be free to adopt business models that best suit the market. One model is the approach used in selling pico-hydro units presently, where hardware dealers sell products to customers on a cash basis after obtaining products from wholesalers. Another model would involve dealers of complementary products, such as batteries, that would sell and serve the renewable energy products. Other possible models include the credit sales approach used by Selco-Vietnam (if difficulties can be overcome), as well as the concessions approach used in Argentina.

Improved pico-hydro units are expected to be purchased on cash basis. Businesses marketing improved pico-hydro units must meet standards (to be specified) in order to qualify to receive a grant, for example, of $0.15 per Watt during the first phase. No grant is deemed necessary during the second phase.[43] If the businesses pass on 50 percent of the grant to customers, an improved 200 W unit will have a retail price of VND 350,000. In contrast, a Chinese-made unit with a nominal 500 W rating retails at VND 400,000. A key challenge for businesses is to use the support provided during phase I to expand sales. They must convince customers that the improved pico-hydro unit provides better quality electricity services than the larger Chinese units that are presently in the market.

While some PV systems will be sold on a cash basis, credit or installment sales are expected to be essential to develop large-scale markets. Grant assistance to companies is expected to buy down the capital cost. For example, if a 40 Wp system costs VND 5.6 million (US$400) and if the businesses pass on 50 percent of a US$2 per Wp grant to customers, the final cash price would be VND 5 million per unit. For credit sales, the grant would reduce the down payment from 1.1 to VND 1 million and monthly payment from VND 125,000 to 111,000.[44] Similarly, a 20 Wp PV system costing VND 3.5 million would require a down payment of VND 700,000 and a monthly payment of VND 80,000 after the grant.

Even with the proposed grant, these payment amounts during the loan repayment period are three to four times higher than the average household expenditures in rural Vietnam for kerosene and battery charging.[45] Therefore, the purchasers of PV systems are likely to be richer households or institutions. Customers will purchase PV systems only if they recognize and are willing to payment for the higher level and quality of electricity services from a PV system. As noted in Table 9 below, even a small PV system can provide far greater service levels compared to kerosene and re-

[43] The exact amount of the grant must be specified after assessing the incremental costs of developing and supplying improved quality products and the willingness of consumers to pay for higher quality products.

[44] The assumed grant amount of US$2 per Wp is based on grant level used in comparable PV projects in other Bank and GEF-assisted projects. Credit sales assumes a 20 percent down payment, 48-month loan repayment and 20 percent per annum interest rate.

[45] Kerosene expenditures average VND 30,000–40,000 per month, excluding cost of lanterns and their maintenance. Recharging a 20 Ah battery costs about VND 12,000 per month.

Table 9:
Comparative Service Levels from PV System, Kerosene and Recharged Battery

Service Provided	Kerosene (10 liters per month)	20 Ah Battery (Recharged 4 times per month)	20 Wp PV Lighting & TV
Lighting (lumen-hours per month)	2,700	0	32,000
12 W B&W TV Viewing (hours per month)	0	55	72

Assumptions Kerosene consumption 35 gm per hour for wick lantern producing 12 lumens Black & White TV requires 14 watts. DC Fluorescent lamp produces 30 lumens per watt. Peak useful sunlight hours is 3.5 per day.
Source: Team estimates

chargeable battery use. In other countries, rural households have shown a willingness to pay for high quality service for PV systems.

2.4 Technical Assistance Subcomponent

Experience internationally with both Bank-supported projects and commercial efforts have shown that it takes considerable time and effort to develop businesses that offer affordable and reliable products and services.[46] TA will include support to commercial renewable energy enterprises for (a) increasing awareness and providing information, (b) strengthening the sales and service infrastructure, (c) increasing access to financial services, and (d) improving equipment quality and safety (see Table 10).

TA would also be provided to financial institutions, including commercial banks and microfinance organizations, which would provide credit and other financial services to enterprises and consumers. This TA would increase the banks ability to appraise loans. Efforts would be made to involve microfinance institutions, which are expected to be more effective in delivering credit to rural consumers.

A technical standards agency would be strengthened, to guide product development and improvement efforts. This entity would support standards development and enforcement, offer grant assistance to encourage quality improvement in products and services and support quality testing and awards of "seals of approval."

Finally, a Management Support Group (MSG) would be supported to effectively administer the program, address policy and institutional issues and improve the business environment. Given the limited experience in Vietnam with commercial market approaches, it is recommended that an independent group be assigned the responsibility to oversee and coordinate implementation support. The group's responsibilities will include program administration, management and monitoring grant disbursements, equipment testing and certification, consumer protection information activities, training and capacity building, coordination with EVN and other agencies responsible for rural energy services delivery, reporting to government and other participating donors, information dissemination, and ensuring the grants are used properly.

[46] Cabraal, A., Cosgrove-Davies M., and Shaeffer L. 1996. *Best Practices for Photovoltaic Household Electrification Programs: Lessons from Experiences in Selected Countries.* World Bank Technical Paper 324, Asia Technical Department Series, Washington, D.C.

Table 10·

Capacity Building for Individual Household/Institutional Component

Target groups	Activities
Consumers, institutions, villages and communes that are potential purchasers of systems	Market promotion to increase awareness, knowledge and confidence in the technologies Examples include exhibitions, radio and TV advertisements, product demonstrations, community meetings
Rural enterprise—retailers, traders, installers, and repairers at district, commune, and village levels who participate in distribution	Business development for rural distribution networks—including building skills in areas such as direct sales to rural households, creating links with suppliers and credit services, and comparative studies with other enterprises
Urban enterprises—suppliers, importers, workshops, wholesalers, distributors	Business development for equipment and service supply including business planning, product development, market, technical and distribution network development. Activities build skills in managing the supply chain, credit financing, technology and distribution in rural areas
Urban-based providers of support services—NGOs, universities, other educational institutions, enterprise associations, consulting firms, and institutes, such as RERC SolarLab, VIAE, HPC.	Information and training would be provided to increase capabilities to provide professional and technical support services for pico-hydro and solar PV. Some, such as SolarLab, VIAE, RERC, HPC, may have dual role of receiving and supplying training.
Financing institutions, including banks and official and NGO microfinance organizations	Workshops and other activities to increase understanding and lower perceptions of risk of financing these technologies at consumer or business levels
Opinion leaders, enterprise associations, policy makers, donor representatives	Investment promotion activities Studies, analysis and dissemination to increase understanding and support aimed at improving micro business environment.

Source: Team estimates

2.5 Component Costs

The proposed program will require about VND 90–210 billion (US$7–15 million) in the first five years, of which 33 to 46 percent would be for TA (see Table 11). Grant assistance required is US$3–5 million, to cover the cost of TA and to buy down a portion of the cost of the systems (to increase affordability and help develop the market).[47] The balance of funds are from, consumer payments, loans to consumers, and equity contributions of enterprises.

The indicative estimates for the second five-year phase are VND 160–330 billion (US$11–24 million), of which only 16–20 percent is for TA. Grant assistance required is US$2.5–4.2 million to cover the cost of TA and to buy down a smaller portion of the cost of the PV systems.

The unit investment costs are about VND 2–2.8 million per consumer (US$140–200 per consumer) during Phase I. Unit cost is unlikely to decline in Phase II as consumers are expected to demand larger, higher priced units that provide higher levels of service. However, this estimate can be compared to US$400–500 per consumer for rural electrification grid extension and household connections under the World Bank–Assisted Rural Energy Project. Given that the renewable energy system include generation costs, these costs are reasonable given the levels of service to be provided.

[47] Grant assistance for system sales is assumed to be US$2 per Wp for a PV system and US$0.15 per watt for an improved pico-hydro unit in the first five years. Grant amount drops to US$1 per Wp for PV systems in the subsequent years. No grants are needed for improved pico-hydro units after five years.

Table 11

Estimated Cost of Individual/Institutional Systems Component

	Phase I: 0–5 Years		Phase II: 5–10 Years		0–10 Years	
	Low	**High**	**Low**	**High**	**Low**	**High**
			Million US$			
Investments	49	140	130	291	179	431
PV	21	56	56	134	77	190
Pico-Hydro	28	84	74	157	102	241
Technical Assistance	42	70	28	42	70	112
Total	**91**	**210**	**158**	**333**	**249**	**543**
			Million US$			
Investments	3.5	10.0	9 3	20.8	12 8	30.8
PV	1.5	4 0	4.0	9.6	5.5	13.6
Pico-Hydro	2 0	6.0	5.3	11.2	7.3	17.2
Technical Assistance	3 0	5 0	2.0	3.0	5.0	8 0
Total	**6.5**	**15.0**	**11.3**	**23.8**	**17.8**	**38.8**
		Unit Investment Costs				
Million VND per Unit	2.0	2.8	2.2	2.9		
US$ per Unit	140	200	154	208		

Assumes that during Phase I, PV costs US$10 per Wp and the cost drops to US$8 per Wp in Phase II Pico-hydro unit cost is estimated to be US$500 per kW during Phase I and US$350 per kW in Phase II. Phase I technical assistance (TA) costs include 50 percent for business and market development, 10 percent for business environment improvement, 20 percent for quality improvement, and 20 percent for implementation support

Source: Team estimates

2.6 Economic and Financial Viability of Individual Household Systems

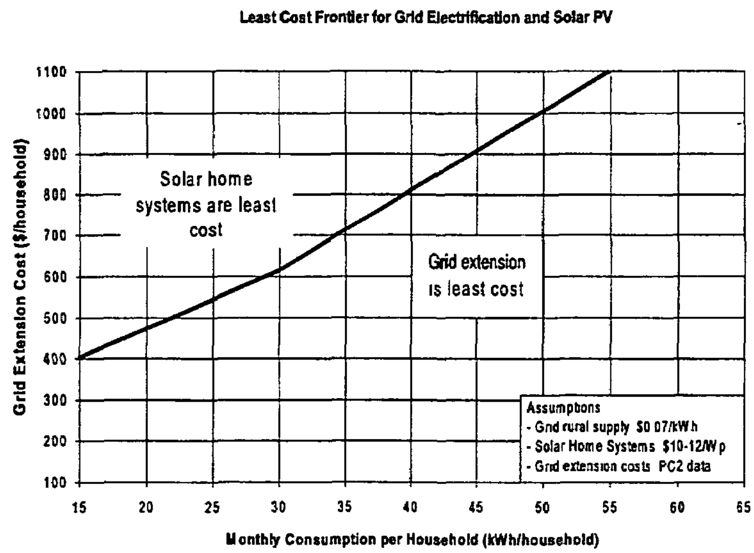
To provide service levels represented in Table 9, a PV system would have an economic internal rate of return (EIRR) of about 17 percent, based on the willingness to pay for kerosene lighting combined with battery-powered TV viewing[48] even ignoring the superior quality and quantity of light from a PV system. The EIRR for a pico-hydro unit would be higher.

Individual systems can be very cost-effective compared to grid supply at low levels of electricity use. Economic cost-effectiveness analyses show that at a consumption level of 15 kWh per month per household, solar PV is the lowest economic cost option if grid extension cost is US$400 per household (VND 4.2 million) or more.[49] If average consumption level is 30 kWh per month per household, SHSs should be used only if grid cost is greater than US$600 per household. Similarly, if consumption is 60 kWh per month

[48] Assumes that the household spends VND 40,000 per month (7–8 hours per day use) on kerosene and VND 30,000 every 3 years for lantern replacement; VND 140,000 per year on battery charging; and VND 280,000 every 4 years for battery replacement (2 hrs/day of radio or B&W TV). A household using a 20 Wp PV system would spend VND 3.5 million initially and then 150,000 every 4 years for battery replacement and 30,000 every year for lamp replacement. The PV system life is assumed to be 10 years.

Figure 3:

Least Economic Cost Frontier for SHS and Grid Extension



Source: Team estimates

per household, grid supply is preferred if grid connection cost is less than US$1,200 per household. The cost effectiveness boundary is depicted in Figure 3. Where perennial water resources are available nearby, pico-hydro units have even lower economic life cycle cost compared to solar systems. This has led to their widespread use in Vietnam despite the poor quality of electricity service delivered.

3. Community Isolated Hydro Grid Component

3.1 Objective

The component will support the development of community isolated hydro grids, where it is not possible to extend the national grid and where there are potential productive uses. The systems will be operated by miniutilities, cooperatives, and communities using good business practices with active involvement of local organizations.

Based on topographical and hydrological conditions, it estimated that some 700 communes not-to-be electrified before 2005 have small hydro resources that could be suitable for either commune based hydro generation. However, not all of the small hydro resources associated with each commune will be technically and/or economically viable. It is estimated that about 45 percent of the 700 communes (that is, 300 communes) have hydro resources that can be technically and eco-

[49] Grid extension costs include MV and low-voltage (LV) lines, meters and connection. A solar PV system of 50 Wp offers similar levels of service to 15 kWh per month of grid electricity. It provides electricity for three fluorescent lights and a black and white TV for about 5 hours per day. The system corresponding to 30 kWh per month is a 100 Wp PV system and a 200 Wp PV system offers equivalent service to 60 kWh per month of grid service. Unit costs are US$12 per Wp for the small system and US$10 per Wp for the large system.

nomically developed within 10 years to provide electricity to about 110,000 households in about 220 communes.[50]

The REAP component to support the development of these Hydro-Based Community Electricity systems has the following target profile:

- Phase 1 would aim to provide service to 10,000–40,000 households in about 20–80 sites.[51] Aggregate capacity would be 2–6 MW.
- Phase 2 would aim to provide service to an additional 80–110, 000 households in about 160–220 sites. The aggregate capacity would be 14–19 MW.

The range of estimates reflects the uncertainties in the extent of support from government, local communities and international agencies. At least three substantial international initiatives are under consideration. JICA will finalize in 2002/2003 a Renewable Energy Master Plan in the Northern part of Vietnam which lays out financing and technology transfer plan to provide electricity to 276 communes, mainly using hybrid isolated grid systems. JBIC will consider supporting follow-up implementation as well. SIDA has indicated that a substantial part of their energy program will support rural electrification over the coming years. The World Bank has agreed with MOI to support a Hydro-Based Community Electricity component under the proposed SEIER Project (2002), aiming to provide service to about 8,000 households in about 20 communes.

Phase 1 will build on preparatory activities that have already taken place these include data based on communes not-to-be electrified by EVN including a list of existing and potential isolated hydro sites; a turnkey micro hydro-diesel hybrid pilot project at Na Bo Village in Hua Pang Commune; and a feasibility study of a program to develop community-scale hydro-based mini grids. This has resulted in prefeasibility studies for 25 communes, allowing rapid start-up of the component. The community isolated hydro grids component will be expanded if the JICA funded investigation identifies additional sites.

3.2 Background

Hydro-based community isolated grids are needed when it is not economically possible to connect to the national grid, but a sufficient cluster of loads exist to justify a stand-alone network. A commune based network, in comparison with the individual systems discussed in the previous section, has the advantage of providing sufficient electricity for productive and income generating activities. Typically, a small hydro network will provide enough electricity for productive loads (for example, irrigation, milling, sawing), public loads (for example, schools, health centers, street lighting), and households. An additional advantage of these systems is that they can be designed, installed and maintained by local companies. A typical range of generator size in Vietnam would be 1,000–1,200 kW. Such systems can have strong economic and social benefits, as shown by the experience of Duy Son 2 commune (see Box 3).

International Experience with Community Hydro Grids. Village- and commune-based hydro electricity is not a new way of electrifying rural areas, it is one of the oldest. More than 100,000 commune- or village-

[50] Meritec, 2000.'*REAP Package E: Feasibility Study of a Program to Develop and/or Rehabilitate Community-Scale Hydro-Based Mini Grids* Consultant report to EVN, Hanoi.

[51] In dozens of communes, multiple sites have been identified. The REAP program will initially focus on supporting the development of the best site in a commune. Therefore, the number of communes is the same as the number of sites.

based hydro systems have been installed around the world. Four relevant models from different countries are described below.

Sri Lanka: a cooperative/business approach. About 100 village hydro systems have been installed, of which about 11 have been supported through the World Bank/GEF ESD Project. These systems have an installed capacity from 4.5 to 40 kW and serve an average of 800 households each. Average investment costs are US$2,500 per kW and US$465 per household. Village Electricity Consumers Cooperative Societies operate the village hydro projects as businesses. They have legal status, accounting and financial management systems, and a reward system for their employees. Several private firms and NGOs play a key role in mobilizing communities and developing facilities. They identify suitable sites, discuss project development with villagers, and support the village in developing and operating the facility. Appropriate technical specifications were adopted to reflect the low capacity of the systems, without compromising safety, resulting in lower investment costs. The World Bank/GEF financial support is offered in three ways: (a) a credit line on commercial terms for the cooperatives and societies; (b) grant funding of maximum US$9,000 to cost-share project development; and (c) grant funding of US$400 per kW for capital subsidy up to US$20,000 per installation. This financial support complements the funds from the Government, private sector and village. While some grant funds have been provided by Provincial Authorities, the role of the government in village hydro development is limited.

Cambodia: a private sector/commercial approach. In Cambodia, more than 100 rural electricity entrepreneurs supply rural areas using diesel based mini grids. These entrepreneurs operate for profit, selling electricity for high tariffs (US$0.22–0.53 per kWh) to about 133,000 households (7 percent of all rural households). Even with these high tariffs, there is demand growth of 10–15 percent per year, and an estimated 30,000 households are currently waiting to receive connections. At the moment, without regulation, many of the entrepreneurs operate unsafe systems and provide low quality of electricity service compared to international standards. Government involvement in rural electrification is very limited. A new electricity law has been promulgated in the first quarter of 2001, which will create a regulatory body and support further expansion of private sector involvement.

China: a government rural development approach. In China, more than 23 GW of small hydro power systems have been installed, originally as isolated grids. Most systems are owned and operated by county power companies, and were financed by a combination of government grants and loans combined with local labor. During 1996–2000, the national government provided 10 percent of the funds as subsidy, and 38 percent in loans; provinces, regions and counties provided about 30 percent of the funds as loans, and about 2 percent came from foreign investments and other sources. To encourage development, the Government offered technical support and financial incentives. For example, the hydro power projects have an exemption of income tax and lower VAT, and profit can be retained in the company. While government support is expected to be reduced as China shifts to a market economy, small hydro-based grids have played a major role in creating prosperity and industrial development in rural China.

Guatemala: a community infrastructure lending approach. Guatemala Genesis Empresarial (GE) financing organization established a credit line for rural electrification. GE has an extensive network and is a provider of microcredit. It offers infrastructure loans to rural communities, and provides TA and training to borrowers. The infrastructure loans support a program whereby rural communities initiate electrification projects and must contribute to the project costs to qualify for public subsidies. All members of the community must contribute equally toward these costs. GE provides loans to groups of poorer households providing them with the needed funds. All group members are jointly liable for repayments, which helps to ensure repayment—less than 8 percent of loans are nonperforming. The loan amounts are up to US$450 per household for up to four years. GE makes a number of group loans in each community, with households grouped by incomes. Local commercial banks handle disbursements and repayments and interest rates are on commercial basis. GE began offering community electrification loans in 1993. In its first five years, it disbursed almost 1,000 group loans with a value of approximately US$35 million to 8,700 families in almost 200 communities.

Vietnam Experiences[52] In Vietnam, more than 350 hydro-based commune electricity systems have been installed with mixed results. Operation of some systems has had exemplary results, where communities were committed and management strong. Nevertheless, it is estimated that more than half of the systems are not operational for several reasons. First, in many cases the systems were installed with donor funds and it was unclear who owned and who was accountable for the operation of the system. Systems were built, tested, installed and funded by the GOV, then transferred to local authorities for daily operation. This transfer was made without clearly defining responsibility for maintenance, securing funds for major repairs, and accountability for financial management. Second, there were inadequate reward and training systems for operators and employees. Third, constraints on funds resulted in lower quality equipment as quality compromises were accepted during the selection and installation of the systems. At the same time, contractors were minimally supervised.

Box 3

Community Hydro Creates Labor Hero

Duy Son 2 in Quang Nam province had no electricity despite its proximity to the Chop Xoi mountains and various streams. On the initiative of the head of the cooperative, a 400 kW turbine was installed in 1984, and increased to 1,200 kW by 1990. All 2,800 households in the cooperative were served with electricity. By 1995, the power plant earned VND 1 billion annually and supplied water to enable 2–3 rice crops per year. Rice production increased from 1,946 to 3,560 tons between 1984 and 1996. A garment workshop was set up, which employed 250 female workers, exporting to other Asian countries. Seeing this success, the cooperative bought 20 weaving looms and provided loans to members for another 80 looms, and set up a rattan workshop employing 120 workers and a shoe production unit employing 70 workers. In 1996, the cooperative made a profit of about VND 200 million, and its fixed asset value has increased to VND 8.6 billion. As a result of his efforts, Mr. Lu Ban, the former head of the cooperative who had dreamed of harnessing the waters for electricity, was awarded the title of "Labor Hero."

[52] This section is based on studies commissioned to prepare the Rural Energy 1 Project and the REAP, including (a) data collection of communes not to be electrified by EVN, including potential and existing isolated hydro sites; (b) feasibility study of a program to develop community-scale hydro-based mini-grids; and (c) a turnkey micro hydro-diesel hybrid project at Na Bo Village, in Hua Pang Commune.

Fourth, operation of the system was often limited to a few hours per day, and sometimes only during the rainy season. This resulted in potential users installing other systems like small generator sets or pico-hydro systems.

Plants that were operated successfully had the following characteristics. The plants were operated under strong community leadership, and sufficient management skills were available in the commune. End users and owners of the plant were actively involved in project design. And there was an appropriate financial management system that at least covered the cost of operation and repair. In one case, operators were offered technical training and a salary comparable to those in major cities

EVN together with the World Bank has supported a pilot hydro-based commune electricity scheme in Na Bo Village to test some of the best practices including organizational set up, an adequate financial system and participatory capacity building approaches. Initial experiences with this pilot confirm the difficulties and risks of promoting community hydro systems with inadequate community commitment and insufficient support from county and provincial level.

Summarizing Experiences. Summarizing the international and Vietnamese experiences with Hydro-Based Commune Electricity systems the following key elements should be addressed in the design of a community isolated hydro-grid component.[53]

1. Strong community commitment is a precondition for sustainability of projects. It was observed in various communes in Vietnam that where community members were part of the design process in its early stages, routine maintenance was better performed, the willingness to maintain was higher and financial contribution was greater and more reliable.
2. The community should be committed to make a financial contribution to the capital cost to ensure ownership. This can be done in by providing a certain percentage of the investment capital, and/or in kind contribution of labor and material.
3. A blend of financing is required, including subsidies, contribution from the community, and commercial loans. Subsidies should be provided in a transparent way. O&M and major repair costs must be covered by the revenues from selling electricity at an affordable rural rate.
4. The commune or cooperative should be responsible for the continued operation of the power plant. At a minimum, the tariff must cover the operational cost including funds for repairs and spare parts. At the same time, the tariff must be affordable for a substantial part of the end users (at least 60 percent). This should be agreed and formalized in a legal document.
5. There should be a clear organizational set-up following good business practices. This includes the establishment of a legally independent entity like an electricity cooperative. Also, a sound accounting and bookkeeping system and financial management should be adopted; and training and an appropriate reward system for the employees established.
6. Productive loads should be available from the first day of operation of the plant. If no productive loads exist, it is more cost-effective to provide the households with individual systems. Productive load development and income generating activities must be

[53] For synthesis of recent best practices see also ITDG. 2000. *Best Practices for Sustainable Development of Micro Hydro Power in Developing Countries.* ESMAP Technical Paper 006. World Bank, Washington, D.C.

promoted through a targeted dissemination program.

7. Access to technology and TA is necessary. For repairs and replacement of parts, support from district and/ or provincial level should be available building on existing infrastructure.
8. The system should operate year round. If the water resources are not sufficient, a combination with a diesel system should be adopted.

3.3 Investment Subcomponent

In the Phase 1, MOI will support investment in community isolated hydro grids to provide service to 10 to 40,000 households in about 20 to 80 communes or sites. Aggregate capacity would be between 2 to 6 MW. A feasibility study has identified 25 sites in 3 northern provinces, Son La, Ha Giang and Lai Chau (see Annex 7). This list will provide a starting point for selection of communities, but will be augmented. The 20 community systems to be financed are expected to

- Have an aggregate installed capacity of 2,000 kW, comprising 1,650 kW of micro hydro generation and 350 kW of diesel back-up generation.
- Serve 8,100 consumers.
- Cost US$4.4 million to construct, US$80,000 per year to operate and maintain, and produce US$200,000 per year worth of electricity sales at a tariff of VND 1,100 per kWh (including VAT).
- Require 60 to 70 percent of an investment subsidy financed by community contributions and direct grant. The remainder of the investment costs would be funded by a loan to be repaid by the community.

The following activities will be carried out as part of the investment subcomponent:

Site selection. Candidate provinces for the initial program will most probably be Son La, Ha Giang and Lai Chau as indicated in Annex 7. It is recommended that a competitive selection of the provinces and of the communities be used. Selection would be based on presentation of business plans that will show the viability of the project and the community contribution. Assistance to communities will be needed, including a community awareness program and support for preparation of the business plans.

Detailed Design, Procurement, Construction, Installation and Commissioning of Systems. Survey, investigation, detailed design of the schemes will be carried in close consultation with each Commune Electrification Committee. Environmental, social, land acquisition and resettlement aspects will be considered. Labor and materials will be provided as a community contribution to project construction, including clearance of vegetation; excavation of trenches for the penstock pipe; building platforms for the powerhouse; poles. Procurement, construction, supervision of installation and commissioning of each scheme or system will be carried out.

Additional support will be provided through TA, to the community, and the renewable energy fund at the provincial level, as described below.

3.4 Technical Assistance Subcomponent

TA will be provided for the following activities.

Community Mobilization Program. A community mobilization program will be undertaken in likely communes. The communes will be offered assistance to prepare business plans, and the opportunity to bid for grant funds. The business plans will demonstrate that the proposed tariff would meet requirements for operations and maintenance, plus an annual fee to be paid to the renewable electricity fund. It is planned that at least 60 percent of the consumers in the commune must agree in writing to take a metered electricity supply, pay the connection charge, pay the cooperative or joint stock company for electricity consumed and provide the agreed quantities of labor and materials for project impleme ntation.

Organizational Arrangements. Appropriate options for commune organization are likely to include a cooperative management model, a miniutility (company) model, and a joint stock company. The commune-level cooperative model, with support from district and or provincial level, may represent the best option for management and operation of the systems. This system is well understood down to the commune level. Particular attention will be paid in piloting the models to defining management responsibilities at commune and provincial levels, operations and maintenance frameworks, technical and safety specifications (see O&M requirements below), and monitoring and evaluation of performance, costs and benefits.

Productive Uses Promotion Program. A productive uses promotion program will be carried out in each commune, in conjunction with the community mobilization program. The aim of the program will be to identify and assist in the establishment of productive uses that consume electricity during the daylight hours and do not contribute to the evening peak load. The productive uses are likely to be agricultural processing, timber working, water pumping, battery charging and refrigeration, including replacement of diesel-powered processes with electric motors.

O&M Support Program. Lack of post-implementation service and support has been a common contributor to failure of micro-hydro systems in the past. Accordingly, intensive O&M training and support will be provided during commissioning (when it will be most effective). Access to management and technical advice and support will be provided during operation.

Monitoring and Evaluation (M&E) Program. The M&E program will monitor and evaluate the social and economic benefits as well as the physical implementation, performance, O&M of the program, The M&E program would monitor the projects during the construction and commissioning stage, and for a minimum period of 2 years after commissioning.

3.5 Financial and Economic Analyses

Financial and economic evaluations have been carried out for 8 representative schemes (see Annex 8 for details). The results indicate that the EIRR ranges from + 9.6 percent in Duong Am to + 17.3 percent in Ngoc Chien, based on an estimate of willingness to pay of US$0.138 per kWh, including a consumer surplus.[54] The three sites that require diesel back-up have lower EIRRs than the sites that can service the demand from the hydro scheme alone. This is caused by the additional capital cost of the diesel generator and the cost of operating the diesel during the dry season (when hydro output is constrained by low water flows). The EIRRs and net present values (NPVs) for equivalent transmission grid extensions and equivalent diesel generation were calculated, and compared with those of the community-scale hydro-based systems. This confirms the results of the screening, that in all cases, the cost of the selected community-scale hydro-based systems are cheaper options than either grid extension or diesel generation. Sensitivity analyses were carried

[54] The economic analysis uses willingness-to-pay values taken from Annex A of the Project Appraisal Document for the Vietnam Rural Energy Project, the economic price of diesel, and a shadow factor of 0.85 on local costs.

Table 12:
Economic Least Cost Life-Cycle Analysis of Four Commune Electrification Options[56]

	Commune Hydro	Grid Extension (15 km)	Diesel Commune	Solar PV
	US$ per hh	US$ per hh	US$ per hh	US$ per hh
Household only 18 kWh per month per hh	610	740	590	450
Household plus productive uses 37 kWh per month per hh	770	1,100	1,310	n.a.

n a Not applicable
Source: Team estimates

out for one representative scheme, and indicate that with changing development cost, and changing sales of electricity, approximately proportional changes in scheme viability occur.

Economic cost-effectiveness analyses show that without productive load during daytime it is not justifiable to install a Hydro-Based Commune Electricity system for a typical Vietnamese commune. Without productive load, the cost for providing electricity for a typical commune would be US$610 per household on a life cycle cost basis, which is substantially higher than the US$450 per household for a solar PV system (see Figure 3) or even a diesel based commune system. However, if small productive loads are available, this picture changes.[55] The hydro-based isolated system would be the least cost option (levelized life-cycle cost of US$770 compared to US$1,100 for grid extension, and US$1,310 for an isolated diesel system, see Table 12).

The financial analysis was done assuming that the tariff would be VND 1,100–2,200 per kWh (see Annex 8). Without subsidy, the financial internal rate of return (FIRR) ranges from + 0.6 percent in Ngam La to -4.9 percent in Dai Son.[57] An additional analysis was conducted to estimate the capital subsidy required to achieve a FIRR of 10 percent that will cover O&M costs, provide a margin for unexpected repairs, expenses, and service debt.[58] The required subsidy level ranges from

[55] Doubling the electricity use from 18 kWh per month per household to 37 kWh per month per household equivalent mainly caused because of usage during day time.

[56] Based on REAP studies, a typical not-to-be-electrified commune by EVN is more than 15 kilometers away from the national grid. It has 500 households, of which 60 percent will be connected to the mini grid. Average consumption per household in year 1 is 18 kWh per month with a peak capacity of 200W; increasing to 23kWh per month year 10. Productive loads include irrigation pumps, mills, sawing machines, etc. A peak capacity for productive systems of 20kW is necessary, of which 30 percent is used during daytime in the base scenario.

[57] The financial analysis is from the viewpoint of the cooperative that operates the hydro-based system. The cost of diesel is the price that would be paid in rural towns plus delivery to remote rural communes.

[58] The analysis calculates the level of subsidy, assuming the remainder of the development cost is funded with a loan bearing an interest rate of 10 percent. The capital subsidy includes the total subsidy required, and includes both a community contribution (10 percent) and grant funding. Thus a 70 percent capital subsidy would comprise a 10 percent community contribution and 60 percent grant.

58 percent of initial investment in Muong Lan to 73 percent of initial investment in Dai Son. The capital subsidy required is sensitive to changes in tariff. Analysis shows that if no subsidy were provided, the tariff would need to be raised to VND 2,500 per kWh. Tariffs at this level are likely to be unaffordable, thus dismissing a possible REAP approach of supporting only full commercial and for-profit operations. On the other hand, if the subsidy were raised to 80 percent of the investment, the tariff in many communities would be less than VND 1,000 per kWh. During project design, attention will be given to determine an appropriate tariff.

3.6 Estimated Cost of Community Isolated Hydro Grids Component

Estimated cost of the component is indicated in Table 13. The unit costs are approximately US$225,000 per commune; US$2,250 per kW; and US$450 per household served. Possibilities for obtaining grant funding to assist with project development will be examined, and the means of application, amount of support available and probability of success assessed. The GOV-supported Project 135 Poverty Alleviation Program; the JBIC (formerly OECF) supported Rural Infrastructure Development and Living Standard Improvement Project; and the World Bank supported Community-based Rural Infrastructure Project can all support hydro-based commune electrification. Information on these programs will be made available as part of the community awareness program. In addition, the Renewable Energy Fund is expected to provide grant funding for community hydro grids, with a strong productive uses sub-program.

4. Renewable Electricity for Grid Supply

4.1 Objective

Small power producers invest in renewable energy small power facilities, build-own-operate the stations and sell electricity to EVN and/or PCs on a commercial basis. The small power producers could be enterprises owned by provincial, local, commune, cooperative, private sector entities. The small power producers provide electricity with high quality and safety standards and at a lower cost than

Table 13
Estimated Cost of Community Isolated Hydro Grids Component

	0–5 Years		5–10 Years		0–10 Years	
	Low	High	Low	High	Low	High
	Billion VND					
Investments	63	252	504	693	567	945
Technical Assistance	17	43	42	42	59	85
Total	**80**	**295**	**546**	**735**	**626**	**1,030**
	Million US$					
Investments	4.5	18.0	36.0	49.5	40.5	67.5
Technical Assistance	1.2	3.1	3.0	3.0	4.2	6.1
Total	**5.7**	**21.1**	**39.0**	**52.5**	**44.7**	**73.6**

Source: Team estimates

alternatives. The revenues earned by the small power producers by selling electricity are sufficient for their businesses to operate on a sustainable basis and to have a reasonable profit.

The proposed program consists of two subcomponents, (a) Nonutility Investment for Grid Supply, and (b) Rehabilitation of EVN-owned mini-hydro projects. These will be executed in two five-year sequential phases as described below.

4.2 Background

Potential Use of Renewable Electricity for Grid Supply. Preliminary indications are that about 700–1,200 MW of small renewable energy potential could be technically feasible for augmenting grid supply (see Table 14). This amounts to about 15–25 percent of existing generation in Vietnam. The value of small power generation using renewable energy extends far beyond its energy value. Small renewable energy projects are within the capacity of small and medium-sized local investors, that is, provincial or commune authorities, cooperatives, or private companies. Therefore they reduce investment needs of EVN and expand the participation of local companies, thus supporting the government's *Doi Moi* Policy. Small grid connected renewable energy projects also reduce losses in transmission as generation occurs closer to rural load centers, improving the quality and reliability of rural power supply, and help postpone investments needed to upgrade the transmission network to meet growth in rural loads.

Only about 10–15 percent of the grid-connected small hydro potential is presently exploited. Although Vietnam has significant biomass resources in the form of sugar bagasse, rice husk, coffee waste, coconut shells and wood residues, very little is used to generate electricity to supply the grid. Only three sugar mills sell electricity to EVN. Although Vietnam is the second largest rice producer after Thailand, many of the rice mills have low capacities. If the husk can be transported to a central generation facility (for example, at dis-

Table 14:
Potential and Current Use of Renewable Energy in Vietnam

Resource	Potential	Current Usage	Geographical potential
	MW	MW	
Grid-connected hydro power[1]	400–600	60	North and center
Biomass—sugar bagasse[2]	100–200	50	South and center
Biomass—rice husk[3]	150–200	0	South and center
Geothermal[4]	50–200	0	Center
Grid-connected wind power[5]	TBD	0	Islands and center coast
Total	**700–1,200**	**110**	

1. Includes mini hydro plants not connected to the grid, but within 15 km of a medium-voltage (MV) per HV line.
2. There are 43 sugar mills with a total capacity of about 100 MW. Sugar milling capacity additions may add another 100 MW Current usage reflects mainly captive generation (IE)
3 Total technical potential from rice husk is about 450 MW. About two thirds are used for animal feed or cooking Available potential estimated at one-third to one-half of technical potential. Other resources include coffee waste, wood residue and coconut shells (IE)
4. Private developer is negotiating a PPA for a 50 MW project. Estimated geothermal potential is about 200 MW
5. A German developer has reportedly expressed interest in a 20 MW wind farm in the central coastal area
Source: Team estimates

trict level) in a financially feasible way, power generation from husk would be viable. In addition, there could be opportunities to produce rice husk ash, which has a value of about VND 200,000 per ton.

International Experience with Renewable Energy for Grid Supply

India. Among developing countries, India is at the forefront of nonutility generation of renewable electricity. During the past 8 years, the Indian private sector has invested in 1,200 MW of wind farms, 1,160 MW of small hydro and more than 235 MW of power generation from sugar bagasse has been commissioned or under construction. A 35 MW solar thermal electric project is under preparation. Key to India's success has been the issuance of policies and regulations requiring the State Electricity Boards (SEBs) to support such projects. The SEBs in several states are now required by State law to buy electricity from small renewable energy plants at about VND ~875 per kWh (US$0.063 per kWh) under SPPAs. Wheeling of power, using the SEBs transmission lines from the generation site to the investors demand center, is also permitted. The wheeling fee is 2 percent. Where generation and demand are not coincident in time, the SEBs permit the generators to bank the electricity for up to one year. Third party sales are also permitted, although with a higher wheeling fee of 12.5 to 15 percent. India also gives tax incentives for power generation at the national and state levels. At the national level, energy investments can be depreciated fully (100 percent) in the year the investment takes place. Five-year income tax holidays are also granted. Long-term financing has been made available through the IREDA. Significant local financing has been also mobilized for such investments from local investors, and banks.

In the early years, investments were made mainly to obtain tax relief, without adequate attention to power generation. However, with the increasing cost of power, there is now stronger incentive to maximize power output. Since 1990, unit costs of small hydro and wind power have declined to about US$800–1,000 per kW. A strong indigenous industry has developed to provide design, engineering, manufacturing, installation and operation and management services. Wind technology local content has increased from 20 percent in the early 1990s to 80 percent today.

Thailand. The Thai government has a policy to encourage private sector participation in power development from small power producers. The National Energy Policy Council (NEPC) recognized that electricity generated by nonconventional energy, waste or residues from agricultural activities or production processes, and cogeneration would create environmental benefits and reduce waste disposal problems. It would also reduce government investment in electricity generation and distribution. Therefore, Thailand promulgated policies and regulations to encourage small power producers to sell electricity to the national utility, Electricity Generating Authority of Thailand (EGAT). Under this program, EGAT is required to purchase up to 3,200 MW from small power producers. Electricity is purchased under an SPPA. The purchase tariff is based on avoided cost. To date, firm contracts for 63 MW of power from rice husk, bagasse and wood chips projects have been signed. In addition, 400 MW of renewable electricity capacity is being developed under nonfirm contracts.

Sri Lanka set up a small power purchase program, with World Bank assistance to support renewable electricity development. Under the program, Ceylon Electricity Board (CEB), purchases electricity under an SPPA. About 26 MW of small hydro plants have been commissioned and another 12 MW are under construction by nonutility developers in the first 5 years. The World Bank–funded credit line permits commercial banks to offer 6–10 year financing for such projects. As in the case of India, all projects have been developed by local investors. Although the CEB was required to transparently update the purchase tariff annually, the process has not worked smoothly. Disagreements have arisen between the utility and the developers as to the assumptions used in the tariff calculations. Without an independent regulator to intervene, the developers are at a disadvantage as the CEB is the sole buyer of power.

Small Power Purchase Agreements (SPPAs). In the countries mentioned above, a key to unlocking the nonutility sector interest in renewable energy development has been the establishment of suitable legal and regulatory framework. A clear, well-crafted SPPA is an essential requirement. The small scale of the projects makes lengthy negotiations on the purchase agreements and the tariff impossible. The agreement must strike a balance between the interests of the small power producer, the power purchaser and other stakeholders. If the procedures are too onerous, developers will have no interest in the program. Similarly, if the price and risks are not competitive with other options, the utility will be opposed. Based on these considerations, the approach of a standard (in contrast to a "model"), non-negotiable PPA together with a published purchase tariff has been adopted in a number of countries. Characteristics of three such agreements are given in Annex 9. Average SPPA tariffs across a number of countries are summarized in Table 15.

A number of useful lessons can be drawn from the experiences described above:

- Small scale generation using renewables is in the national interest. The scale of investment needed is well suited to local investors and developers. Therefore, such projects help build local industry and business capacity. Such projects also do not carry the risks of currency depreciation or face issues of repatriation of profits offshore. Most projects are in rural areas and support rural development.
- Small nonutility developers can implement these small projects more efficiently and at lower costs compared to utilities. However, cooperation and support of the utility is absolutely essential if these projects are to be developed.
- An SPPA is needed to reduce the transaction costs associated with developing these small power projects. The tariff formulation should be transparent and the rules and assumptions for updating the tariff must be clear so that the developers and the lenders can estimate the likely revenue stream with greater confidence.
- An independent regulator (preferable) or arbitrator (at a minimum) is necessary to

Table 15:

Average Small Power Purchase Tariff Comparison Across Countries

	Computed Average Tariff (VND per kWh, equivalent)
Thailand (energy only)	451
Thailand (energy + capacity)	714
Sri Lanka (energy only)	534
India (utility sales)	875
India (captive generation and 3rd party sales)	1,000

Source: Team estimates

intercede between the small power procedures and the purchasing utility when differences arise.

- Long-term loan financing is essential. Loan terms of at least 5, but preferably 10 years are necessary.
- The purchase agreement duration should be at least as long as the debt service period to give confidence to the lenders.

Vietnam Experience[59]. There is limited experience in Vietnam of small renewable energy generation that is not owned and operated by the utility (EVN or power companies). There are three sugar mills selling electricity to EVN under individually negotiated purchase agreements. They are Bourbon selling up to 12 MW of electricity to EVN at US$0.0435 per kWh; Son La selling 1 GWh per year at VND 400–440 per kWh and La Nga selling 1.5 GWh per year at VND 400 per kWh.[60] Some cooperative-owned small hydro plants also sell electricity to EVN or power companies. The Duy Son 2 cooperative sold power in 1998 at VND 351 per kWh.

A recent survey indicated that there are 60 MW of grid connected mini hydro installed in 48 systems, ranging from 100 to 7,500 kW capacity each. Most of the systems are in the north and center, especially in Ha Giang and Cao Bang, Quang Nam and Quang Ngai Provinces. Twenty percent of the systems were developed in conjunction with irrigation development by the Ministry of Agriculture and Rural Development (MARD). Since the government aims to irrigate 80 percent of all cultivated land, the number of irrigation projects will continue to increase, providing more opportunities for joint operation for electricity generation.

Only 6 out of the 48 were reported as not in operation (13 percent) due to equipment failure. Though most of the systems are functioning, there is substantial scope for improvement through rehabilitation. Many of the hydro systems were imported from China, others from France, Russia, and Bulgaria. Some were produced in Vietnam based on Chinese designs. The most common system is run-of-the-river (capacity from 0.1 MW–7.5 MW). Most of the systems are in operation year round. The plant factor of the working systems ranges from 0.23 to 0.60, which is low in comparison to other countries. All the grid-connected systems were government financed, either directly or through international aid. Typically the grant was used to import equipment and material while the O&M costs were borne by EVN.

EVN, as a condition for the World Bank–assisted Rural Energy Project has agreed to adopt an SPPA with a published tariff. Presently, EVN is finalizing both. There are a number of outstanding issues with respect to the SPPA, which is presently under resolution (see Annex 10 for details). While both an energy-only and an energy-plus-capacity tariff have been computed, EVN favors offering an energy-only tariff as they are not confident that the small power plants can deliver firm power. The proposed Vietnam energy-only tariff is

[59] This section is based on studies commissioned as part of the preparation of the REAP, the Rural Energy 1 Project and others. They included (a) Renewable Energy Small Power Purchase Agreement; (b) Small Purchase Tariff Development; (c) Pipeline Development of Small Hydro Projects; (d) Pipeline Development for Rehabilitation and Upgrade of Grid Connected Renewable Energy Projects; (e) Biomass for Power Generation; (f) Renewable Energy Master Plan Study, prepared in conjunction with the Rural Electrification Master Plan.

[60] In 1997, an IFC-led consortium gave a loan of US$42 million to the Sucrerie de Bourbon sugar mill, which produces 100,000 tons per year of refined sugar. The investment included a 24 MW bagasse-fired power plant

Table 16.

Comparison of Small Power Purchase Tariffs and Economic Avoided Costs in Vietnam[61]

	Average Tariff (VND per kWh, equivalent)
Vietnam Economic Avoided Cost (energy only)	427
Vietnam Economic Avoided Cost (energy + capacity)	750
Proposed Vietnam (energy only) small power purchase tariff	420
Proposed Vietnam (energy + capacity) tariff	602
Vietnam Bourbon Sugar Mill (maximum 12 MW)	US$0.0435 per kWh (VND 609 per kWh)
Vietnam (other agreements with sugar mills)	400–440
Vietnam Duy Son II Coop (Small Hydro)	351

Source: Team estimates

comparable to the avoided economic energy-only cost while the proposed energy-plus-capacity tariff is about 80 percent of the economic avoided energy-plus-capacity cost (Table 16). The proposed tariffs in Vietnam are low compared to the other countries, including Sri Lanka, which has a similar hydro dominated power system.

4.3 Subcomponent I: Nonutility Investment for Grid Supply

The GOV as part of its market-oriented development policies will encourage renewable electricity investments for grid supply, by nonutility public and private enterprises, cooperatives and other nongovernmental entities. These entities would invest in new small hydropower plants, biomass power plants and possibly wind farms and geothermal power. To encourage investments, the enabling environment and institutional process must be sympathetic to the need to minimize transaction costs, manage risks and equitably allocate benefits.

To encourage such investments, efforts will be required by the GOV, EVN, development and commercial banks, and other relevant agencies, including the following:

- EVN needs to issue a notification to purchase power under the SPPA, as agreed to during negotiations of the Rural Energy Project IDA credit agreement.
- EVN and MOI need to establish transparent and streamlined approval and contractual processes.
- Access to financing through development and commercial banks must be facilitated.
- EVN must offer a fair purchase contract and price under an SPPA, for projects under 10 MW. Without an acceptable SPPA, few small power projects are likely to be developed. The only projects that are likely to be developed are those that already have spare capacity (for example,

[61] Avoided cost is based on generation costs given in Table 2.5 of World Bank report, *Fueling Vietnam's Development* (1999) with network investment and transmission losses obtained from Fitchner-Colenco tariff study. Diesel gas turbines are at the margin during peak hours and coal-based steam is at the margin during off-peak hours. The proposed tariff assumes generation from small hydro occurs 65 percent during wet season and 35 percent during dry season. The tariff may be higher for biomass generation as a greater proportion would occur during the dry season

sugar mills), and those that can be developed with little or no additional investment. EVN is in the process of finalizing the SPPA and tariff.

Investment. Given the outstanding SPPA issues, limited access to financing, and limited experience to date, the REAP program expects small power developments to begin slowly. About 15–25 MW of investment could occur during the first five years. During the second phase, accelerated progress can be expected as institutional capabilities are built, greater confidence in the renewable energy small power generation is created, costs are lowered through experience and there is greater local industry participation.[62] A development target of 100–200 MW of renewable energy projects could be feasible in the second phase, depending on progress achieved during Phase I and on the availability of financing. A preinvestment study of 40 prospective small hydro sites identified 10 that are technically, environmentally and economically viable.[63] The 10 sites constitute about 50 MW of capacity and require about VND 1 trillion (US$75 million) in investment. Their characteristics are summarized in Table 17.

However, as noted in Annex 10, there are a number of outstanding issues with respect to the SPPA, which will determine the financial viability of these small power plants. At a tariff that reflects only energy value (off-peak 2.3, peak US$0.043 per kWh), only plants with capacity factors exceeding 60 percent and costing under US$1,000 per kW are likely to be financially viable as commercial investments. Cooperatives or other not-for-profit enterprises may be interested in projects with lower financial rates of return. Likely small hydro candidates drop down to just one or two—Nam Mo and Dan Sach 1. If EVN offers both a firm (energy-plus-capacity) and nonfirm tariff as in Thailand, the number of financially viable small renewable energy small power investments would increase.[64]

In addition, the larger sugar mills with capacities exceeding 2,000 tcpd and the larger rice mills are likely to have financially viable opportunities for excess power generation for supply to the grid. With greater proportion of generation occurring during the dry season, compared to small hydro, electricity from these plants will be of more value to EVN as it would displace more expensive generation and provide firm power when EVN requires it most. Sugar bagasse power projects are likely to include the larger mills with existing underutilized boiler capacity where an additional steam turbine-generator could be added at about US$500 per kW. Rice mills with their longer operating season and with the additional benefit of a high value ash by-product could be attractive investments at up to US$1,500 per kW even at the energy-only tariff. However, as the majority of rice mills are small, efficient husk transport will be needed to aggregate the husk from several mills to permit a larger, more cost-effective power plants to be constructed and operated.

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[62] In both India and Sri Lanka, the SPP projects are being developed at a faster pace and at lower unit costs through experience gained by developers. For example, wind power projects in India now cost under US$850 per kW compared to US$1,200 per kW seven years ago. Small hydro projects (~1 MW per station) in India are being developed at under US$900 per kW with groundbreaking to commissioning occurring in 15 months. Seven years ago, unit cost of small hydro were US$1,400 per kW and it took 48–60 months for completion. In Sri Lanka, small hydro project unit costs are US$650–850 per kW, installed. All developers are local enterprises.

[63] Meritec, 2000. *Vietnam Rural Energy Project. Pre-Investment Study Report for Pipeline Development of New Small Hydro Projects*. Consultant report to EVN, Hanoi.

[64] Financial viability assumes a FIRR on equity, after tax of 15 percent or greater (in nominal VND).

Table 17.

Technical and Financial Characteristics of Selected New Mini-Hydro Schemes for Grid Connection

Project	Province	Installed Capacity	Generation	Financial Cost		EIRR (%) (a)		FIRR on equity after tax (%) (b)	
		MW	GWh per year	Billion VND	Million US$	Energy only avoided cost	Energy + capacity avoided cost	Energy only tariff	Energy + capacity tariff
Nam Mou	Ha Giang	5.9	43 1	79	5 7	21.0	36.1	16.9	29.8
Dan Sach 1	Binh Thuan	8.9	52.7	124.	8.9	24.3	43.2	20.0	36.8
Na Loi (c)	Lai Chau	7.5	38 8	126	9.0	15.0	27.5	8.6	18.3
Da Dang	Lam Dong	6 3	41 1	142	10.1	15.3	27 2	9 1	18.1
Da Cho Mo	Lam Dong	2.8	21.0	74	5.3	15.0	26 7	9.0	18 1
Na Loa	Cao Bang	6.5	36.0	150	10.7	15 5	28.4	8.6	18.4
Pa Khoang	Lai Chau	1.6	12.6	59	4.2	15.1	26 8	9.0	18 0
Sa Deung	Lam Dong	1.1	9 2	43	3 1	14 8	26.5	9 0	17.9
Dan Sach 2	Binh Thuan	2.4	14.2	67	4.8	15.0	28.4	8.3	18.6
Nam He	Lai Chau	5 1	25.8	139	10.0	15.2	28.6	8.4	18 6
Thac Voi	Lam Dong	1.1	7.8	42	3.0	14.5	26.6	8.6	18.0
Total		**49.2**	**302.3**	**1,045**	**75**				

a Energy-only avoided cost: VND 427 per kWh; Energy + capacity avoided cost: VND 750 per kWh.
b Energy-only small power purchase tariff: VND 420 per kWh; Energy + capacity small power purchase tariff: VND 602 per kWh.
c. Na Loi is reportedly under development by private sector interests
Source: Mentec 2000c.

Access to long-term financing (more than 5 years, up to 10 years) is needed to support small power producer investments. State-owned enterprises that can obtain such financing with little or no collateral would be the early entrants to the program. To encourage broader participation by other nonutility entities, access to long-term financing must be facilitated.

Capacity Building. The capacity has to be built in Vietnam to facilitate development of nonutility markets for small renewable energy power generation projects. The following work needs to be undertaken:

- Advise EVN on purchasing power under the SPPA;
- Assist MOI in packaging identified mini-hydro and other projects as BOO projects, designing award procedures, and offering sites to interested developers;
- Help sugar production and rice milling associations, as well as the responsible government agencies, to inform and encourage their members to participate in the small power producer program;
- Facilitate contacts between potential project developers, equipment suppliers, engineering service providers, financiers, MOI and EVN and conduct information dissemination;
- Provide matching grant funding to interested renewable energy small power project developers to assist in preinvestment activities;
- Provide business development services to

Table 18.
Characteristics of Grid Connected Mini-Hydro Rehabilitation Projects[65]

Project	Province	Capacity (kW)	Estimated Cost		EIRR (%)
			Billion VND	Million US$	
Ban Thach	Thanh Hoa	1,000	26	1.9	13 1
Thac Bay	Lai Chau	2,800	7	0.5	63 5
Chieng Ngam	Son La	2,000	22	1.6	33.2
Thac Ba	Gia Lai	300	1	0 1	33 3
Iadrang 2	Gia Lai	1,200	4	0 3	42 4
Kon Dao	Kon Tum	600	5	0 4	24 2
Phu Ninh	Quang Nam	1,760	4	0.3	47.2
Am Diem	Quang Nam	5,640	3	0.2	111.4
Nam Suu	Ha Giang	500	13	0.90	13.5
Viet Lam	Ha Giang	800	11	0.8	17 5
Nam Ma	Ha Giang	3,600	24	1 7	46 7
Thac Thuy	Ha Giang	850	13	0.9	10.8
An Kroet	Lam Dong	4,400	27	1 9	39 0
Total		**25,450**	**160**	**11.5**	

Source: Fichtner and Colenco 2000

developers to support preparation of conceptual designs, hardware specifications, financial analysis, financing plans, environmental and social assessment and compliance reporting, business planning, and attracting the necessary financing; and

- Help developers to prepare projects for support from clean energy funds, such as the PCF or the CDM.

A consultant team will be established to provide these services, with significant participation of national experts. International experts would be used primarily in an advisory capacity. During the course of this assignment, the national experts will work alongside and in partnership with international experts and thereby strengthen local expertise and capabilities in small power development. When this assignment ends, there will be a substantially improved capability in-country to continue provision of small power development assistance. This approach has been proven to be effective in other countries.

4.4 Subcomponent II: Rehabilitation of EVN-Owned Mini-Hydro Projects

Investment. A recently concluded appraisal of 30 existing, small hydro plants identified 13 plants that could be rehabilitated. All 13 projects have economic rates of return above the threshold of the World Bank's 10 percent hurdle rate, and a majority of these plants have

[65] Fichtner and Colenco. 1999. *Technical Assistance for Preparation of Proposed Rural Energy Project, package 2· Pricing Policy for Rural Electrification.* Consultant report to EVN, Hanoi.

EIRRs greater than 30 percent (see Table 18). The aggregate capacity of these 13 plants is estimated to be around 25 MW, and the total investment cost would be about VND 160 billion (US$11.5 million).

A number of these plants will be renovated by EVN. However, the consultant noted that management of these systems is particularly difficult for EVN. The sites are in remote areas and retention of staff is difficult. Therefore, EVN needs to consider alternate management methods that give greater incentives to operators and managers to ensure that these plants do run optimally. Options include performance-based Management and Operations Contracts or some form of revenue sharing contracts. In the future, EVN may wish to divest themselves of these small plants through equitization.

It is assumed that by the second phase, under power sector reform initiatives, EVN would have divested itself of small hydro plants. Therefore, no small hydro rehabilitation projects executed by EVN or PCs are anticipated in Phase 2.

Capacity Building. The Power Engineering and Construction Companies under EVN, have adequate capacity to renovate small hydro plants. They can specify the requirements, prepare bid documents, assist EVN in tendering and in construction supervision. It would however be useful to strengthen their capabilities by recruiting an international team knowledgeable about the advances taking place in small hydro technologies; experienced in environmental and social assessment and mitigation of problems; application of new performance-based contracting meth-

Table 19
Cost Estimate for Grid-Connected Renewable Energy Program

Grid-connected renewable energy	Phase I (0–5 years)			
	Physical Targets		Total Cost	
	MW		Million US$	
	Low	High	Low	High
EVN Mini-Hydro Rehabilitation	10	26	5	13
Small Power Producers	15	25	18	30
TA			2	4
Total	**25**	**51**	**25**	**47**
	Phase II (5–10 years)			
	Physical Targets		**Total Cost**	
	MW		**Million US$**	
	Low	High	Low	High
EVN Mini-Hydro Rehabilitation	0	0	0	0
Small Power Producers	150	200	180	240
TA			1	2
Total	**150**	**200**	**181**	**242**

Source: Team estimates

ods and new construction management and supervision techniques; and small generation systems control and management.

4.5 Cost Estimate

The preliminary cost for a first five-year phase of a grid connected renewable energy development program is estimated at about US$26–47 million, including US$3–4 million in grant assistance for capacity building and institutional strengthening. Such a program will improve the capabilities of the public and private sectors to undertake such projects and to support the development of about 25 to 50 MW of rehabilitated small hydro plants and new small hydro and biomass power projects. During the next phase, depending on the progress achieved during the first phase, 150 to 200 MW of installations could be achieved. An indicative cost estimate is given in Table 19.

Representative allocation of institutional strengthening and capacity building TA funds are as follows:

- Small Power Producer Project Support (60 percent)
  - Consulting Services (30 percent)
  - Information Dissemination (10 percent)
  - Matching grants for feasibility studies (20 percent)
- EVN Support for Mini-Hydro Rehabilitation (40 percent)
  - Designs and bid documents (10 percent)
  - Training & Capacity Building (15 percent)
  - Monitoring & Evaluation (5 percent)
  - Implementation Support (10 percent)

Investment financing would have to be obtained from multilateral or bilateral sources, from funds mobilized locally and equity contributions form developers.

5. Renewable Energy Assessment and Technology Improvement Component

5.1 Objective

The objective is to support activities that will broaden and deepen the development of renewable energy in the long term. The program to be carried out will be defined in detail during implementation of Phase 1. The activities described below are examples of the activities that should take place during first phase of the renewable energy program, leading to further up-scaling in the second phase.

The currently identified activities are as follows:

- Study to accelerate institutional markets for stand-alone renewable electricity systems;
- Development of a publicly available data base on renewable energy resources;
- Renewable energy technology improvement program;
- Preparation of REAP Phase 2, Large-Scale Implementation;
- Other activities not yet defined.

5.2 Background

International Experience. Renewable energy development programs internationally include a number of activities that are directed toward medium to longer term development of the sector. These activities include targeted support for research and development; resource assessment; market assessment; testing facilities for technologies and international cooperation (for example, participation in conferences and technology development activities of agencies, such as the International Energy Agency.

5.3 Study to Accelerate Institutional Market for Stand Alone Renewable Energy

The objective is to accelerate the current pace of development of institutional markets for stand-alone renewable energy systems, including solar PV systems, improved pico-hydro systems, and small wind systems. The project team will work together with interested ministries (health, education and/or telecommunication), renewable energy supply companies, and international agencies, to identify opportunities and establish an investment pipeline for these professional and institutional systems. The pipeline will be based on projects and programs the ministries are planning to implement on the medium term. The project team will identify and propose financing mechanisms for the programs, including government financing, customer contributions, international support and making use of the earlier proposed rural renewable energy fund. They will prepare feasibility studies for each subprogram, which will include financing plan, institutional arrangements, economic and financial feasibility, risks and benefits. The project team will determine the appropriate procurement mechanisms that will include minimum quality specifications of the systems. They will also produce a five-year business plan for each subprogram. Organizations that could be involved in the activity are the Ministries of Health, Education, Agriculture and Rural Development, General Department for Post and Telecommunication as well as the Committee for Ethnic Minorities and Mountainous Areas (CEMMA).

It is estimated that about US$350,000 is required to complete the activity.

5.4 Development of a Public Data Base on Renewable Energy Resources

The objective of the activity is to make available to renewable energy businesses and project developers the data necessary to identify opportunities for investment. Such data is not yet publicly available in Vietnam. The situation varies by resource, with small hydropower having the most potential sites identified and geothermal being the least well documented. However, in all cases, the information is scattered and incomplete. During preparation of the REAP study, Hydro Power Center (HPC) prepared several data bases on small hydropower, but the information available is not yet adequate to prepare a large-scale program.

This activity would prepare and initiate implementation of a public data base on renewable energy. It would include resource measurement, resource assessment, and publication of the results on the most promising sites for development of small hydro, wind, biomass and geothermal resources. It would characterize the resources at promising sites in Vietnam to a level sufficient for conducting prefeasibility studies for grid-connected projects or isolated power supply projects in mountainous, coastal or island regions. It would then create a publicly accessible data base that contains the results of the assessments, and publicize the availability of the information. This activity would be ongoing throughout the REAP program, increasing the amount of information available over time. This activity would include training and provision of equipment and resources to ensure that data is obtained, processed and disseminated in a way that ensures usefulness and quality. Organizations that could be involved in the activity are Institute for Meteorology and Hydrology (IMH), Institute of Energy (IE), and the RECTERE.

It is estimated that about US$1.25 million is required to complete the activity. It would be carried out in two stages, an initial planning study and then implementation of the program.

5.5 Renewable Energy Technology Improvement Program

The objective of the activity is to help equipment suppliers to improve the renewable energy technologies currently available in Vietnam. This will involve cost sharing of activities that will result in improved technologies or strengthening of equipment supply businesses. Such activities could include product development, product demonstration and evaluation, product testing, twinning arrangements between Vietnamese and foreign suppliers, feasibility studies of joint ventures, and preparation of agreements for licensing. Local and foreign equipment suppliers will make proposals to the program, including business plans showing the results if the activity is successful, and apply for funding. The proposals would be judged on a competitive basis. Such programs have had considerable success in industrial countries and could encourage institutions in Vietnam to seek out commercial opportunities and look for foreign partners.

It is estimated that about US$1.75 million is required to complete the activity, which would again be carried out in two stages, an initial planning study and then implementation.

5.6 Preparation of Phase 2: Large-Scale Implementation

The objective of the activity is to update the REAP and prepare an implementation plan for Phase 2, that is, large-scale implementation and up-scaling of the best-practice activities from phase I. The activity will review the lessons learned from Phase I, including the pilot projects, resource assessment studies, tests of implementation models, and capacity building efforts. It will also reassess expanding the scope of the action plan to other renewable energy systems including wind farms, solar heating, and biogas. The review will be prepared using a participatory process involving all relevant parties similar too what has been done during the preparation of the current REAP. The lessons will be clearly documented with as aim to disseminate them internationally. Based on these lessons, the REAP will be updated with the objective of significantly up-scaling electricity services to the rural poor, initially following the targets set in the current REAP.

It is estimated that about US$0.65 million is required to complete the activity

5.7 Estimated Component Cost

The cost of this component is estimated at US$5 million as shown in Table 20 below.

Table 20:
Estimated Cost of Renewable Energy Technology Assessment/Development Component

Subcomponent	Cost (million US$)
Study to Accelerate Institutional Market for Stand Alone Renewable Energy	0.35
Development of Public Data Base on Renewable Energy Resources	1.25
Renewable Energy Technology Improvement Program	1.75
Planning of REAP Phase 2	0.65
Other Activities	1.00
Total	**5.00**

Source: Team estimates

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2	Pham Tien Khoa	Director, Viet Phong Consulting
3	Nguyen Hoai Chung	Vietnam Women's Union
4	Tran Thi Thin	Deputy Director, Vietnam Bank for the Poor
5	Dang Dinh Thong	Director, Renewable Energy Research Center, Hanoi University of Technology
6	Nguyen Duc Loc	RERC, HUT
7	Pham Cong Dinh	Industrial Dept., Ministry of Planning and Investment
8	Ma Trung Ty	Committee for Ethnic Minorities and Mountainous Areas
9	Hoang Trong Do	Industrial Dept. of Son La Province
10	Phan Van Lan	Director, Industrial Dept. of Gia Lai province
11	Tran Van Dinh	Industrial Dept. of Tra Vinh province
12	Hoang Van Thang	Director, Hydro Power Center/MARD
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14	Nguyen Tan Loc	Director, Rural Network Dept., EVN
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24	Do Thiet Hung	Deputy Head, ICD, IE
25	Oystein Botillen	UNDP
26	Nguyen Ngoc Ly	UNDP
27	Susan Bogach	World Bank
28	Anil Cabraal	World Bank
29	Jon Exel	World Bank
30	Van Tien Hung	World Bank Vietnam
31	Pham Nguyet Anh	World Bank Vietnam
32	Nguyen Thuy Anh	World Bank Vietnam
33	Enno Heijndermans	Moderator (World Bank)
		Workshop on Draft Report, October 2000
1	Andrew Steer	Country Director – World Bank Vietnam
2	Tran Van Duoc	Vice President – Electricity of Vietnam
3	Pham Van Vy	Assistant to President & CEO, EVN
4	Nguyen Tan Loc	Director, Rural Network Dept., EVN
5	Trinh Ngoc Khanh	Deputy Director, Rural Network Dept, EVN
6	Vu Ngoc Thu	Director, Planning Dept., EVN

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14	Cao Quoc Hung	International Cooperation Dept., MOI
15	Pham Cong Dinh	Industrial Dept., Ministry of Planning and Investment
16	Nguyen Ba Vinh	Dept. for Science & Technology Management, Ministry of Science Technology and Environment
17	Ma Trung Ty	Committee for Ethnic Minorities and Mountainous Areas
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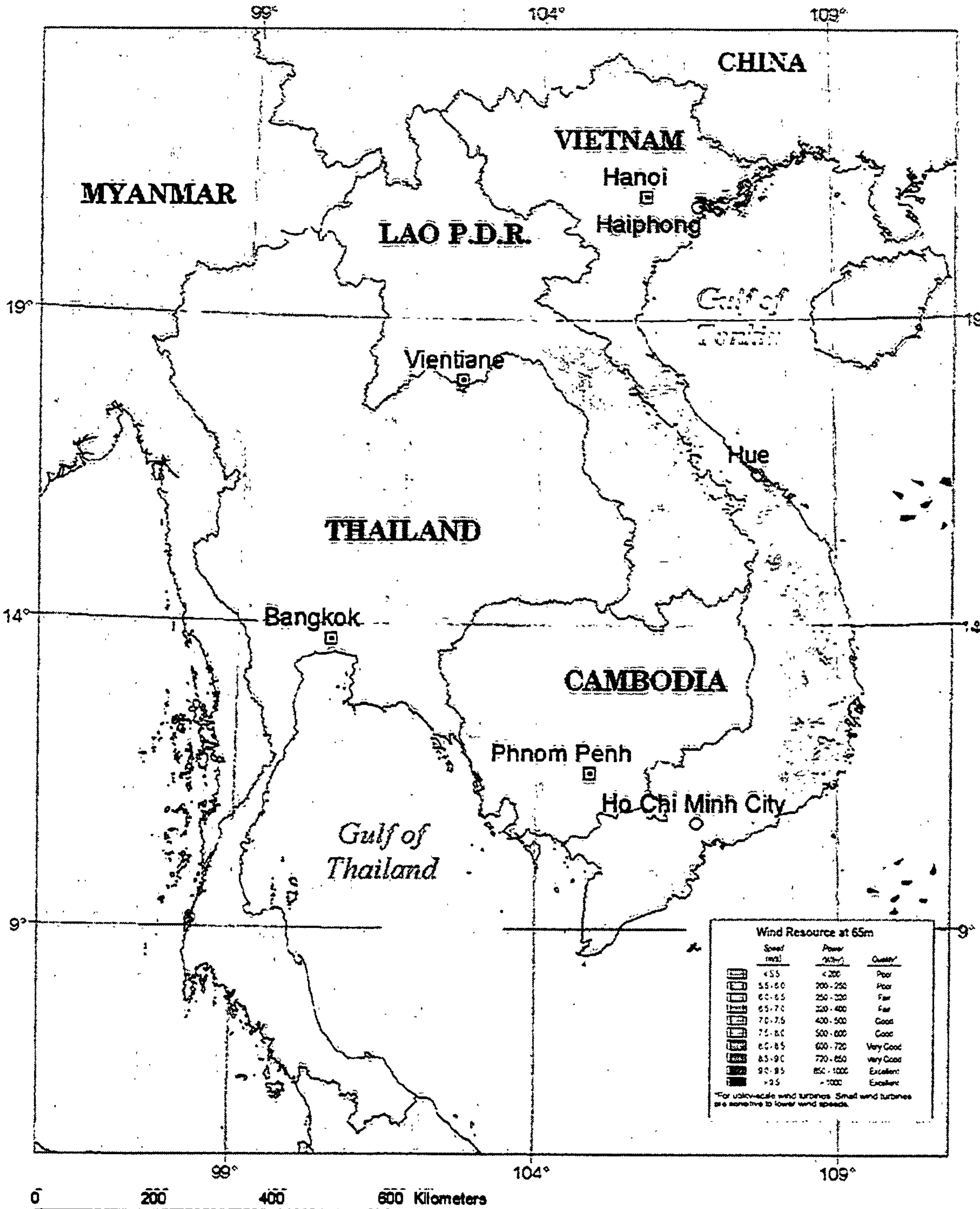
42	Anil Cabraal	World Bank
43	Jon Exel	World Bank
44	Van Tien Hung	World Bank Vietnam
45	Pham Nguyet Anh	World Bank Vietnam
46	Nguyen Thuy Anh	World Bank Vietnam

Wind Resource at 65 m



Projection: Universal Transverse Mercator (Zone 48)
Scale: 1:10,400,000 (1cm = 104 km)
Resolution of Wind Resource Data: 1km

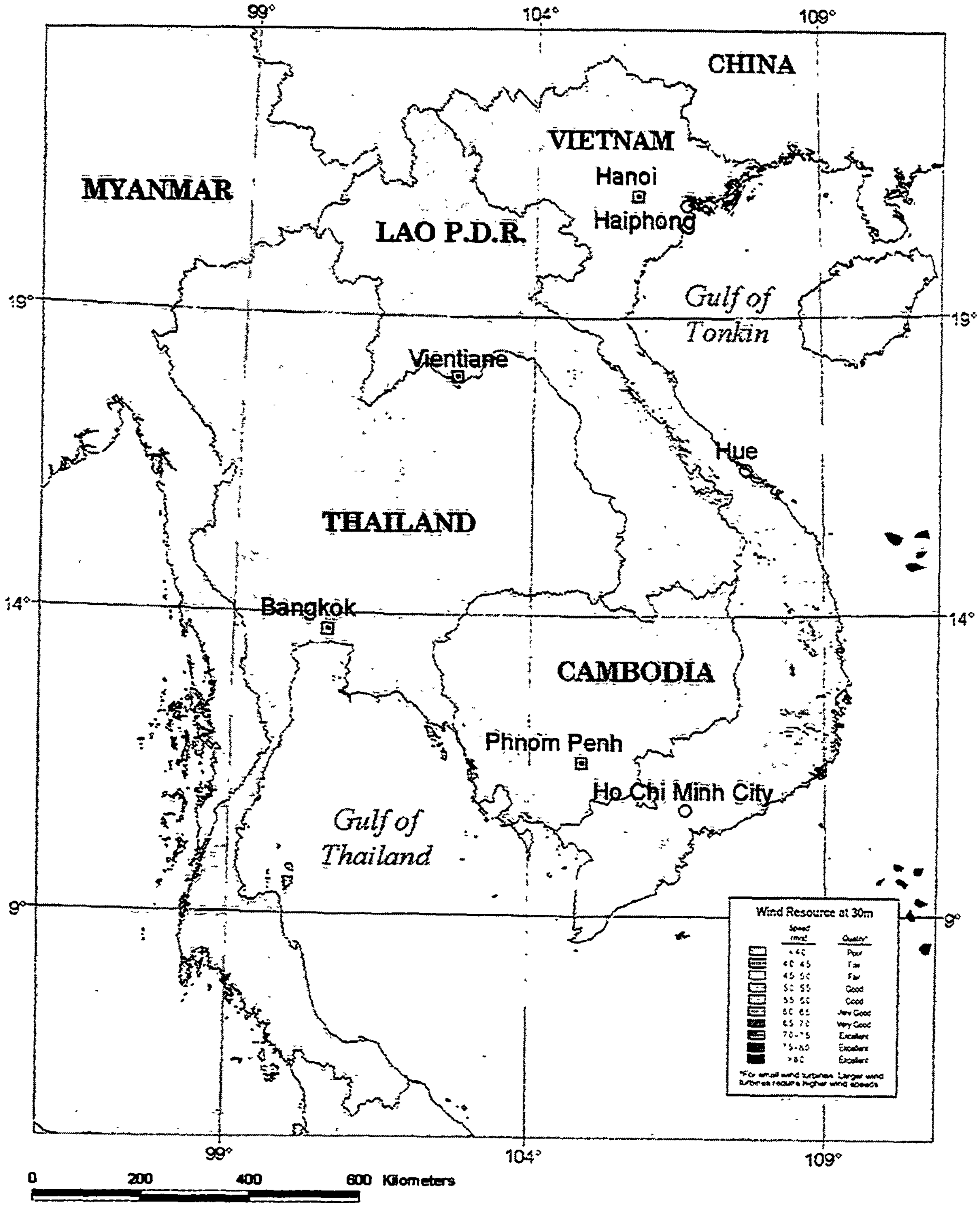
This wind resource map of Southeast Asia was created for the World Bank by TrueWind Solutions using MesoMap, a mesoscale atmospheric simulation system. Although the map is believed to present an accurate overall picture of wind resources in Southeast Asia, resource estimates for any particular location should be confirmed by measurement.

Wind Resource Atlas of Southeast Asia
Source: Truewind Solutions 2001

Annex 2

Macro-Level Wind Map of Vietnam and neiboring countries

Wind Resource at 30 m



Projection. Universal Transverse Mercator (Zone 48)
Scale 1 10,400,000 (1cm = 104 km)
Resolution of Wind Resource Data 1km

Wind Resource Atlas of Southeast Asia
Source Truewind Solutions 2001

This wind resource map of Southeast Asia was created for the World Bank by TrueWind Solutions using MesoMap, a mesoscale atmospheric simulation system. Although the map is believed to present an accurate overall picture of wind resources in Southeast Asia, resource estimates for any particular location should be confirmed by measurement.

Renewable Energy Policy Studies. A number of studies have been conducted to prepare the REAP resulting in (a) a data base[1] on more than 1,100 communes that will not be electrified by EVN in the next five years; (b) a feasibility study on a program to support individual renewable energy systems for households and institutions; (c) a feasibility study for community scale hydro-based mini grids; (d) an institutional and policy background document was prepared; and (e) as a techno-economic analysis report. As part of the preparation of the Rural Energy 1 Project, key stakeholders visited the hydro and solar projects in Sri Lanka. Studies and support were provided for the development of an SPPA and tariff to be used by independent small power producers that will sell electricity to EVN.

Preparation of investment pipelines for hydro. EVN undertook two investment studies, one on rehabilitation and upgrade of grid connected hydro projects and one on new small hydro projects. The rehabilitation study identified 13 economically viable projects with total capacity of 26 MW and a required capital of US$11 million. The study on new small hydro projects identified 11 economically viable projects with total capacity of 50 MW and required capital of US$74 million. EVN and the World Bank are considering the option to finance some of these projects as part of the next energy lending operation.

Commune based micro-hydro-diesel pilot project. This project will test and demonstrate a model to supply electricity to a commune on a sustainable way. Particular attention is given to the organizational and management set up to assure technical quality control, commercial operation, proper maintenance and after sale services. If the project is successful, it could create momentum to develop 200 similar sites in the northern part of Vietnam.

Private sector development support for hydro organization. A twinning relation has been established between the RERC in Hanoi and a Swiss hydro company. Together they are developing a business plan to spin off the household scale pico-hydro production facility into a new business. A similar activity is planned with the HPC in Hanoi.

Renewable energy training and awareness material for communes. The project has supported the development of training material for trainers who will work with communes and government authorities to prepare commune based renewable energy investment proposals. The material is prepared with local training experts and consists of leaflets, flipcharts, draft proposal, training guides, and a fact book. It will support the communes in making an informed choice in selecting their energy technology to fulfill their electricity need.

Financing of solar company. IFC is supporting SELCO Vietnam, a commercial solar company that is selling solar PV systems.
Macro level wind mapping Furthermore a macro level wind resource map is being prepared for the Indochina region.

[66] Data includes population, number of households, per capita income, village spacing, access to seasonal road, perennial road, health center, school, market and small hydro potential.

Annex 4

Overview of Donor-Supported Renewable Energy Projects in Vietnam

Donor Country	Donor Organization	VN Organization	Focus	Period	Amount (US$)	Remarks
China/Japan	ODA	HPC	Small hydro power			Northern and Central Part
Denmark	DANIDA		TA on wind power; wind assessment			
Denmark		EVN	RE master plan		1.1 million	
EU	ASEAN Cogen		Bagasse Cogen			
Finland						Mission in Sept '98
France	Fondem		Solar PV	1990–1998		South of VN
France	ACCT	HUT, Hanoi University of Technology	Renewable Energy Technologies			Central Part
Germany	GTZ	Can Tho University	Biogas			Agric. University, South of VN
Germany			PV/diesel hybrid			
Japan	NEDO	IE	Solar/hydro hybrid			Kon Tum Province
Japan		IE	New and renewable energy			
Netherlands	SNV	SNV-VN	Rural Renewable Energy Advisor	1999–2001		Central Part
Netherlands	NEDA		Transport, biogas, cogen		0.2–2 million	CDM
Netherlands	NEDA	MOSTE	EC and Efficiency			EDF involved
Swedish	SIDA		PV research and demonstration			Under Renewable Energy Technology in Asia Program
Swiss	VN-Swiss Association	HCM University of Technology	Wind Turbines			
Worldwide	IFC	SELCO-VN	PV		750,000	
Worldwide	GEF		Geothermal			
Worldwide	UNDP		PV Potential in Vietnam			
	ESCAP					

Renewable Energy Projects in Vietnam Supported by the World Bank Group

Main Issues	All Technologies	Household Systems		Community Mini-Grid	Grid-connected Hydro or Biomass
		Pico-Hydro	SHS		
Policy	Environment and social benefits not valued Proposed subsidy for rural electrification less than for conventional	No subsidy from GOV unlike grid Dumping of Chinese systems below cost	No subsidy from GOV unlike grid High import duties, taxes	Subsidies from GOV less than for grid	Investor must negotiate deal No standard PPA or tariff
Technical	Equipment and operation not best international practice Number of professionals not adequate for large scale	Poor quality and performance Short Lifetime Safety issues in operation		Equipment standards inadequate, safety issues Seasonal supply Environmental impact	Same as mini-grid
Business	No renewable energy businesses Government approvals complex and difficult Public enterprises get preferential treatment over private		Only 1 company operating noncommercially	No management model Usage levels too low O and M inadequate HPC not commercial	Few potential investors as IPP is new business in Vietnam
Information	Lack of awareness Lack of data on the grids and on villages and communities not to be electrified by EVN[1]		Lack of consumer awareness		None since opportunity only now being identified
Resource	Lack of adequate measurement, assessments, no public data base	Limited number of sites, only in north	Adequate only in south	Lack of adequate data on sites	Same as mini-grid
Finance	Lack of long-term finance and consumer finance		No source of finance for consumer	No source of finance for community	No long-term finance for developer

Soure. ASTAE 2000

[1] Now addressed by REAP Package B, in which HPC has collected this information and made it available. See Hydro Power Center. 2000. *Package B: Collection of Basic Information and Mapping Information for Vietnam*. Consultant report to World Bank, Washington, D.C.

Annex 6

Implications of Rural Electrification Policy for Renewable Energy

Policy on Rural Electrification Policy and Power Sector Policy	REAP Implications
Basic Principles (Headings and section numbers correspond to that in the Rural Electrification Policy paper)	
The purpose of *rural electrification* is to deliver electricity efficiently and reliably to rural consumers in order to improve their standard of living and ability to earn income. The following principles will guide the evaluation, development and implementation of the rural electrification in Vietnam: 2. Rural electricity supply will be based on both grid-based and off-grid systems.	Renewable energy-based off-grid and mini-grid options are proposed where they are least economic cost compared to either grid extension or using diesel mini-grids.
4 Priority should be given to those areas that have the capacity to enhance the pace of agricultural productivity, modernization and economic restructuring of strategic areas.	Emphasis for minigrids will be on areas with productive use opportunities. Where productive uses are likely to be limited, off-grid options may be lower cost solution to enhance quality of life.
5. The responsibilities for investing, managing and operating rural electricity networks and providing supply and service functions should maximize the use of local authorities, local people and local investors.	Off-grid services and mini-grid systems will be owned, operated and managed by local authorities. In addition, experiences in other countries show that given the small scale of these investments, main investors in such ventures are local.
6. The costs of operations, maintenance and the economic depreciation of rural electrification infrastructure and supply should be financially recovered from the revenues earned by EVN, PCs and other operating entities in Vietnam's power sector. The GOV should provide a transparent subsidy for investment in rural electrification networks and supply infrastructure when these are deemed commercially unviable by revenue earning entities in Vietnam's power sector. 7. Electricity supply for rural consumers should be considered a commercial service, except for those areas Government has subsidy policy when it is deemed to be socially necessary and consistent with the objective of equitable development. All entities that are responsible for the final delivery of electricity service to rural consumers should have an adequate financial incentive to continue in business and maintain an acceptable level of service.	Consistent with the government policy of equitable distribution, it is hopes that renewable energy-based grid and off-grid services will receive transparent subsidy. This is likely needed for mini-grids even where they are least cost compared to grid extension or diesel mini-grids. Grid connected renewable energy generation projects to be financed are economically and commercially viable when energy generated is credited on avoided cost basis
The Policy Framework for Rural Electrification 1. Project Selection Criteria The selection of unserved areas and individual communes for electrification should be consistent with the Government's socioeconomic development objectives and should include, among others, the following principles: (a) that communes should have a potential for economic development so as to ensure that energy consumption will be sufficient to justify the investment in economic terms that are defined as below: - The methodology for conducting the economic evaluation of any *rural electrification project* will be based on regulations to be issued by the Government - A *rural electrification project* is defined as the capital investment decision for a medium-voltage and low voltage system including all associated downstream investments. A typical *rural electrification project* would therefore cover multiple communes. - Only those *rural electrification projects*—would be selected for investment if they are able to demonstrate a minimum EIRR of 12 percent. - Specially difficult communes selected for electrification under a specific *project* should achieve a minimum EIRR (probably 8 percent). - Those communes that have EIRR below the above criteria will be electrified under a specific decision by the Government.	Selection of communes to be served by electricity, either grid, mini-grids or off-grid would meet the EIRR criteria proposed.

Implications of Rural Electrification Policy for Renewable Energy

Policy on Rural Electrification Policy and Power Sector Policy	REAP Implications
(b) that the connection of communes to the grid should be the least-cost solution to supply electricity,	The decision to use off-grid, mini-grid options are based on least cost criteria compared to providing equivalent services using either grid extension or isolated diesel grids.
(c) that the selection should be done following a process whereby local groups, that is, local community and households, will have an opportunity to participate.	Local communities would make the ultimate decision on level and choice of technology solutions.
3. Ensuring Appropriate Design Standards and Construction Quality All rural electrification investment from the medium-voltage level down to the consumer meter will have to meet nationally promulgated design standards. MOI will issue nationwide applied design standards for rural electricity networks.	Design and quality standards will be set and enforced to ensure quality of service, safety and reliability criteria for off-grid and mini-grid systems (solar PV, pico-hydro, and hybrid systems).
EVN will undertake the responsibility of certifying or ensuring that the medium and low-voltage rural network invested by the PCs meet national design standards.	Mini-grids will meet EVN standards consistent with level of service proposed. Such designs low-cost mini-grids have been developed with Bank support in other countries in Asia. These will be made available to MOI for consideration
Departments of Industry in the provinces and central cities will undertake the responsibility of evaluating rural electricity network projects that are designed and invested by other investors to meet national design standards and existing regulations An agreement on design standards with EVN or PC(s) if an electricity network needs to be connected to the national grid	Grid-connected renewable energy plants will be required to meet EVN interconnection standards
The Power Companies and local network owners and operators are obliged to meet the nationally promulgated design standards.	
4 Diversifying Ownership and Management Responsibilities for Rural Electrification Networks and Supply The GOV encourages the diversification of investment and management forms in the provision of electricity to consumers - Foreign and local investors are encouraged to invest in generation of power to supply rural electrification networks—The Government will not limit the participation of entities and individuals in owning, managing rural network and supply businesses, provided that these activities are in compliance with legal regulations. Different operation and management schemes will be encouraged and applied depending on the local situation providing the mechanisms are transparent and incentives appropriate. - The low-voltage network developed by the PCs may be leased or sold to a business entity that may have sufficient operating capacity and be assigned the responsibility of operating the low-voltage network	Renewable energy-based grid and off-grid systems would be owned and operated by commercial enterprises, such as community organizations, cooperatives and private sector. The small scale of the projects and the correspondingly small investment requirements are ideally suited for local investors as experience in other countries have shown. Moreover, these small operations are more efficiently and cost-effectively run by such commercially functioning enterprises rather than EVN or PCs MOI may wish to consider selling or offering on long-term lease to commercial enterprises the mini-hydro plants that need to be rehabilitated. The enterprises would then rehabilitate the plants and sell electricity to EVN or PCs on an avoided cost basis.

Implications of Rural Electrification Policy for Renewable Energy

Policy on Rural Electrification Policy and Power Sector Policy	REAP Implications
5. Encouraging Decentralized On Grid Generation Supply *To encourage* investment in economic decentralized generation in the low voltage grid, the PCs will offer *avoided cost* capacity and/or energy payments to potential decentralized generators (avoided cost capacity and/or energy payments are the highest price that the power purchase can be afford to buy electricity from outside generation source instead of their self investment, generation and transmission to the consumers). These *avoided cost* capacity and/or energy payments will be linked to the load profiles and location at which this power is supplied to the network. The EVN will specify and proclaim the principles for establishing these avoided cost *payments*	This is an important policy to support decentralized generation Avoided cost-based tariff reflecting the cost of supply at the specified voltage in each PC service area is important in ensuring that economically viable decentralized renewable energy sources are developed. The tariff should include both capacity and energy payments as a function of season and maybe even on time-of-day basis if justified by metering cost and complexity. Penalty for not meeting capacity requirements could be considered to encourage these generators to ensure capacity is supplied when needed by EVN. The tariff formulation and assumptions should be transparently derived and updated and the principles, formula and data should be made known to the developers as required in the rural electrification (RE) policy.
[From Power Sector Policy] C. Reform Strategy (c) Electricity Pricing - introduce a cost-based bulk transfer price for bulk power sales to the distribution companies. EVN will ensure that the difference between cost-reflective bulk supply tariff (BST) to PCs and retail tariff by year 2000, which results in an operating loss to PCs is compensated transparently, that is, not through the bulk supply tariff. 1 3 2 Implementation of full cost-based bulk supply tariff to PCs may be phased, if necessary. - 1998 70 percent of actual G&T cost - 1999 85 percent of actual G&T cost - 2000 100 percent of actual G&T cost	Since the grid-connected renewable energy systems are most likely to be connected to the PCs medium-voltage (MV) grid, the purchaser of electricity will be the PCs. Therefore the Power Sector Policy statement that the PCs will purchase power at 100 percent of G&T costs by 2000 is important to ensure that all economically justified decentralized generation is supported. The current practice of adjusting the bulk tariff through a hidden subsidy to ensure that the PCs that serve rural consumers are financially viable is a disincentive for PCs to purchase power from other generators as they can get subsidized bulk power from EVN. Tariff setting by an independent regulatory authority is important as proposed in the Power Sector Policy.
6. Incentives for off grid supply For some mountainous communes and island areas not being able to connect to the national grid, respective provinces will establish the on-spot or local generation projects suitable with the specific conditions of each location, such as diesel, small hydropower, and solar power. The Government will encourage foreign and local investors participating in investment, local generation businesses for electricity supply to consumers, especially in remote areas where the national grid cannot reach.	A large number of communes and consumers who could be more economically and in a least cost way be served by off-grid and mini-grid options were identified in the REAP. The GOV commitment to support such service delivery by foreign and local investors is encouraging.

Implications of Rural Electrification Policy for Renewable Energy

Policy on Rural Electrification Policy and Power Sector Policy	REAP Implications
7. Retail Price The Government through its assigned price setting authority will establish a ceiling price for retail supply to rural consumers. This retail price ceiling will be readjusted and increased if the overall financial subsidies made available through the differential pricing of bulk power to urban and rural power distribution companies is inadequate to sustain acceptable financial performance for EVN, the PCs and other rural electricity supply business entities. (This financial performance is as follows: self-financing ratio is 30 percent, debt service ratio is 1.5 and debt-to-equity ratio is 60:40) The mechanism of subsidizing the price of electricity to rural consumers should ensure that there are incentives for (a) efficient purchase of bulk power by the supply entity; (b) entities responsible for electricity delivery to cover costs.	It is important to ensure that this policy statement regarding differential pricing of bulk power is consistent with the statement in the Power Policy referenced above (1.3.2), which stated that by 2000, the bulk tariff will cover 100 percent of G&T while any necessary subsidy will be transparently and independently provided.
8. Funding Arrangements for Rural Electrification The GOV will ensure the following when providing funds to EVN, PCs and other business entities for investment in rural electrification: - Refundable or partially refundable capital sources from multilateral and bilateral loans will be allocated as special budget fund aimed at investing in rural electrification once the investment is determined appropriate.	Access to long-term financing will be important to support renewable energy investments. Financing from multilateral, bilateral or local sources could be coursed through the commercial banking sector following good investment banking practices. Experiences in other countries should that while long-term (10 years) financing is needed to make decentralized renewable energy projects financially viable, concessional interest rates are not necessary or recommended. Where appropriate and justified, grants reflecting global environmental values of these projects should be transparently provided.

Annex 7

Summary of Sites and Communes for Inclusion in the Pilot Commune-Based Hydro Program

No.	Province	District	Commune Name	No. of Consumers	New or existing	Hydro Capacity	Diesel Capacity	Peak Load (kW)	System Cost (US$)	O&M Cost (US$)	Revenue (US$)	Ratio Rev/O&M Cost	Community Subsidy (US$)	Estimated Grant (%)
1	Son La	Son La Town	Chieng Co	296	Ex	40	30	59	146,242	5,643	7,266	1.3	14,624	64
2	Son La	Quynh Nhai	Muong Chien	367	New	80	0	73	192,048	2,769	8,987	3.2	28,807	54
3	Son La	Song Ma	Chieng En	295	New	60	0	59	162,374	2,608	7,237	2.8	24,356	59
4	Son La	Song Ma	Muong Lan	407	New	90	0	81	208,106	2,853	9,972	3 5	31,216	51
5	Son La	Song Ma	Chieng Phung	292	New	60	0	58	161,559	2,606	7,163	2 7	24,234	59
6	Son La	Song Ma	Huoi Mot	259	New	60	0	52	152,435	2,574	6,339	2.5	22,865	59
7	Son La	Song Ma	Muong Cai	210	New	50	0	42	134,095	2,482	5,148	2.1	20,114	62
8	Son La	Muong La	Ngoc Chien	537	New	110	0	107	253,747	3,068	13,164	4.3	38,062	46
9	Son La	Muong La	Chieng Cong	227	New	50	0	45	138,820	2,498	5,575	2 2	20,823	62
10	Son La	Muong La	Muong Trai	350	New	50	40	70	188,677	6,108	8,590	1.4	28,302	62
11	Son La	Bac Yen	Bac Nga	403	New	90	50	81	227,537	2,849	9,869	3.5	34,131	51
12	Ha Giang	Dong Van	Lung Cu	272	New	40	30	54	158,077	4,646	6,663	1 4	23,712	64
13	Ha Giang	Meo Vac	Tat Nga	224	New	50	0	45	137,843	2,495	5,486	2.2	20,676	62
14	Ha Giang	Meo Vac	Lung Pu	253	New	60	0	51	150,969	2,569	6,207	2.4	22,645	59
15	Ha Giang	Meo Vac	Nam Ban	226	New	50	0	45	138,494	2,497	5,545	2.2	20,774	62
16	Ha Giang	Meo Vac	Niem Son	455	New	100	0	91	226,446	2,945	11,164	3 8	33,967	49
17	Ha Giang	Yen Minh	Ngam La	253	New	60	30	51	163,149	2,568	6,192	2 4	24,472	59
18	Ha Giang	Yen Minh	Du Gia	572	New	100	60	114	282,740	6,501	14,017	2.2	42,411	49
19	Ha Giang	Hoang Su Phi	Tien Nguyen	328	New	70	40	66	192,935	2,686	8,046	3.0	28,940	57
20	Ha Giang	Xin Man	Quang Nguyen	295	New	60	0	59	162,374	2,608	7,237	2.8	24,356	59
21	Ha Giang	Xin Man	Na Chi	324	Ex	70	0	65	152,194	2,473	7,943	3.2	22,829	57
22	Ha Giang	Bac Quang	Lien Hiep	303	Ex	50	40	61	155,749	3,864	7,428	1.9	[illegible]	62
23	Ha Giang	Bac Me	Duong Am	221	New	50	30	44	149,534	2,492	5,427	2.2	22,430	62
24	Lai Chau	Muong Lay	Nam Hang	317	New	70	0	63	173,382	2,675	7,766	2.9	26,007	57
25	Lai Chau	Phong Tho	Nam Xe	392	New	80	0	78	198,890	2,792	9,605	3.4	29,834	54
			Totals	8,079		1,650	350	1,614	4,408,416	79,869	198,036	2.6	653,950	57.6

(1) No. of Consumers equals 60 percent of the households in the commune.
(2) Subject of detailed financial and economic analysis.
(3) Subject to sensitivity analysis.
Soure: Meritec 2000.

Annex 8

Summary of the Results of the Financial and Economic Evaluations for Eight Selected, Representative Schemes

No.	Project or Commune	Hydro/Diesel Capacity (kW)	FIRR (unsubsidized; %)	Tariff (VND, used for calculation of FIRR)	EIRR (unsubsidized; %)	Capital Subsidy Required to Achieve FIRR of 10% (% of development cost)
1.	Tri Nang	40/30	-2.9	2,200	+10.0	72
2	Muong Lan	90/0	-0.8	1,100	+15.9	58
3.	Chieng Phung	60/0	-2.2	1,100	+14.4	63
4.	Ngoc Chien	110/0	+0.4	1,100	+17.3	52
5.	Lung Pu	60/0	-3.3	1,100	+13.2	67
6.	Ngam La	60/30	+0.6	1,800	+10.9	22
7	Duong Am	50/30	-0.6	1,800	+9.6	71
8.	Dai Son	40/0	-4.9	1,100	+11 6	73

FIRR = Financial internal rate of return.
EIRR = Economic internal rate of return.
Soure: Meritec 2000.

Annex 9

Comparison of SPPA and Tariff Structure among Countries

Characteristic	Thailand	Indonesia	Sri Lanka
Capacity Limit	60 MW	Java/Bali 30 MW; other 15 MW	5 MW, but could be used for up to 10 MW
PPA period	5-25 years	Non-firm 2 years Firm: 3-20 years	**~10-15 years**
Tariff	Non-negotiable, avoided cost based. Energy + capacity payment for firm contracts (VND 100,000-200,000 per kW per month + VND 370 per kWh) Energy only for non-firm contracts (VND 450 per kWh)	Non-negotiable, avoided cost based Energy + capacity for firm contracts and energy-only for non-firm contract	Non-negotiable, avoided energy cost based. Wet season (May-Jan): VND 520 per kWh Dry season 590 per kWh
Electricity Payment	Varies by time-of-day. Penalty for firm contracts if contracted capacity is not met. Payment in Bhat	Varies by time-of- day, firm or non-firm, facility location, HV or MV, and facility type. Payment in Rupiah	Varies by wet (May-Jan) and dry season Payment is in Rupees.
Tariff adjustment	Annual according changes in avoided cost. Avoided cost is indexed to price of utility's generators at the margin (fuel oil in Thailand, diesel GT in Sri Lanka, and a mix of fuel depending on region, in Indonesia)		
Operation of Facility	Annual CF > 80% (53% for waste-to-energy). Monthly CF>51% for firm contracts	According to Prudent Utility Practices Monthly CF >50% for firm contracts	According to Prudent Utility Practices. "Must-run facility"
Interconnection	Seller responsible for cost.	Seller responsible for costs but work done by seller or utility Connection at MV or HV and follows Prudent Utility Practice	Seller pays the utility to contract interconnection. Connection at 33 kV and follows Prudent Utility Practice
System Standards	Utility Grid Code Regulations for Synchronizing Generators	Utility Standards	Utility Standards, plus G/59/1 British Electrical Association

Source: Worley International in association with Clayton Utz, *Renewable Energy Small Power Purchase Agreement*, Draft Final Report prepared for EVN, September 2000.

Outstanding SPPA Issues

Issue	Concerns	Discuss of Options
Period of Contract	EVN wishes to enter into no more than 10-year contract for small hydro plants and not more than 5 year contracts for thermal plants, such as bagasse-fired stations	Rather than setting the contract term based on source of fuel, it may be more appropriate to issue 5-year SPPA for energy-only contracts that are renewable at EVN and developers option. Longer-term contracts of 10 years could be considered for small power producers that commit to delivering both energy and capacity. Without a purchase agreement at least as long as the loan repayment period for loans taken to finance the investment, few small power producer investments would occur. Only investments that will occur are those financed on the balance sheet of companies or those needing little external financing.
Purchase tariff	EVN will pay only energy component of the tariff and not the capacity component as EVN cannot depend on the small power producer to deliver electricity dependably when required	EVN may wish to offer both firm and non-firm contracts as in Thailand Non-firm contracts would receive only an energy payment. The firm contracts will receive an energy and capacity payment with penalties if minimum capacity (annual and monthly) is not met. The capacity payment is paid only during peak demand periods Many of the identified renewable energy small power projects have plant load factors comparable to EVNs own base load generators (~65%) and therefore deserve capacity payments (for example, small hydro plants identified to date have average annual PLF of 63-93%, rice husk-fueled plants 63% or more, sugar bagasse plants around 40%, and geothermal plants 90+ percent)
Uniform national tariff vs. regionally differentiated tariff	The tariff as presently constructed assumes that the avoided cost is the same throughout the country and considered existing hydro at the margin during off-peak periods	The tariff fails to recognize that with the N-S transmission capacity constraints, there is a distinct cost differential between generation in the north, and the south. Therefore, a regional tariff would be more economically rational. Moreover, with coal plants being built in the north and new hydro being build in the south, it is these plants that will be at the margin and appropriate for considering in the avoided cost formulation. If the tariff is below that which is economically appropriate, Vietnam as a nation would not be able to benefit optimally from developing its own natural resources.
Standard SPPA vs model SPPA	EVN wishes the SPPA to be a model contract rather than a standard contract and to have the option to negotiation individual agreements with each developer	The critical need for a standard, as opposed to a model contract for these small power producers is that it reduces the time and cost to both the developer and EVN of coming to closure on the agreement. The size of the investment is small so that extended negotiations will discourage most developers. Experience in Thailand, India and Sri Lanka has clearly demonstrated the value of such standard agreements.
Deemed energy output/Must Run Facility	EVN is concerned that if they are obliged to buy electricity from these facilities on a must-run basis, the Load Dispatch Center (LDC) would be prevented from optimal load dispatch.	The small power producers, by definition, are small plants Even if 100 MW in aggregate are developed, it is only about 2 percent of EVN's capacity. Therefore, buying power from such plants will have little influence on EVN's merit order dispatch. Moreover, as EVN is a monopoly buyer, discretion on dispatch leaves the small power producer vulnerable. If EVN is to insist on having dispatch control over such small power producers, the EVN should be willing to pay the capacity payment so that cash flow does not cease if EVN decides not to dispatch the plant If not, few developments will occur
Buy-out provisions	EVN does not wish to accept the provision of a compulsory buy-out in the case of EVN defaulting on purchase of electricity for the following reasons: (a) A small power producer may artificially inflate the development and construction costs and thus the economic value of the plant (b) It would be difficult to determine the fair market value of the plant and could result in long, protracted and bitter negotiations	If the single buyer, EVN, defaults, the small power producer has no alternative market for its product—electricity, and is left with a stranded asset. Therefore, this provision was included to reduce the perceived risk to the developer. This provision is a contractual mechanism to shift the risk of Buyer default to the party best able to manage or control the risk. To address EVN's concerns, the SPPA could contain a schedule outlining procedures and formulas to determine the buy-out price. The buy-out provision would cease if sector reform is implemented and includes the establishment of a competitive power market with multiple retailers

Giấy phép xuất bản số: 138/2001/XBNT-VHTT. In 1000 cuốn khổ 21x28cm.
tại Xưởng in Tổng công ty Phát hành sách Việt Nam, Nộp lưu chiểu Quý 3 năm 2001

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	Mini-Grid Design Manual	09/00	007/00
	Photovoltaic Applications in Rural Areas of the Developing World	11/00	009/00
	Subsidies and Sustainable Rural Energy Services: Can we Create Incentives Without Distorting Markets?	12/00	010/00
	Sustainable Woodfuel Supplies from the Dry Tropical Woodlands	06/01	013/01
	Key Factors for Private Sector Investment in Power Distribution	08/01	014/01

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