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TERMINAL REPORT

Technical Assistance to DOE for Enhancing Private Sector Participation in New and Renewable Energy Investments for Off-Grid Rural Electrification (TASK 6 – Collection, Analysis and Packaging of Critical Investment Information)

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THE MARKET FOR NRE

Until recently, the promotion of new and renewable energy (henceforth, NRE) in the Philippines was pursued in the context of attaining energy self-sufficiency. Such perspective has changed in light of the pressing need to provide power to some 10,000 unenergized barangays. NRE has become a strategic instrument to attain the goal of rural electrification.

The challenges posed by rural electrification are by no means facile. It involves supplying power to sites that have widely dispersed population. Inevitably, the cost of infrastructure increases as the site becomes more remote. Energy demand in these sites are generally low; payback period is long and uncertain. While the investment is highly profitable from a social point of view, the converse holds from private standpoint.

Yet promoting NRE is no less formidable as providing power to remote areas. Foremost, many NRE systems are uncompetitive to grid power and diesel generators that benefit from various tariff support and investment incentives. Even when the NRE system is cost-effective on a life-cycle basis, the system requires large front-end investment. As most financing institutions still view NRE technologies as either unproven or non-commercial, it has been difficult to mobilize investment capital. Then there is often a lack of appreciation among end-users on the capabilities of NRE technologies. Utilities remain conservative in regard to small, decentralized and nonconventional technologies.

Matching rural electrification with NRE technologies may yet be the appropriate strategy to attain two elusive goals. The fact is NRE systems become increasingly competitive against conventional power source as the site grows farther from the grid. Not only is the cost of grid extension prohibitive, maintaining conventional power supply is impractical in the absence of technical support. Moreover, modularity and ease of maintenance are characteristic of NRE systems that make them suitable choice for deployment in rural areas.

This report probes the prospects of deploying NRE systems to achieve the goal of rural electrification. In particular, it inquires on the market environment for NRE systems, the fiscal incentives afforded to investors, and the investment, operation and maintenance costs of the systems. It assesses the potentials for off-grid rural electrification of four NRE technologies, namely solar, wind, hydro and biomass. The report concludes with a prognosis on the prospects of utilizing NRE technologies in the Philippines in view of pending reforms in the electricity sector.

1.1 NRE Installations in the Philippines

NRE installations in the Philippines have reached close to 46,000.[1] Of this number, only 5,822 systems or 12 percent are designed to generate electricity. Photovoltaic systems are concentrated in Region VIII, while Region III has the largest number of wind energy installations. Close to half of small hydro systems are in the Cordillera Region. Biomass systems, specifically biogas,

[1] This is based on NESCON data and an ad hoc survey conducted by SATMP involving NRE suppliers and organizations. NESCON is the most comprehensive available database on NRE energy installations in the Philippines. It was last updated in October 1999. The SATMP survey was undertaken between March-April 2001 to obtain information on installations after the last NESCON date.

biomass-fired boilers and gasifiers, are represented in all regions, but most installations can be found in Regions III, IV, VI and VII.

Table 1.1
NRE Installations for Off-grid Rural Electrification
As of 30 April 2001

Region	Photovoltaic[1, 2]	Wind Turbine & Pumps	Small Hydro	Biomass[3]
CAR	807	6	68	20
I	217	20	2	22
II	312	7	8	21
III	81	117	3	112
IV	598	9	6	81
V	126	2	7	9
VI	502	52	14	82
VII	301	24	12	71
VIII	1,035	2	5	17
IX	16	6	6	25
X	53	1	8	19
XI	224	6	4	46
XII	16		3	4
XIII	142			28
ARMM	420	2	1	12
Total	**4,850**	**254**	**147**	**571**

[1] *Excludes solar dryers and solar heaters.*
[2] *Excludes NEA-GTZ PV systems scheduled for installation in year 2001, but unreported to date.*
[3] *Includes only biogas, biomass-fired boiler and gasifiers, as of 30 September 1999.*
Source: NESCON, Survey returns.

On the province-level, Eastern Samar, Lanao del Sur, Abra and Kalinga-Apayao have the most number of photovoltaic installations. Biomass-fired dryers are more popular in Surigao del Norte, Misamis Occidental, Misamis Oriental, Agusan del Norte and Lanao del Norte. The largest concentration of small hydro facilities is in Benguet, having a total of 101 installations. Ilocos Norte, Batanes and Iloilo are favorite sites for wind turbines. **Annex I** shows the distribution of NRE installations in the Philippines by region and province.

Various studies have confirmed the enormous energy resources in the Philippines that may be harnessed for power generation. The wind mapping study of the DOST-PCIERD, PNOC and Winrock International reveals that 76,000 MW may be tapped from wind resource. The Department of Energy estimates that about 888 mini-hydro facilities may be installed in various parts of the Philippines to generate 1,784 MW of electricity. On biomass, the WB/ESMAP study indicates that 60 to 90 MW may be generated from grid-connected sugarcogen facility, and another 40 MW from rice residues.

The proliferation of NRE systems is an offshoot of a number of public and private initiatives. The biggest to date is the Rural Photovoltaic Electrification (RPE) program of the National Electrification Administration (NEA). Since its launching in 1992, the RPE program is responsible for installing 2,454 solar home systems and 195 battery charging stations nationwide. NEA is also involved in installing small hydro facilities; 15 mini-hydro power plants have been constructed to date, with an aggregate capacity of 21.2 MW. For year 2000-2009, NEA has allotted P60 billion to its rural electrification program, of which P5 billion is committed to NRE.

Since 1997, the Department of Interior and Local Government has been managing a community-based program dubbed Municipal Integrated Social Development Project (MISDP) that deploys solar energy packages to meet the infrastructure needs in rural areas. The first phase of the program has installed 1,145 solar facilities in selected provinces in Visayas and Mindanao. Another 4,663 solar packages are targeted for the second phase that slated to begin in year 2002.

In December 1999, the Department of Energy launched a five-year drive to energize all barangays in the Philippines. The inaugural year saw 64 projects implemented; 17 micro-hydro, 3 hybrid and 40 solar facilities were installed.

NRE projects are still unattractive as financing proposition, but a few financing windows are open. One such window is being managed by the Development Bank of the Philippines. The project called "Financing Energy Services for Small-Scale End Users"(FINESSE) extends loans for small hydro, solar, wind and biomass energy projects. The Netherlands Government through the United Nations Development Programme (UNDP) provides the funds in the form of Official Development Aid (ODA). Among the projects funded by the program are the 100 solar home systems in San Pascual, Masbate; 1.5 MW mini-hydro plant in Matling, Iligan, Lanao del Sur; solar PV project in Palawan; and 500 kW minihydro in Dinagat Island, Surigao del Norte.

The Decentralized Energy Systems (DES) Project, managed by the Philippine National Oil Company-Energy Research and Development Center, is another financing window. DES aims to commercialize selected decentralized energy systems by providing financial assistance to entrepreneurs and private organizations. Funding support comes from the European Union. To date, DES has awarded loans to 15 NRE projects, of which 11 are biomass systems.

1.2 Fiscal and Non-fiscal Incentives for NRE Projects

The government's commitment to renewables has been marked by a series of policy pronouncements and laws aimed at promoting awareness and creating a market for NRE systems. A review of these edicts follows.

1.2.1 P.D. 1068

Efforts to develop NRE dates back to the pre-War years, but these were mostly ad hoc and uncoordinated. An earnest attempt by the government to spur investments in renewables began with the promulgation of Presidential Decree (PD) 1068 in 1977. PD 1068 directed the acceleration of research, development and utilization of non-conventional energy resources. Two of its most important provisions pertain to granting of incentives and allowing private sector participation in energy generation.

Among the incentives provided by PD 1068 include: (i) capital & organizational expenses chargeable to expenses and deductible from gross income in the year incurred; (ii) **e**xemption from duty and compensating tax of importation of capital equipment; (iii) high priority in financing assistance from GFIs.

The decree also directed the Energy Development Board to develop and implement specific programs requiring the participation of the private sector. This provision presaged the Build-Operate-Transfer Law of 1990 which would later provide impetus for private investments in infrastructure.

While PD 1068 laid the incentives for NRE projects, there were flaws in the implementation. One was the discretion given to Customs Examiners in interpreting whether an imported machinery, equipment or part was for tax and duty-free importation. Since many parts and components have multiple uses or applications, the burden of proving that the imports were to be used exclusively for NRE projects rested on the proponent. However, as a revenue-generating unit, the Customs Office was inclined to impose the tax; appeals were seldom heard. Thus, the proviso that allowed for duty-free importation of parts and components was not enforced. In the same vein, NRE project financing was hardly given priority by GFIs; the requirements to present collaterals and proof of project viability hampered the chances of NRE projects from accessing the funds of GFIs. It would be noted that the same problems constrain recent NRE policies from stimulating investments.

1.2.2 EO 226 Omnibus Investment Code of 1987 as Amended by RA 7918

The Omnibus Investment Code provides a set of incentives to spur investments in identified key sectors of the economy. NRE investors can claim entitlement to these incentives, having qualified in what the Code defines as a pioneer enterprise. Specifically, an enterprise may qualify for pioneer status if, among others, "it produces non-conventional fuels or manufactures equipment which utilize non-conventional source of energy or uses or converts to coal or other non-conventional fuels of sources of energy in its production, manufacturing or processing operations."[2]

As a pioneer enterprise, the investor can avail of the following:

- *Income Tax Holiday.* Qualified pioneer enterprises are exempt from payment of income taxes for 6 years from commercial operation. The exemption may be extended by another year if the project utilizes indigenous raw materials at rates set by the Board of Investments.

- *Additional Deduction for Labor Expense.* During the first five years of registration, an enterprise that expands its employment may claim additional deduction from taxable income equivalent to 50% of the wages corresponding to the increment in direct labor hired. If the project were located in a less developed area, the additional deduction may be doubled.

- Expansion expenses can be deducted from taxable income in proportion to such expansion, but enterprises that are availing of such privilege cannot claim additional deduction for incremental labor expenses incurred during such period.

- *Exemption from Contractors Tax.* Registered enterprises shall be exempt from contractors tax (equivalent to 10 percent VAT), whether national or local.

- *Simplified Customs Procedures.* Customs procedures for the importation of capital equipment and parts shall be simplified by the Bureau of Customs.

- *Unrestricted Use of Consigned Equipment.* Registered enterprises are not subject to restrictions on the period of use of such machinery, equipment and parts.

- *Employment of Foreign Nationals.* A registered enterprise may employ foreign nationals in supervisory, technical or advisory position for a period not exceeding five years from its registration.

[2] Art. 17, Chapter 1, Book 1 of The Omnibus Investment Code of 1987 as Amended.

- *Incentives to Less-Develop-Area Registered Enterprise.* An enterprise registered with the BOI and located in less-developed area shall enjoy pioneer status and be entitled to the incentives provided for pioneer enterprises. Off-grid NRE projects, by reason of their location, may avail of this privilege.

- *Incentives for Necessary and Major Infrastructure and Public Facilities.* All expenditures on necessary infrastructure related to project development may be deducted from the enterprise's taxable income, subject to BOI approval. Any amount not deducted for a particular year may be carried over for deduction in subsequent years not exceeding ten years. This would include expenses on access roads, bridges, communication facilities and the like.

Until 1997, pioneer enterprises can avail of tax and duty exemption on imported capital equipment and tax credit on domestic capital equipment. The latter pertains to the taxes and customs duties that would have been waived on the machinery, equipment and spare parts, had such items been imported. As part of the commitment to the Trade-Related Investment Measures (TRIMs) of the World Trade Organization, the BOI has to discontinue granting incentives related to capital equipment. It would be noted though that these incentives have been restored in the case of mini-hydro projects by virtue of RA 7156.

1.2.3 Mini-Hydro Power Incentives Act (RA 7156)

Cognizant of the significant contribution of hydropower to the country's goal of energy self-sufficiency, the government enunciated RA 7156 or the Mini-Hydro Power Incentives Act in 1991. While other NRE projects may invoke the Omnibus Investment Code to avail of incentives, mini-hydro projects are accorded special privileges through RA 7156. The law provides the following incentives:

- *Special Privilege Tax Rates of 2 percent* on gross receipts from the sale of electric power and from transactions incident to the generation, transmission and sale of electric power.

- *Tax and Duty-free Importation of capital equipment, materials and parts* within seven (7) years of the award, subject to certain conditions and with expressed approval of the DOE.

- *Tax credit (VAT+Duty) on Domestic Capital Equipment.* Local purchases of capital equipment shall be eligible for tax credit equivalent to 100% of the customs duties and value added tax had such items been imported, subject to certain conditions.[3]

- *Special Realty Tax Rates on Equipment & Machinery*. This limits the rate of realty tax that can be imposed on mini-hydropower developer to not more than 2.5 percent of the original cost of machinery and equipment.

- *VAT Exemption on gross receipts from electricity sales.* Gross receipts derived from the sale of electric power, whether through NPC grid or existing utility lines, shall be exempt from the VAT.

[3] Availing of this incentive is often mired by the problem of demonstrating that the imported equipment is equivalent to domestic capital equipment.

- *Income Tax holiday for seven years.* RA 7156 explicitly provides for seven years tax holiday for mini-hydro projects, compared to the six year income tax holiday provided by the Omnibus Investment Code.

- *Exemption from Contractors Tax.* Registered enterprises shall be exempt from contractors tax (equivalent to 10 percent VAT), whether national or local.

The term of contract with mini-hydropower developers is for a period of 25 years, which may be extended another 25 years. The developer must first offer to sell electric power to the NPC, franchised private electric utilities or cooperatives at price equivalent to the utility's avoided cost, *i.e.*, the costs had NPC generated the equivalent power itself. The NPC will also provide wheeling privilege to mini-hydro developers for them deliver power to their customers.

If the contractor commits to develop less than 50 percent of the hydroelectric power potential of a site, the contract shall be non-exclusive. NPC may grant the right to develop the full potential of the site to another qualified developer if the existing developer relinquishes his right of first refusal. In this case, the first developer will be reimbursed by the successor-developer for the value of his investments, which would be based on the declared value of the development for real estate tax purposes for the last three years.

The Act also provides that Official Development Assistance can be availed by the private sector for mini-hydro electric power projects without the need to pass through the evaluation process set by the National Economic and Development Authority (NEDA) Board.

1.2.4 EO 462 as Amended by EO 232

While RA 7156 accorded special privileges to mini-hydro power projects, the intent of Executive Order (EO) 462 is to provide the same for ocean, solar and wind (OSW) technologies. Promulgated in 1997, EO 462 elicits private sector participation in the exploration, development, utilization and commercialization of ocean, solar and wind energy resources for power generation and other energy uses. However, the law covers only OSW energy generation exceeding 1 MW. The private sector is made to enter into a production sharing contract with the DOE after due consultation with the host communities and local government units (LGUs) concerned, through public bidding or negotiation.

In 1999, EO 232 amended EO 462 and provides specifically that production sharing contracts shall be applied to projects satisfying two criteria: (i) that it harnesses OSW resources in lands of the public domain and/or offshore waters within the Philippine territory, contiguous zone and exclusive economic zone; (ii) that it has a net electric power output of more than 1 MW for sale to an electric utility. Projects that do not meet the above criteria shall be considered a private endeavor, hence exempted from the requirement of entering into production sharing contract with the government. OSW energy generation of more than 1MW in private lands and privately-held offshore shall also be regulated by the DOE using existing accreditation system for power plants. Generation projects of 1MW or less shall be regulated by the local government concerned according to local energy plans approved by the DOE.

EO 232 strengthened the set of incentives to OSW developers by directing the DOE to extend assistance to OSW developers in obtaining all applicable fiscal and non-fiscal incentives, including registration as pioneer industry with the BOI. In addition, OSW developers can charge the cost of assessment, field verification and feasibility studies on other sites to their current commercial projects. They can also secure access to land and/or offshore areas where OSW energy resources can be harnessed.

1.2.5 Agriculture and Fisheries Modernization Act of 1997 (RA 8435)

Section 109 of the Act provides trade and fiscal incentives to agriculture and fisheries projects for a period of five years from the promulgation of the Act. Such incentives allow duty-free importation of machinery and equipment including renewable energy systems such as solar panels, provided such equipment is for the exclusive use of the importing enterprise.

1.2.6 Build-Operate-Transfer Law (RA 6957, July 1990; amended by RA 7718, May 1994)

This law aims to mobilize private sector resources in financing the construction, operation and maintenance of infrastructure and development projects such as power plants, hydropower projects, water supply, etc. Project proponents are authorized to charge reasonable fees, tolls and rentals for the use of the project facility based on a reasonable rate of return. Projects costing more than one billion pesos are included in the year 2000 Priority Investment Areas and are entitled to incentives provided in the Omnibus Investment Code. This law provides a route for NRE projects to qualify for investment incentives of the BOI. The Masbate wind farm is reportedly being pursued under this scheme.

1.2.7 Clean Air Act of 2000 (RA 8749)

The Act sets emission standards on stationary and mobile sources of greenhouse gases, including power plants. NRE projects are favored to the extent that some of its technologies, such as photovoltaics, have zero emissions. But the Act imposes outright ban on incineration facilities. This may have adverse impact on biomass combustion facilities. Accordingly, the combustion process should be made to attain a very high temperature level for the combustion to be completed and the system to be free of emission.

1.2.8 NIPAS or National Integrated Protected Areas System Act of 1992 (RA7586)

Some areas in the Philippines have been declared protected, thus construction of NRE projects in these sites would require special permit. The Department of Environment and Natural Resources (DENR) issues the Environment Compliance Certificate to all projects that have impact on the environment. For NRE projects that are to be located in areas considered ancestral domain, the proponent must secure permits from the indigenous communities.

1.2.9 DOE Circular No. 2000-03-004

The Circular amends the IRR of EO 215 on "Private Sector Participation in Power Generation" as amended by Circular No. 97-01-001. The amendments relevant to NRE development are the following:

(i) Companies do not have to show a 5-year track record to receive accreditation for NRE generation facilities, provided that the commercial status of the technology has been established and is locally adaptable, or if the project is for self-generation purposes.

(ii) Spinning reserve is required on NRE projects that will be connected to the backbone grid. This is will be evaluated on a case-by-case basis. NRE projects on small grids are not covered by the requirement.

(iii) Thermal efficiency requirement for cogeneration facilities using NRE has been removed.

(iv) Renewable resource power production facilities are exempt from 10-year power purchase requirement and are only required to demonstrate potential net foreign exchange savings.

(v) For projects that supply electricity to a designated utility or user, the power development plan review and approval requirements of the Department of Energy have been dispensed.

1.2.10 DOE Circular No. 2000-10-011

To accelerate the implementation of the Rural Electrification Program, this Circular instituted summary procedures in the approval and subsequent release of the electrification fund to the franchised distribution utility or project implementor. Moreover, Section 2f of the Circular specifies that the electrification of target areas should be accomplished in the least-cost possible manner, which implies adoption of conventional line design or utilization of indigenous or renewable energy sources as may be optimal.

1.2.11 DOE Circular No. 2000-03-003

The Circular amends the 1994 DOE regulation that prescribes the provision of direct benefits to local government units hosting energy resource development projects and/or energy-generating facilities. The amendments streamlined provisions concerning allocation of fund and generation of livelihood projects. Section 7 of the Circular also provides that in cases where the grid type is deemed unavailable for energizing a particular local government unit, the electrification fund may be redirected by the DOE in favor of utilizing NRE system to speed up the electrification of the area.

1.2.12 Electric Power Industry Reform Act

The passage of the Electricity Power Industry Reform Act 2001 is expected to boost the NRE program of the government. This may be gleaned from the Act's Declaration of Policy which states that it is the State policy to promote the utilization of indigenous and new and renewable energy resources in power generation in order to reduce dependence on imported energy.

Two specific provisions of the Act favor NRE systems. First, Section 34 provides the imposition of universal charge on all electricity end-users to be used for missionary electrification, and equalization of taxes and royalties applied to indigenous or renewable sources of energy *vis-a-vis* imported energy fuels. In addition, an environmental charge of P0.0025/kWh will be levied and used solely for watershed rehabilitation and management. Another provision is Section 35 which empowers the President of the Philippines to reduce the royalties and taxes collected from the exploitation of all indigenous sources of energy to effect parity of tax treatment with existing rates for imported coal, crude oil, bunker fuel and other imported fuels.

Apart from these specific provisions, major reforms in the power sector are likely to have indirect effects on NRE projects. In particular, the new law provides that the power generation sector shall be considered a public utility operation. As such, any person engaged in power generation and supply of electricity shall not be required to secure a local or national franchise. Moreover, the new law eschews regulation of electricity prices charged by the generators upon implementation of retail competition and open access. Sales of generated electricity is also to be exempted from value-added tax. While these provisions apply generally to all power generators, these provisions are aimed at reducing the cost of generating power, and eventually the price of electricity to users.

1.3 Financial Implications of Fiscal Incentives

From an investor's standpoint, the incentives afforded to NRE projects are relevant to the extent that they impact on the finances of the project. Specifically, the incentives should be able to reduce the large investment cost that is often regarded a major hurdle in curving a niche for NRE in the rural market. Moreover, NRE projects must be able to realize returns comparable with other investment opportunities. Of course it is not fair to stack up NRE simply against any other business opportunity, since the more important returns from NRE investments actually accrue to the environment. An accurate comparison requires one to impute the costs on the environment of alternative investments. This, however, is beyond the scope of this report. Nonetheless, the financial returns on NRE projects should be reasonably attractive, at least to investors who would inherently place premium on the environment to favor NRE.

There is also interest in minimizing the levelized cost of power. Here again, it is inappropriate to compare cost per kW of NRE systems with grid electricity prices, especially since grid extension is not only prohibitive, but also in some cases, technically infeasible. But the costs of NRE generated power must be able to spur economic activity in the host community.

Except for fiscal incentives, many NRE policies are difficult to translate in monetary terms. Thus the financial impact can only be assessed for a few incentives that have direct impact on the investor's income statement. Then again, what can be legally availed may actually be redundant or difficult to implement in practice. A case in point is the tax credit on domestic capital equipment to which NRE investments are entitled by virtue of the Omnibus Investment Code. The tax credit applies to locally fabricated capital equipment that otherwise would have been imported. In practice, this provision is hardly availed since no clear criteria has been set to determine if a locally fabricated equipment is an "equivalent" of an imported equipment. The matter is often left to the discretion of tax and customs authorities.

A similar problem applies when an investor attempts to avail of exemption from taxes and duties on imported parts that are used in the NRE system. Hitherto, only solar panels have been exempted from tariffs. Other major components of the NRE systems are still levied tariffs between 3 to 20 percent. **Annex II** presents a schedule of import duties imposed on major parts and equipment that are used in the NRE system. To claim relief from these duties, the investor has to convince the tax authority that the components are to be used exclusively in the system. By no means is this an easy feat; it can be costlier than paying the corresponding duties.

Notwithstanding the problem of implementation, it is still a worthwhile exercise to determine the potential impact of the policies on the financial portfolio of NRE investors. A simulation exercise is undertaken for minihydro and gasifier projects.

Four measures are used to assess the financial impact of the fiscal incentives, namely, investment cost per kW, payback period, internal rate of return and levelized cost of generated electricity. The first measure can be obtained straightforward by dividing the front-end costs of the system by its capacity. Payback period is the number of years necessary to generate an income stream sufficient to cover for the investment cost of the system. The economic internal rate of return (IRR) is the interest rate realized from the income stream generated by the system. Finally, the levelized cost discounts the costs of installation, operation and maintenance of the system over its lifetime, and allocating such costs to the output of the system. A capital recovery factor of 12 percent is assumed. Loans related to the investments in the system are also assumed to carry an interest rate of 12 percent, payable over a 15-year period.

1.3.1 Fiscal Incentives on Mini-hydro Projects

The financial impact of some of the major provisions in the Mini-Hydro Power Incentives Act are simulated on a prospective 550-kW mini-hydro facility in Loreto, Dinagat Island, Surigao del Norte. The relevant provisions are:

(i) Special privilege tax rate of 2 percent on gross receipts;
(ii) Tax and duty-free importation of capital equipment, materials and parts;
(iii) A ceiling of 2.5 percent on special realty tax rate on equipment and machinery;
(iv) VAT exemption on gross receipts from electricity sales; and
(v) Income tax holiday for seven years.

The simulation is based on the following assumptions:

(i) The electro-mechanical equipment is imported and levied 3 percent tariff and 10 percent value-added tax.
(ii) The electricity generated by the system can be sold at P4 per kWh;
(iii) Annual electricity generation is 3,018 MWh.
(iv) The cost of equipment and civil works will be financed by a loan carrying an interest rate of 12 percent and payable in 15 years.

Table 1.2 presents the results of the simulation. Fiscal incentives reduced the investment cost by 4 percent; nearly doubled the internal rate of return; shorten the payback period by 3 years; and lowered the levelized cost of power by 3.6 percent. Indeed, the fiscal incentives enhanced the financial profile of the project.

Table 1.2
Impact of Fiscal Incentives on 550-kW Mini-hydro System
(*in pesos, unless otherwise stated*)

	Without Incentives	With Incentives
Investment Cost		
Imported equipment (CIF price: US$269,563)	15,308,921	13,511,845
Civil works	30,126,384	30,126,384
Total	45,435,305	43,638,229
Investment cost per kW	82,610	79,342
Internal rate of return (%)	6.46	12.81
Payback period (*years*)	11.89	8.87
Levelized cost per kWh	3.92	3.78

1.3.2 Fiscal Incentives on other NRE Projects

As discussed in Section 2, the relevant set of incentives for other NRE installations not covered by RA 7156 is found in the Omnibus Investment Code. However, except for income tax holiday, the other incentives have only indirect impact on investment cost, hence difficult to quantify.

The basis of simulation is a 250-kW gasifier, consisting of an imported BG-System Equipment. Since Code has lifted the tax exemption on capital equipment, a 3 percent import tax and 10 percent value-added tax will be paid on the imported gasifier. It is assumed that the generated electricity may be sold at P6 per kWh.

From Table 1.3, the fiscal incentives raised the internal rate of return by 22 percent and advanced the payback period by 1.5 years. The investment and levelized energy costs are not affected.

Table 1.3
Impact of Fiscal Incentives on 250-kW Gasifier
(*in pesos, unless otherwise stated*)

	Without Incentives	**With Incentives**
Investment Cost		
Imported equipment (CIF price: US$214,500)	12,181,804	12,181,804
Civil works	1,430,000	1,430,000
Total	13,611,804	13,611,804
Investment cost per kW	54,447	54,447
Internal rate of return (%)	4.84	5.93
Payback period (*years*)	12.89	11.26
Levelized cost per kWh	6.60	6.60

1.4 Plan of Work

In light of the fiscal incentives afforded to NRE projects and the renewed thrust of the government in rural electrification, the succeeding chapters evaluate the technical and economic potentials of the different NRE systems. For each of these systems, namely, biomass, wind, hydro and solar, the different applications are described. Instructive experiences on current and past installations, as well as government promotions and initiatives on specific technologies are examined.

The main contribution of this study is an assessment of the economic viability of these various systems. In particular, the life-cycle costs of each of the applications are appraised. Biomass systems emerge as the most economically viable, followed by small hydro systems. Given the present state of technology, PV systems would require enormous subsidies if they have to be utilized. The fact however is that among the renewable technologies, PVs are the most flexible and easiest to deploy. Thus, in many instances, PVs are regarded the most viable option in supplying power to rural masses.

BIOMASS ENERGY SYSTEMS

Biomass is a versatile source of energy; it can produce electricity, heat or fuel for transportation and is storable. Production units can vary from small scale up to multi-megawatt size. It is estimated that biomass constitutes the world's fourth largest energy source today and contributes at least 14 percent of the world's primary energy demand. In developing countries, biomass contribution represents at least 35% of primary energy supply. In more developed economies such as the European Union, biomass contribution ranges from 2 to 14 percent.[1]

The Philippines has abundant agricultural residues that are suitable for power generation. The EC-ASEAN COGEN Programme estimated that the volume of residues from the rice, coconut, palm oil, sugar and wood industries at 16 million tons per year. Bagasse and coconut husks and shell can contribute at least 12% of total national energy supply. The World Bank Energy Sector Management Assistance Program estimated that residues from sugar, rice and coconut could produce 90 MW, 40 MW, and 20 MW, respectively, of excess power for export to the grid.[2] Rice husk, has been found by Agrilectric of the United States, of capable of generating one kilowatt for every kilogram of rice husk burned. This is made possible by improving burning efficiency in which rice husks are ground or pulverized and fired as powder fuel.[3]

The Philippine Energy Plan, 1999-2008 envisions the aggregate biomass fuel supply potential to grow from 247.9 MMBFOE in 1999 to 301.5 MMBFOE in 2008, or annual growth rate of 2.2 percent. Bagasse is projected to account for almost half of NRE contribution for commercial/industrial sector. Municipal solid waste is expected to provide 10MW in 2005 and 50 MW in 2008.

Table 2.1
Biomass Fuel Supply Projections
In Million Barrels of Fuel-Oil-Equivalent, MMBFOE

	1998	**1999**	**2004**	**2008**
Rice Residues	7.5	7.7	8.7	9.6
Coco Residues	22.9	23.2	24.8	26.2
Bagasse	17.8	18.1	20.0	21.6
Woodwastes	83.2	84.7	92..1	97.7
Animal Wastes	12.1	12.2	12.8	13.4
Municipal Wastes	98.7	101.9	119.1	133.1
Total	**242.1**	**247.9**	**277.6**	**301.5**

Source: Philippine Energy Plan, 1999-2008

[1] EUREC Agency, *The Future for Renewable Energy, Prospects and Directions.* Section 2.1 draws heavily from this source.
[2] Trade Guide on Renewable Energy in the Philippines, p.7.
[3] Society for the Advancement of Technology Management in the Philippines, *Can the Philippines Become an Energy Exporter by the Year 2020?*. Roundtable discussion on Energy, Monograph Series No. 97-01, p. 32.

2.1 Technology, Materials and Processes

The primary biomass materials include: (i) short rotation forestry (e.g., ipil-ipil) ; (ii) wood wastes(e.g., saw dusts); (iii) sugar crops (e.g., bagasse) ; (iv) starch crops; (v) herbaceous lignocellulosic crops; (vi) oil crops; (vii) agricultural wastes (e.g., rice hull); (viii) municipal solid wastes and refuse; and (ix) industrial wastes.

Figure 2.1 provides an overview of the different materials, processes and end-products from biomass. For purposes of producing electricity, there are four alternative processes, namely, combustion, gasification, pyrolysis and anaerobic digestion. Other processes such as fermentation and extraction can produce liquid biofuels that may be used to run engines. The conversion involves three main processes: thermochemical (combustion, gasification, pyrolysis, liquefaction), chemical (esterification) and biochemical (acid hydrolysis, enzyme hydrolysis, fermentation) processes.

2.1.1 Thermal Conversion

Combustion can be defined as the direct burning of biomass to produce heat that can be used directly (heating or drying) or indirectly (steam turbine) transformed into electrical energy. The amount of heat produced depends on the humidity of the biomass source, the level of excess air required and the degree to which the combustion process is accomplished. Present combustion technology is considered well advanced allowing for various industrial applications. Developed economies view future developments towards large combined heat and power plants. In the Philippines, rice hull, as an abundant biomass resource, has been the subject of several development initiatives. In view of the scattered distribution of the resource, however, the scope of applications has remained limited.

Rice hull thermal conversion processes may be classified into three major process types: (i) direct combustion; (ii) gasification; and (iii) pyrolysis. In the direct combustion process, rice hull is burned in a furnace to produce steam (in a boiler) for use in running a steam engine or a steam turbine, which, in turn, can drive an electric generator. In gasification and pyrolysis, rice hull is converted into combustible gas to fuel internal combustion engines (diesel or gasoline types). The thermal conversion occurs inside a reactor containing the rice hull. In gasification, air is utilized as an oxidant medium of conversion in order to facilitate production of combustible gas. Pyrolysis is done without an oxidant. It is a more energy intensive process, and the gas quality produced is better. The latter process produces liquid and solid (charcoal) by-products. The liquid portion contains methanol, acetone and other organic acids.

Direct Combustion

Not all the heat released by direct combustion of rice hull is absorbed by the water in a boiler; the efficiency is normally between 50% and 90%. If used for power generation, the efficiency can go down to about 20%, albeit this could be improved under a cogeneration scheme where the spent steam can be used for other applications such as drying of palay.[4]

In a direct combustion process, boilers are primordial components of the system. There are two types: boilers with fixed or travelling grates; and boilers with fluidized bed. The first type is

[4] A system installed in Denmark burns 5.3 tons of barley straws to produce 5.1 MW of electricity and 46800 MJ/hr of heat for domestic heating. Cogeneration increased efficiency to 85% from 22.5%.

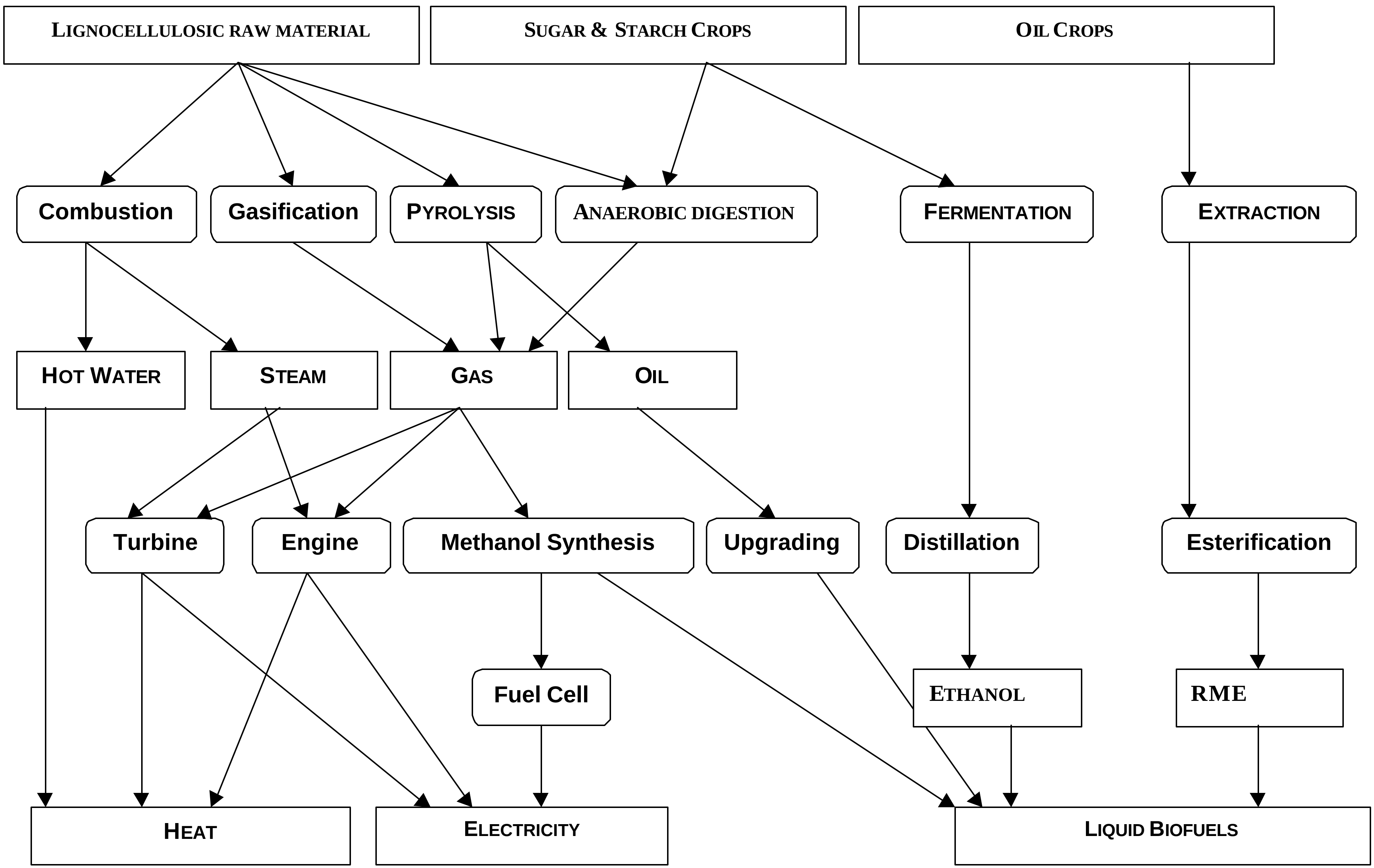

Figure 1. Overview of Processes from Biomass to End-Products

Source: EUREC Agency (1996), *The Future for Renewable Energy: Prospects and Directions*, p.19.

common; they range from household boilers to large scale 50 MW industrial furnaces. They accommodate combustible materials of varying humidity values and granulity. However, these types of boiler do not adapt readily to variations in load. In a fluidized bed boiler system, fluid is passed upward through a bed of solids with a velocity high enough for the particles to separate from one another and become freely supported in the fluid.

Boilers can be further classified as water-tube boilers and fire-tube boilers. Water-tube boilers are more complicated to operate since more rigid treatment of feed water is required. Fire-tube boilers are relatively cheaper, simpler, easier to maintain and thus more practical for rice millers. The steam produced by these boilers is fed into a steam engine or steam turbine, which then is coupled to an electric generator.

Gasification

This process is characterized by incomplete combustion of a solid and gas, where a mixture of combustible gases is diluted in nitrogen (except when gasification is performed with oxygen). The combustible gas components are mainly carbon monoxide and hydrogen [collectibly called producer gas] with traces of hydrocarbons such as methane. These gases could be generated either through a fixed-bed (updraft or downward gasifier) or a fluidized bed gasifier. Downdraft gasifier produces cleaner gas than the updraft unit, and thus is more suitable for internal combustion engines.

One major problem is the use of producer gas is in the elimination of tar that may damage the engine. To address this problem, an elaborate gas clean up system involving scrubbers, cyclones, tar condensers, water scrubbers and packed bed filters is usually employed.

Pyrolysis/Carbonization Process

Pyrolysis is a process of decomposition through the effect of temperature in the absence of oxygen. The products obtained by pyrolysis of lignocellulosic matter are: solids (charcoal), liquids (pyrolysis oils) and a mix of combustible gases. The proportion of each of the products depends on the reaction parameters, i.e., the temperature, heating rate and residence time of the process.

There are major R&D initiatives on the production of pyrolysis oils, which have the advantage of being easier to handle than the starting biomass and have a much higher energy density. It is estimated that up to 80% weight liquid may be obtained from biomass material through fast or flash pyrolysis at moderate reaction temperatures. These liquids, also referred to as bio-oils or bio-crudes, are intended to be used in direct combustion in boilers, engines or turbines. However, bio-fuels contain unwanted characteristics such as poor thermal stability and heating value, high viscosity and corrosivity.

2.1.2 Chemical Processes

Esterification

Esterification is the chemical modification of vegetable oils into oil esters that can be used as biofuels in engines. Oils are extracted from oil crops, e.g., rapeseed, coconut, sunflower, and made to undergo esterification to adapt the vegetable oil to the requirements of diesel engine. The introduction of alcohol and a catalyst (sodium hydroxide or potassium hydroxide) eliminates glycerides. Methyl esters are formed when methanol is used while ethyl esters are formed if ethanol is used. It is estimated that 1 ton of methyl ester can be produced from 3 tons of rape seed.

2.1.3 Biological/biochemical Processes

Biological processes include anaerobic digestion, acid and enzyme hydrolysis and fermentation. Anaerobic digestion of wastes to produce methane is a mature technology for waste treatment. Methane can be used for direct burning or for internal combustion engines. A kilo of dry solids can produce 0.2-0.3 m^3 of biogas.

The main product from acid and enzyme hydrolysis, fermentation and distillation is ethanol. Ethanol can be used as fuel for engines either in its pure form or in mixture with gasoline. The technology for acid hydrolysis, fermentation and distribution are already in commercial stage, especially for sugar and starch substrates. Acid and enzymatic hydrolosis of cellulosic substances still need strong R&D support.

2.2 Biomass Installations and Development Initiatives

Biomass constitutes the largest NRE systems installations in the Philippines. In 1999, out of the 42,872 operating NRE installations, 40,735 (95%) are biomass systems. This represents a modest growth of 10% over 1998 installations, and constitutes 99.91% of NRE energy in terms of fuel oil equivalents (MMBFOE). In 1999, biomass was estimated to contribute 70.27% MMBFOE in the NRE sector, and further forecasted to grow to 88.84% by year 2008.[5] While the contribution of biomass to energy generation has been substantial, utilizing biomass for generating electricity remains on the R&D and demonstration phases.

Table 2.2
Installations of Biomass Systems in the Philippines

System	Units
Biogas	374
Biomass-fired Boilers	177
Gasifiers	19
Cookstove	4,720
Biomass-fired Dryers	14,958
Biomass-fired Furnace	18,378
Other Biomass	2,109
Total	**40,735**

Source: NESCON.

In terms of capacity, 19 operating gasifiers have aggregate capacity of 307 Hp; 307 biogas digesters have a combined 4,728 cubic meters of digester capacity, and 177 operating biomass-fired boilers are capable of generating an estimated 30,535 kW energy.

[5] Quejas, Reuben E.T. *Philippine Renewable Energy Policies and Opportunities for Development.* International Workshop on Energy Efficiency, Cebu City, 21-22 June 2000.

Table 2.3
Operating Biomass Energy Systems in the Philippines
By region, 1999

	Units	Capacity
Biogas system		
CAR	22	96.8
I	20	80.6
II	19	92.0
III	105	552.3
IV	67	249.2
V	7	44.5
VI	16	186.1
VII	49	191.9
VIII	5	1.1
IX	24	67.5
X	9	84.5
XI	27	3,065.5
XII	1	0.3
XIII	1	15.0
ARMM	2	0.6
Total biogas systems	**374**	**4,727.9 cu m**
Biomass-fired boilers		
I	1	-
II	2	111.3
III	6	1,179.1
IV	14	5,168.9
V	2	-
VI	63	10,342.8
VII	22	2,761.6
VIII	8	740.0
X	10	447.4
XI	18	5,646.6
XII	2	604.0
XIII	27	3,433.7
ARMM	2	100.0
Total biomass-fired boilers	**177**	**30,535.5 kW**
Gasifiers		
III	1	8.9
VI	3	71.5
VIII	4	215.0
IX	1	7.4
XI	1	0.0
XII	1	0.3
ARMM	8	3.5
Total gasifiers	**19**	**306.7 Hp**
Total biomass installations	**570**	

Source: NESCON.

Table 2.3 provides the regional breakdown of operating biomass Systems. Central Luzon (Region III) has the most number of biogas installations, 105 units, but Davao (Region XI) have the largest capacity, 3,065 cu.m. For biomass-fired boilers, the installations are concentrated in

Western Visayas (Region VI) that has 63 units, accounting for total capacity of 10,342 kW. This could be traced to the presence of sugar mills in the area that utilize bagasse as fuel. For gasifiers, Region VIII or Eastern Visayas has the largest operating capacity at 215Hp.

Two-thirds of biogas systems uses manure; they account for 41 percent of installed capacity. The other biogas systems use industrial wastes. For biomass-fired boilers, bagasse, coconut and woodwaste are the common fuel used. The characteristics of typical biogas, biomass-fired boiler and gasifier in the Philippines are presented in the following tables.

Table 2.4
Average Configuration of Operating Biogas System
By fuel type

	Manure (237 installations)	**Industrial Waste** (137 installations)
Total digester capacity (cu. m.)	158.7	77.2
Years in operation	12.2	9.6
Operating hours per day	1.7	1.4
Operating days per year	105.0	94.7

Source: NESCON.

Table 2.5
Average Configuration of Operating Biomass-fired Boilers
By fuel type

	Bagasse (98 installations)	**Coconut** (22 installations)	**Woodwaste** (48 installations)
Rated output (kW)	200.2	160.4	140.6
Ann. energy generated (kWh)	878,761.2	78,444.4	0.5
Biomass used per day (tonnes)	1,071.5	182.3	173.1
Operating days per year	127	166	120

Source: NESCON

Table 2.6
Average Configuration of Operating Gasifiers
By fuel type

	Charcoal (6 installations)	**Coconut** (6 installations)	**Other Biomass** (7 installations)
Rated capacity (Hp)	37.4	0.4	11.4
Gas output (cu m/kg)	18.3	1.8	9.9
Fuel input (kg/hr)	130.2	45.8	138.9
Operating hours per day	8.3	15.3	7.0
Operating days per year	95.4	360.0	213.1
Years in operation	8.8	11.0	8.2

Source: NESCON.

The Biomass Atlas

The development and publication of the *Biomass Atlas of the Philippines* is a significant milestone towards rationalizing biomass development in the Philippines. The *Atlas* is a consolidation of biomass resource data that converts various information into a convenient form for analysis and project development.

Developed by the Philippine Biomass Energy Laboratory of the University of the Philippines Los Banos, with the support of the USAID and the Philippine DOE, the Atlas identified major production regions for six biomass resources, namely: rice hull, bagasse, coconut residues, animal manure, forestry wastes and urban refuse. The main feature of the Atlas is the development of Geographic Information System (GIS)-based maps (regional, provincial & municipal) that could be linked to automated programs of the US National Renewable Energy Laboratory. Moreover, the processing centers that can serve as point sources of biomass resources were identified using a differential global positioning system (DGPS). The use of DGPS provides a more accurate estimate of the biomass resource, transport distances and relevant costs. The database covers ten years starting 1990. Data validation included ground verification, hence a high confidence level can be placed on the resource estimates. Table 2.7 shows the breakdown of estimated biomass resource by region.

Table 2.7
Philippine Biomass Resources, 1999
In Metric Ton

Region	Rice hull	Bagasse	Coco shell	Coco husk	Coco coir
CAR	44.3			0.4	0.3
I	216.4		14.9	33.0	23.1
II	341.8	55,591.4	86.2	16.0	134.0
III	368.5	392,732.9	546.7	1.1	850.0
IV	241.5	521,779.1	65.0	740.3	101.1
V	144.0	74,836.3	7.2	252.9	11.2
VI	306.3	3,441,250.8	0.5	97.4	0.8
VII	41.7	687,724.0	333.1	136.9	518.2
VIII	101.3	183,257.9	114.2	509.6	177.7
IX	65.2		43.8	539.0	68.2
X	66.4	426,274.4	61.6	191.5	95.8
XI	136.2	135,649.9	229.3	1,214.9	356.7
XII	159.8	66,742.9	242.6	144.5	377.0
XIII	56.0		43.0	95.5	66.8
Philippines	**2,357.3**	**5,985,840.5**	**1,948.9**	**4,330.8**	**3,031.6**

Source: Biomass Atlas of the Philippines, 2000.

2.3 Major Biomass Installations

FBC--Asia Rattan Co., Inc.[6]

An example of Biomass combustion technology using Fluidized Bed Combustion (FBC) process is a project of the ASEAN-AAECP III Project on Energy from Biomass Residues. The FBC technology has been effectively demonstrated at the Asia Rattan Co., Inc. based in Angeles City, Pampanga. Asia Rattan claims that it is the only successful FBC in Asia; counterpart projects in Indonesia and Vietnam have remained non-operational. Asia Rattan's FBC technology is used for the production of combined heat and power utilizing biomass residues (sawdust, rattan shavings, woodblocks/chips). The boiler is rated at 130kWt (about 200kg/hr-steam rate @ 1 bar) using

[6] ASEAN-AAECP III Project—Energy from Biomass Residues, "Design Workshop I—Biomass Fired FBC CHP Plant Design", Philippines' Project.

sawdust and rattan chips as fuel. The FBC system is connected to the factory's process steam system which is used for drying of handicrafts, heat treatment of rattan and live steam heating of rattan bleaching. The small scale system costs P3.97million with a payback period of 2.15 years. It was meant to displace 230,400Kwh of electricity at a cost of P3.08/kwh.

A similar unit was fabricated by Asia Rattan with a higher rating of 300kWt (about 400 kg/h steam rate @ 10 bar) which is being used in another production line. However, power generation still awaits the replacement of the generator provided by Australia, which is rated at 440 volts instead of 220 volts. Asia Rattan is confident that electricity will be generated once the replacement arrives. This unit was estimated to cost P28.5 million with payback of 2.76 years and a yearly electricity savings of 2,304,000kwh.

2.3.2 Biomass Gasification—DA-Philrice

This rice hull gasification system has been proven useful for a wide range of applications (irrigation, grain milling and drying), as it produces an alternative fuel which can effectively substitute 100% of gasoline and 30-70% of diesel for running a spark ignited and compression ignition engine, respectively. Except for the addition of producer gas and combustion air mixer, no major modifications are needed to run these engines.

The PhilRice design is similar to the one being commercialized in India (Ankur Scientific Energy Technologies Pvt., Ltd.) and commercialized by BG Technologies (US). The original design was conceptualized by Dr. Valentino Tiangco, formerly of the International Rice Research Institute (IRRI) and now at the University of California at Davis. Indian researchers also worked in that lab, thus, the similarities in the design.

2.3.3 Communal Biogas System

A community-based biogas system can be found in a number of municipalities involved in hog and poultry farming in Batangas. In the four municipalities of Lemery, Ibaan, San Jose and Batangas City, the SIBAT (Sibol ng Agham at Teknolohiya) has identified 15 biogas operating units. The projects were introduced in 1993 through the collaboration of the municipalities and the Cavite State University-ANEC. Utilizing manure from hog and poultry farms, the system is used for cooking, heating and lighting. Most of the biogas are of the fixed dome model measuring 6-8 cu. meters and installed at costs ranging from P10,000 to P40,000. The largest unit (40 cu.m. fixed dome) operates in Lumil, San Jose in a 5000-7000 chicken farm and cost P40,000.

The Taneg Biogas System in Mankayan, Benguet is another SIBAT-assisted project on biogas production and utilization from hog manure. It is a communal type involving three biogas units that would benefit 16 households. Aside from providing energy for cooking, the system will provide fertilizer and feed materials. The project, presently under construction, will cost P164,000 when completed.

2.3.4 ITDI-Initiated Rice Husk Gasifier Combustor

The Fuels and Energy Division of the Industrial Technology Development Institute has initiated a number of rice husk gasifiers. These include a small scale brickmaking and pottery project in Sto. Nino Ceramic Producers Association in San Jose City, Nueva Ecija, another pottery project in Sta. Barbara Pottery in Victoria, Tarlac and in Lezo, Aklan, brick plants in the Capisan Multi-

Purpose Cooperative Inc. in San Dionisio, Iloilo; the Hinterwealth Agro-Industrial Corporation in Tanauan, Leyte; the Dinalupihan Brick Plant in Bataan, and the San Isidro Brick Plant in Isabela.

Several palay drying facilities were installed. The Norala Foundation in South Cotabato adopted the rice hull gasifier-combustor for palay drying. A project with Philippine Rice Research Institute on rice hull flat bed drier system has been completed while an R&D facility has been set up in IRRI, Laguna.

ITDI has converted wood-fired kilns to rice husk gasifiers combustor fed kiln. In Maasin, Leyte a 1.5 cu.m. wood-fired periodic type kiln using four (4) units drum size gasifier-combustor was converted to rice husk gasifier. At the University of Southern Mindanao, North Cotabato, a wood-fired brick kiln has been converted to rice husk gasifier combustor. In Paete, Laguna rice husk gasifier has resulted in quadrupling production of papier mache by accelerating drying to one hour instead of the 8-hour sundrying. An innovator in Abucay, Bataan has coupled the rice husk gasifier combustor to a mechanical drier and through a heat exchanger and furnace assembly has successfully produced clean hot air. In Kanaga, Ormoc a drum size rice hull gasifier combustor is used as heat source for the extraction of citronella oil.

2.3.5 Bagasse Power Plant

The use of sugarcane bagasse for energy generation has been demonstrated in the sugar provinces of Negros. Victorias Milling Co. has a rated capacity of 15,000TCD producing 263,514 tons of bagasse. Victorias has been utilizing its bagasse to generate its heat and steam requirements. The company plans to expand NRE utilization by establishing a power plant based in VICMICO. Initial phase of the plan calls for generation of at least 32 MW of power. Of these output, at least 20 MW will be sold to the Seneco grid.

For its part, the UPLB Biomass Laboratory has drawn a proposal to establish two biomass plants in Negros. The first plant with a rated capacity of 221MW, to be located in Victorias, will utilize 1,114,432MT of bagasse per year. Total plant cost is estimated at P10.3 billion and a payback period of 12 years. Revenues are forecast at P871 million/yr. Electricity will be priced at P1.50/kWh. The second plant will cost P4.78 billion with a rated capacity of 97MW and payback of 18 years. Revenues are estimated at P263 million per year. The plant will utilize 488 tons of bagasse.

2.4 Fiscal measures applicable to biomass energy system

Several measures have been formulated to promote NRE research, development and utilization. RA 7638, or the DOE Law, and RA6395, amending the NPC charter, cited NRE development as instrumental to indigenous energy generation. However, the major impetus to NRE development emanate from PD 1068 that contains specific provisions on incentives and priority in financing. These provisions have however been superseded by the Omnibus Investment Code or EO 226. The more recently promulgated Agriculture and Fisheries Modernization Act, RA 8435, also provides tax and tariff duty exemption to all types of agricultural and fisheries inputs, equipment and machinery such as renewable energy systems.

Biomass power projects are eligible for BOI registration on a pioneer status since the development of renewable energy sources remains in the List of Priority Investment Areas. The Omnibus Investment Code provides, among others, the following incentives to registered enterprises: (i) 6-year income tax holiday; (ii) additional deduction for labor expenses; (iii) exemption from contractors tax; and (iv) infrastructure expenses deduction from taxable income.

RA 8749, the Clean Air Act, addresses the problem of air pollution coming from mobile and stationary sources. The law subdivides the country into airsheds and prescribes emission standards accordingly. The Act embodies the policy of promoting environment-friendly facilities, which potentially favor renewables over conventional energy systems. But one contentious provision of the law pertains to the ban of incineration plants. The ban in effect favors the use of gasifiers versus direct combustion technologies. While several sectors have raised alarm on the ban, citing the possibility of widespread burning of trash instead of a centralized and contained incineration plant, the DENR-EMB has been steadfast in implementing the law to the letter.

2.5 Economics of Biomass

2.5.1 Gasifier

Gasifiers generate electrical power that is not much different from direct combustion system described previously. Table 2.8 compares imported gasifier with locally fabricated system. The imported system pertains to the 250-kW of BG Technologies. The CIF price of the equipment is quoted at US$214,500, and an additional P14.3 million would be needed for civil, electrical works, systems design, installation, training and commissioning. The annual operating cost and maintenance expense could go up to 10% of initial cost. BG Technologies claims the system can produce at US$0.10/kWe.

Investment cost per Kw for imported gasifier would be cheaper than rice hull thermal power plant and would approximate the cost of bagasse plant. For smaller capacities, however, the savings could be more than half because used engines could be utilized. Levelized cost could go down to P3.43/kwh for a 10kW system compared to P6.60/kwh for the 250kW system.

Table 2.8
Economics of Imported vs. Locallly Fabricated Gasifier

	Imported Gasifier	Locally Fabricated Gasifier
Capacity (kW)	250	10
Investment cost	13,611,804	214,700
IC per kW	**54,447**	**21,470**
Operation	1,361,180	42,940
Maintenance	1,218,180	19,000
Life-cycle cost	41,047,543	851,645
LC per kWh	**6.60**	**3.43**

A locally fabricated gasifier of 10kW would be more expensive compared to a rehabilitated ethanol power genset on a per kW basis. The ethanol plant also comes out with a much lower levelized cost: P1.91 vs. P3.43/kwh. Total investment cost for a locally fabricated gasifier would be the same for the rehabilitated ethanol plant.

2.5.2 Biogas Digester

The most cited work on biogas has been that of the Maya Farms for its large-scale continuous split type biogas systems using floating gas holder. Since Maya Farms has ceased operations, there has been no report of large-scale utilization of biogas for power generation. Numerous small-scale systems utilizing different designs have been reported with intermittent power generation but not for village power.

Table 2.9 presents comparative investment costs for two locally popular designs: metal elevated tank and rectangular concrete commercial type. The first involves a digester of 100-head capacity while the second is designed for 300 heads. The corresponding costs are P300,000 and P865,000, respectively. Operating the first type would involve 4 persons only, while the 300-head system would need 10 persons excluding those for the piggery operation itself. The annual operating cost may be assumed to be about 20% of the initial cost. Maintenance and repair expenses could go up to 10% of the initial investment as well.

Using biogas digester to generate power would require investment cost amounting to about P50,000 per kW. The cost difference is not material albeit there are marginal savings in terms of levelized cost per kWh. Since used engines can be utilized for both systems, there would be no tariff costs to reckon with.

Table 2.9
Economics of Biogas Digester

	Commercial	Elevated Tank
Capacity (kW)	18	6
Investment cost	865,000	300,000
IC per kW	**48,056**	**50,000**
Operation	173,000	60,000
Maintenance	78,500	26,500
Life-cycle cost	2,562,826	904,122
LC per kWh	**5.22**	**5.53**

2.5.3 Ethanol Plant

The continuing rise in prices of petroleum-based fuels provides economic justification for a fresh review of the potential of ethanol production from sugarcane molasses, coconut and nipa sap, among others. The production cost of ethanol (based in sugar-cane) in other countries has gone below the US$1/gallon (P13.21/liter). Ethanol produced from corn costs a little more than US$1.2/gallon (P15.85/liter). While the technological development of ethanol use for power generation in other countries is reportedly more advanced, local demonstration has not gone to commercial stage on account of lower cost of petroleum fuel in the past. The following discussion therefore pertains to a theoretical ethanol power plant.

When the production cost barrier for ethanol has gone below that for gasoline, the limiting step for its technical feasibility for power production is the cost of a modified engine running on ethanol and the of the generator. The highest available engine-generator rating in the local market is only 12-kVA that cost about P472,000. This would involve brand new Honda 4-cylinder engine with a rating of 100hp or 75kW that costs P336,000 and a brand new 12-kVA generator costing P136,000. If surplus genset is used, investment cost would be reduced by about two-thirds. Costs of other equipment and peripherals such as distilling column, boiler and control systems would be the same for both options. Operating expenses are about the same for both systems while maintenance expenses for the brand new units are lower by about 50 percent compared to a rehabilitated genset.

Table 2.10
Economics of Ethanol Rehab vs. Brand New Ethanol Power Plant

	Rehabilitated power gen	**Brand new power gen**
Capacity (kW)	12	12
Investment cost	215,000	612,000
IC per kW	**17,917**	**51,000**
Operation	43,000	43,000
Maintenance	16,500	8,250
Life-cycle cost	624,660	827,093
LC per kWh	**1.91**	**2.53**

Two ethanol plants, one using a rehabilitated, another a brand-new generator, are compared in Table 2.10. The life-cycle cost and the levelized cost of a rehabilitated genset is 25% lower than that of a brand new genset. In a rural setting, maintenance differentials and difficulty of getting replacement parts would favor installing brand new generator set.

2.5.4 Biomass Thermal Power Plants

Several models have been designed locally to utilize biomass for power generation. Most notable are those involving rice hull and bagasse, two of the most abundant agricultural resources in rural areas. However, there is yet no operating biomass power plant in the Philippines for which actual data can be used as basis. Previous biomass power projects such as the 1,920-kW Southern Philippines Grains Complex Power Plant, the 2.1-MW NFA Rice Hull Fired Steam Power Plant in Iloilo, and PNOC's 22-kW Pilot Power Plant, have not been successful.

The data used in the simulation are based on the Biomass Atlas of the Philippines which provides estimates on available biomass resource, costs of transporting biomass fuel, and prices of technologies. The estimates have been carefully validated using ground data of operating rice or sugar mills within a certain economical radius of potential sites. In addition, the use of Differentiated Global Positioning System increases the reliability of the estimates, especially on transport costs which were based on actual road network in rural areas. Nonetheless, the estimates remain theoretical as the feasibility of setting up renewable power plants of this magnitude in rural areas remains to be proven.

Tables 2.11 and 2.12 present the economic viability of rice hull-fuelled thermal power plants to be located in the province of Isabela. The rice hull will be sourced from 71 mills operating within a radius of 10 and 15 kms from Santiago and Cabatuan, respectively. Bulk density of rice hull is set at 125kg/cu.meter; one truckload can carry 25 cu.m or 3.2MT per trip, while transporting the rice hull will cost P63.75/km. Given the seasonality of rice farming, the mills are assumed to operate at 8 hours/day for 210 days or 7-month operation. The power plants are assumed to operate 24 hours per day for 365 days/year. The heating value of rice hull is equal to 16.80MJ/kg. The capacities of the plants were based on maximizing available resource to sustain year-long operating cycle. Thus, the Santiago plant will be fed out of the 12,489 MT generated by mills around the plant which will involve almost 4000 trips at a cost of P1.8 million. The Cabatuan plant will utilize 23,093MT of rice hull involving more than 7000 trips that will cost P6.6 million in freight charges.

The 3-MW Santiago plant will cost P311 million or about P103,667/kW of installed capacity. It will generate revenues of P43.7 million/year against an annual operating cost of P38 million or about P5.7 million profit per year. Materials cost is estimated at P1.87 million, while operating and maintenance expense is estimated at 0.5% of plant cost or P1.4 million. Financial charges would amount to P32.9 million based on interest rate of 10% for 20 years amortization. Its life-cycle cost is estimated at P584.2 million and levelized cost at P2.98/kwh.

The 6-MW Cabatuan plant will cost P436.5 million or P82,750/kW of installed capacity. Annual net profit is estimated at P16.2 million from revenues of P80.8 million and operating cost of P64.6 million. Materials will cost P3.4 million while operating and maintenance expense will be about P2.2 million. Interests charges would amount to P52.5 million at 10% for 20 years amortization. The life cycle cost is estimated at P961.89 million and the levelized cost would be P2.45/kwh.

Table 2.11
Economics of Rice Hull Biomass

	Rice Hull-1	Rice Hull-2
Capacity (MW)	3	6
Fuel	rice hull	rice hull
Location	Santiago City, Isabela	Cabatuan, Isabela
Investment Cost	311,000,000	436,500,000
IC per kW	**103,667**	**82,750**
Transport	1,833,932	6,385,500
Materials	1,873,368	3,441,312
Operation & Maintenance	1,400,000	2,235,000
Life-cycle cost	584,229.6	961,893
LC per kWh	**2.98**	**2.45**

For the bagasse power plant, two sites were considered: plant 1 with a theoretical size of 220MW to be located in Victorias, northern Negros, and a 97-MW second plant in southern Negros. Bagasse will come from 18 mills with a total rated capacity of 98,729 tons canes per day (TCD). The Victorias plant will be served by 1,114,432 DM bagasse tonnage from 14 mills; the second plant will utilize 488,016 DM bagasse tonnage from four mills. The bagasse will be loaded on trucks at 30 tons per truckload-trip. Transport costs are estimated atP63.75/km

The 220-MW Victorias plant will involve 3 generating units (2 x 85MWe and 1 x 60MWe). The 85MW system costs US$82.93 million while the 60MWe costs $63.64 million. In terms of $/MW, the latter is more expensive at $1,060/kW versus the bigger unit at $975/kW. The 94-MW southern plant will also involve three generating units (85MW, 6MW, 3MW). The huge investment was meant to maximize the available resource in the area.

The proposed thermal plants would be operating 365 days per year at 50% efficiency. Bagasse has a heating value of 12.5MJ/kg. The electricity generated will be priced at P1.50/kwh. The first plant will cost P11.47 billion (or P52,159/kW). Life cycle cost would amount to P26.25 billion while levelized cost will be lower at P1.82/kwh.

For the second plant, the project total cost amounts to P4.95 billion (P52,702/kW or not much different from the first plant). Life cycle cost would about half of the first plant at P12.67 billion, levelized cost would amount to P1.95/kwh.

Facilities that use rice hull as fuel for combustion could have smaller investment cost but higher levelized cost of power compared to facilities that utilize bagasse. In terms of investment per kilowatt, however, the use of bagasse is more economical, although the investment required is huge in order to realize scale economies. The levelized costs between the two bagasse plants exhibit not much of a difference and are more economical than those of rice hull thermal power plants.

Table 2.12
Economics of Bagasse Biomass

	Bagasse-1	**Bagasse-2**
Capacity (MW)	220	94
Fuel	sugarcane bagasse	sugarcane bagasse
Location	Negros	Negros
Investment Cost	11,475,000,000	4,954,000,000
IC per kW	**52,159**	**52,702**
Transport	421,031,149	270,638,893
Materials	344,883,364	150,956,399
Operation & Maintenance	51,640,000	24,770,000
Life-cycle cost	26,255,603,872	12,014,324,022
LC per kWh	**1.82**	**1.95**

2.6 Future Prospects and Barriers to Biomass Development

Several biomass power plants are being proposed based on the country's resource distribution identified in the Atlas. They form the bases for the comparative cases enumerated above. The more attractive options include: (i) the bagasse power plants in Negros; (ii) the rice hull-based power plant in Isabela; and (iii) a coconut shell-powered plant in Sariaya, Quezon.

Yet the realization of these projects hinges in overcoming the major barriers to biomass development. Foremost is the inadequate local capability to manufacture, operate and manage biomass-fueled power plants. Local R&D on biomass energy system is nascent. For power generation, the reliability of operation has to be demonstrated, otherwise the local market will not develop as fast. Foreign technologies are sometimes ill-suited to local conditions; local adaptation remains a challenge.

The problem of biomass fuel supply availability becomes more acute when considering large biomass power plants. Compounding the problem are high transport costs and moisture content of the raw material.

There is also difficulty in developing the local market for biomass. For example, while rice mill operators are ready market for rice-hull fueled power plants, they have remained dependent on

power facilities fueled by diesel. The need to develop market standards for the quality of fabricated equipment and systems through an accreditation system has long been recognized, but remains unrealized.
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Finally, while the present prices of biomass residues and wastes are low, it should be recognized that these materials have other alternative uses. Thus, one may expect that their prices will go up when these materials are harnessed on a large scale for power generation. When this happens, the economics of the project would have to change, but it is not expected to materially diminish the competitive status that biomass currently enjoys against other conventional fuel.

SMALL HYDRO POWER

Hydro power is considered the largest and most mature application of renewable energy. The installed capacity worldwide is estimated at 630,000MW, producing over 20% of the worlds electricity. In the European Union, hydro power already contributes at least 17% to electricity supply. Translated in terms of environmental costs, the hydro installations in the European Union are instrumental in avoiding 67 million tons of CO_2 emissions annually.

The developments in large-scale hydro power have resulted in misconception that there is limited scope for further technical innovations for small hydro power. However, there is considerable scope for improving the cost-effectiveness of small hydro power (SHP) systems especially with low-head systems, both through technical and non-technical innovations.[1]

There is still no international consensus on the classification of large and small hydro systems. The European Small Hydro Association however has accepted the benchmark of 10MW and below for small systems. In the Philippines, RA 7156 defines mini-hydro systems as those installations not less than 101kw nor more than to 10MW. By inference, micro-hydro systems consist of installations up to 100kw. SHPs are mainly 'run-off-river' systems requiring insignificant water impounding, constructing of dam and reservoirs. They are therefore considered environmentally benign forms of energy generation. It is estimated that a 5-MW SHP plant can replace annually 1,400 tons of fossil fuel, and avoid emissions of 16,000 tons of CO_2 and more than 100 tons of SO_2, while producing electricity for 5,000 families.

In the Philippines, the Mini-Hydro Division, Energy Utilization Management Bureau of the DOE has identified 1,081 sites with potential capacity of 13,426MW. There are 51 operating installations with an aggregate rated capacity of 82 MW; still in the pipeline for development until year 2008 are installations with a total capacity of 76.8MW. NRE demand projections for the hydro sector is placed at 0.21 MMBFOE in year 2000 and increasing to 0.29 MMBFOE by 2008.

[1] EUREC Agency, *The Future for Renewable Energy: Prospects and Directions.* p.100.

Table 3.1
Philippine Hydropower Potential

Status	Type	No. of Plants/Sites	Capacity MW	Capacity %	Annual Energy GWh	Annual Energy %
Definite Design	Large	3	1,130.00	8.42	3,312.03	7.63
	Small	2	43.00	0.32	211.10	0.49
	Mini	40	55.98	0.42	245.19	0.56
	SUBTOTAL	45	1,228.98	9.15	3,768.32	8.68
Feasibility Study	Large	17	3,229.80	24.06	10,617.52	24.45
	Small	41	873.10	6.50	3,113.05	7.17
	Mini	25	88.72	0.66	388.59	0.89
	SUBTOTAL	83	4,191.62	31.22	14,119.16	32.51
Pre-FS and Desk Study	Large	37	4,646.00	34.60	11,957.00	27.53
	Small	93	1,720.95	12.82	6,676.54	15.37
	Mini	823	1,638.91	12.21	6,906.60	15.90
	SUBTOTAL	953	8,005.86	59.63	25,540.14	58.81
Total		**1,081**	**13,426.46**	**100.00**	**43,427.62**	**100.00**

Source: *Guide on Mini-Hydropower Development in the Philippines*, Mini-hydro Division, Energy Utilization Management Bureau, Department of Energy, February 1999.

3.1 Technology and Process

Hydro power system requires the creation of an artificial head of water so that water can be diverted through a pipe (penstock) into a turbine where it discharges, usually through a draft tube or diffuse back into the river at a lower level. Different types of turbine have been developed to cope with different levels of head and flow. There are generally two general categories: impulse turbines and reaction turbines.

In impulse turbines (e.g., Pelton), a jet of water impinges on the runner that is designed to reverse the direction of the jet and thereby extract momentum from the water. Reaction turbines (e.g., Francis and Kaplan), run full of water and in effect generate hydrodynamic "lift" forces to propel the runner blades. The sizing of turbines should be adapted to the flow characteristics of the river or water stream to be used. The amount of energy captured depends on the sizing strategy. The larger the turbine at site, the poorer is its load factor (or capacity factor) as it will only run at rated power for a shorter period. A turbine designed to utilize minimum flow can only have a load factor approaching 100%, but it will extract less energy than a larger turbine. A technological innovation that captures variations in the flow and volume of water can therefore maximize capacity throughout the seasons. It will also dispense with the need to employ different sizes of turbines, and therefore reduce the investments costs. Such an innovation, developed by the Dela Salle University, is highlighted in the later section of this report.

3.2 Installations and Development Initiatives

The DOE has identified 436 potential sites for microhydro (100kW and below) systems development with a total capacity of 29.06MW. Another 888 sites can be developed for minihydro (100kW to 10MW) installations with a total capacity of 1,784MW. The NEA shepherds 15 operating minihydro projects with an aggregate capacity of 21.23MW. Feasibility studies have been conducted by the NEA for 45 sites, while 25 sites have undergone initial studies.

Table 3.2
Operating Small Hydro Installations in the Philippines
as of 30 April 2001

Region	Units	Capacity (kW)
Micro-hydro (100 kW and less)		
CAR	54	370.31
I	1	20
II	5	3.2
III	2	2.04
IV	2	2
V	2	4
VI	14	16.75
VII	6	16.65
VIII	3	23
IX	4	0.8
X	4	11.1
XI	2	25
XII	3	100
Total Micro-hydro	102	594.85
Mini-hydro (101 – 10,000 kW)		
CAR	14	37,950
I	1	4,550
II	3	8,520
III	1	300
IV	4	2,795
V	5	5,160
VII	6	8,720
VIII	2	2,080
IX	2	950
X	4	9,400
XI	2	2,700
ARMM	1	1,500
Total Mini-hydro	45	84,625
Total small hydro installations	147	85,219.85

Source: NESCON; Mini-hydro Division, Energy Utilization Management Bureau, Department of Energy; Survey returns.

At present there are 45 operating minihydro installations with an aggregate capacity of more than 84MW. For the period 2000-2008, close to 77MW of planned capacity is targeted for the minihydro system. For microhydro system, there are presently 102 operating installations with an aggregate capacity of 594kW. Most of the mini and microhydro systems are expectedly located in the mountainous area of the Cordellera Administrative Region.

3.2.1 Some Major Small Hydro Installations in the Philippines

1.5-MW Matling Mini-hydro Project in Malabang, Lanao Sur

Pressures from international competition drove the Matling Industrial and Commercial Corporation (MICC) to replace its 30-year old, four (4) units of 250-KW diesel-fed generators with a 1.5MW mini-hydro power facility. The mini-hydro system utilizes the 6 cu.m./sec flow of water and 35 meters head from the Matling River. (Matling River's potential is estimated at 10MW) The project, which was completed in May 1995, is the first of its kind in the Autonomous Region of Muslim Mindanao and a classic case for off-grid electrification. It energizes the 3000 hectare MICC compound including the Malabang town surrounding the complex.

The dam intake is placed at an elevation of 320 m. and the catchment area at this point is 330 sq. km. The headrace passes on the right bank looking upstream. The water that generates power drops to elevation 280 m. for a gross head of 40 m. Two-750KW generators were set up based on an original plan to use 750 KW internally and sell the other half to NAPOCOR.

The present value of total development cost is estimated at P70 million composed of P26 million for electro-mechanical equipment sets and the balance of P44 million for civil works. Annual operating cost is estimated at P1.25 million and maintenance cost at P2.69 million. At a conservative estimated useful life of 20 years and capital recovery factor of 12%, the life cycle cost would amount to P153 million while levelized cost is estimated at P1.71/kwh. Payback was estimated at only 4 years.

960-kW Inarihan Mini-hydro Project in Camarines Sur

The Inarihan Mini-hydro power plant, located in the outskirts of Naga City and operated by the Bicol Hydro power Corporation, is the first project implemented under RA 7156. The project was launched in February 1996 and was completed two years after. The project is a run-off-the-river scheme utilizing a 1.80-meter high concrete boulder filled weir across a 30-meter wide river. Water in the amount of 1.52 cu.m./sec., passes an intake structure and proceeds to a 0.90 m diameter, 1.6 km-long polyethylene plastic pipe. From the pipeline, water will be temporarily stored in a 55-meter long by 36-meter wide by 4-meter deep concrete lined forebay before it goes to a 0.70-meter by 289-meter long steel high pressure penstock. The water then proceeds to three-Francis type turbines located at 86 meters below the power intake structure. The project was designed to generate 960 kilowatts of power and to produce an annual energy generation of 5.30 megawatt-hours on the average.

The actual cost of the project is P48 million (at 1997 prices) or about P50,000 per installed kW. The original project cost estimate was P42 million; an additional P6 million was needed for expenditures on right-of-way acquisition, slope and watershed protection. Annual operating and maintenance expenses are projected at P1.2 million and P1.5 million, respectively. The power will be sold to the Camarines Sur Electric Cooperative II (Casureco II) at a rate of P1.80/kwh, or 5% lower than the rate of the National Power Corporation.

The project enjoys several incentives: (i) tax and duty-free importation of capital equipment sourced from China; (ii) tax credit on Domestic Capital equipment equivalent to 100% of the value of the VAT and custom duties for the local purchase of machinery, equipment, materials and parts; (iii) special Realty Tax rates on equipment and machinery not exceeding 2.5% of original cost; (iv) VAT exemption; and (v) income tax holiday for seven years of operation.

Two problems have surfaced during the first two years of operations. The peak kW capacity is 880 kW or about 92% of the designed capacity. A study has been proposed to determine the reasons for the apparent underperformance of the system and to serve as reference for future designs. The second problem pertains to insufficiency of water. The actual annual generation is about 3-4 million kWh (out of projected 5.3 million kWh) which translates to P6 million in revenues. The full utilization of the three turbines was achieved only for three months of the year due to the depletion of water resource.

Villa Escudero (VESCO) Micro-hydro Project

VESCO maintains an old 75-kW hydroelectric plant that was built in 1937. This unit provided for the electricity requirements of the plantation including a 5-ton ice plant, a coffee mill and other small applications. The expansion of Vesco's corporate activities provided the impetus to develop two micro-hydro systems in 1997: a new 38-KW plant downstream of the original one; and a new 75-kW plant in the original location. These brought total installed capacity to 188-kW, possibly expanding to 230-kW if the feasibility of the third power station is confirmed.

The systems are of the run-off-river type, sourced from two rivers, Bulakin and the Labasin Rivers. The headwaters of the Bulakin river is the Kasunguanan Spring which reaches peak-flows during the dry season while its lowest stream flows occur during the usual monsoon months of July to September. The aggregate watershed area of the two rivers is estimated at 2,000 hectares of lush vegetation and 18 natural springs. The area is also near Mt. Banahaw, the least exploited forest in the country.

The 38-kW plant known as the "Kipot" plant has a calculated net head of four feet or half of the original plant and would have the same optimal flow duration discharge of 1200 liters/second. The second "Resort" plant capacity of 75-kW was based on the confirmed flow of 2,000 liters/second occurring in the original plant site. The estimated annual generation of the two plants is estimated at 573,760 kWh per year. At a project cost estimate of P10 million, the payback period would be about 5 years.

Dakkitan Microhydro Project

This project, located in Dakkitan, Hungduan, Ifugao, is a 6-kW micro-hydro which began operation in March 1995. The project is a collaboration among the village association, Samahan ng mga Magsasaka para sa Kabuhayan (SAMAKA), the Ifugao Resource Development Center and the Montanosa Research and Development Center. The micro-hydro project provides power using a Pelton turbine powered by a 32.8-meter head from the Dakkitan River. It runs a rice mill at 3kg/min milled rice capacity including several equipment such as welding, vulcaninzing, blacksmithing, wood polishing and battery charging.

The power cum livelihood project costs about P280,000 including the cost of equipment, amounting to P61,000, that comprise the power load. P93,955 represents capital expenditures for the turbine, powerhouse, intake tank, canal rehabilitation and penstock. SAMAKA's counterpart was valued at P54,000 representing labor contribution.

The project generates close to P7,000 for the community organization. The accessibility of the ricemill has also saved time for the households. Expenditures fell by about P 21 per milling due to reduced milling charges and zero transport costs.

Dulao and Gacab Microhydro Power Projects

The projects include a 3-kW cross-flow turbine for a rice mill and a 10-kW two-cell cross-flow turbine with an electronic load controller and instrumentation for Malibcong village electrification. The smaller system was completed in 1995. The project was a close collaboration among the Department of Science and Technology, PCIERD and the De La Salle University

(DLSU), in partnership with the host community. A parallel objective in installing a second turbine rather than enhancing the existing 3-kW unit was to allow the DLSU team to perform pilot research.

The system runs a rice mill, provides electricity to 44 households, charges automotive batteries and power carpentry and metalworking tools. It operates twice a day (4:00 to 6:00 a.m. and 6:00 to 9:00 p.m.). Each household has two bulb receptacles; a 20-watt bulb is charged P10 per month.

The two projects involved a cash outlay of P 418,475. This is not the true cost of the system since it excludes volunteer work of local residents and technical consultants. Materials and equipment amounted to P130,000 and P180,000 for the first and second phase, respectively. The project reduced rice milling expenses by 20% to P16 per 12-kg can. Moreover, fuel reduction amounted to a maximum of P160 per month in lieu of P 25 tariff for milling.

A much-improved 20-kW version was also designed, fabricated and installed in Gacab, Malibcong. It provides lighting to 72 households. The Electronic Load Controller (ELC) replaces the expensive and imported governor that regulates the speed of the generator. The ELC imposes a constant load on the generator in spite of changing user's load. The controlling element is the inlet guide vane that controls the flow of water coming from the reservoir through the penstock in a cross-flow turbine. The concept is to close the valve if the generator speed becomes faster and open the valve if the generator slows down. The fuzzy logic controller decides which valve to open, and how much opening will be made, 1/3; 2/3; or full opening, to maintain the frequency. In effect, the two-cell cross-flow turbine is a 3-in-1 turbine using two generators of different sizes (10 and 20KVA). The fuzzy logic controller will choose the size of the generator needed for optimum efficiency based on the demand load and select which of the two inlet guide vanes will be utilized.

The cash outlay for latter project was P580,000; again, volunteer labor and technical help were not valued. Imported capital components amounted to P131,000.

Ngibat Microhydro Project

This 5-KW project, located in Tinglayan, Kalinga, provide lighting to 32 households and 15 lampposts in Ngibat village. It also supplies electricity to a rice mill that operates 6 hours per day, an average of 8 days operation per month, and to blacksmiths working an average of 8 hours per day, 10 days per month, for 3 to 4 months in a year. The system load also includes the 500-kWh/month consumption of an electric grinder, drill press, hand drill and grinder.

The project was partly financed by interest-free loan amounting to P189,000, a grant from MRDC amounting to P130,000 and local counterpart labor estimated at P64,000. As this is a community-initiated project, households are charged P22 per month, equivalent to avoided fuel costs. Monthly revenues have been computed at P6,500. Some households are unable to pay the tariff while others are exempted for humanitarian reasons.

Yamog Renewable Energy Development Group, Inc.

This 20-KW pelton turbine project, located in Sitio Polokon, Lamanan, Calinan District, Davao City, provides power to 105 rural households 24 hours a day during rainy seasons and 7 hours per day during normal dry seasons. It derives energy from the strong water flow and high head of four contributing small springs. For reasons of economy, the system uses an induction motor as generator.

The project's pelton turbine has two nozzle jets discharging water that strikes a series of buckets. The impulse type of turbine is appropriate considering the high head (65 m.) and a flow discharge of 50 liters/sec., giving a power design capacity of 20kw. The turbine consisting of 20 buckets/blades has a runner diameter of 300mm that uses two nozzles with spear valves. The bucket split into two halves so that a central area would not act as a dead spot incapable of deflecting water away from incoming jet. A cut-away notch on the lower lip allows the following bucket to move further into place before interfering with the jet which is still propelling the earlier bucket.

3.3 Fiscal Measures Applicable to Hydropower Systems

Hydropower project proponents have to secure four kinds of permits or licenses to set up a project. Water rights are issued by the National Water Resources Board for the use of water. Once operational a fee is charged for water use. The DOE provides the clearance for the project. The DENR-Environment Management Bureau issues the Environment Clearance Certificate, especially in areas identified as protected areas under the National Integrated Protected Areas System (NIPAS). If the project is located in ancestral domain, a permit must be secured from the affected community and the National Commission on Indigenous Peoples. It should be noted that part of the revenues arising from NRE installations are mandated by law to redound to tbe benefit of host communities.

RA 7156 or the Mini-hydroeelectric Power Incentive Act promulgated on 12 September 1991 provides the necessary incentives and privileges to mini-hydroelectric power developers. The objectives of the Act are as follows:

(i) To encourage entrepreneurs to develop potential sites for hydroelectric power existing in their respective localities;
(ii) To encourage entrepreneurs to develop potential sites for hydroelectric power existing in the country by granting the necessary incentives which will provide a reasonable rate of return;
(iii) To facilitate hydroelectric power development by eliminating overlapping jurisdiction of the many government agencies whose permits, licenses, clearances and other similar authorizations issued by various government agencies as presently required for such development, and by vesting in one agency the exclusive authority and responsibility for the development of mini-hydroelectric power;
(iv) To apportion a part of the realty and special privilege taxes and other economic benefits of the hydroelectric power potential to the respective localities where they are established; and
(v) To provide a contractual framework wherein some stability of conditions can be relied upon for long-term financing purposes.

The Office of Energy Affairs shall be the sole and exclusive authority responsible for the regulation, promotion and administration of mini-hydroelectric power development and the implementation of the provisions of the Act. Any person authorized to engage in mini-hydroelectric power development shall be granted the following tax incentives or privileges:

(i) Special Privilege Tax Rates limited to two per cent (2%) of gross receipts from the sale of electric power and transactions incident to the generation, transmission and sale of electric power;

(ii) Tax and Duty-free Importation of Machinery, Equipment and Materials applicable within seven (7) years of the award, subject to certain conditions that said machinery, equipment and parts: (i) are not manufactured domestically in reasonable quantity and quality at reasonable prices; (ii) are directly and actually needed in the project; (iii) are covered by shipping documents in the name of the duly registered developer; and (iv) prior approval of the OEA was obtained before such importation.

(iii) Tax Credit on Domestic Capital Equipment equivalent to 100% of the value of the VAT and customs duties that would have been paid on the machinery, equipment, materials and parts had these items been imported.

(iv) Special Realty Tax Rates on Equipment and Machinery shall be limited to 2.5% of their original cost.

(v) Value-added Tax Exemption on gross receipts derived from the sale of electric power whether through the NPC grid or through existing electric utility lines; and

(vi) Income Tax Holiday for seven (7) years from the start of commercial operation.

Apart from the above incentives, privately-owned mini-hydroelectric power plants shall be eligible for foreign loans and grants without further evaluation by the Board of the National Economic and Development Authority.

3.4 Economics of Hydropower Systems

Table 3.3 compares financial costs of installing micro-hydro facility under two possible modes: contracted and self-administered. The basis of the estimates is a 75-kW installation. Project proponents economizing on project costs might well consider the 30 to 40 percent difference between contracted installations and self-administered construction. However, turnkey contracts provide technical expertise and can lessen the supervisory hustles inherent in engineering projects. In terms of levelized cost of power, however, projects by administration can enjoy almost 40% difference in cost.

Table 3.3
Economics of Micro-Hydro System
By Mode of Construction

	BY CONTRACT	BY ADMINISTRATION
Capacity (kW)	75	75
Investment cost	29,036,250	20,025,000
IC per kW	387,150[a]	267,000[b]
Operation	500,625	500,625
Maintenance	200,250	200,250
Life-cycle cost	56,111,437	40,322,243
LC per kWh	**24.96**	**17.94**

[a] *Excludes distribution cost, estimated at Php 47,850 per kW.*
[b] *Excludes distribution cost, estimated at Php 33,000 per kW.*

Three installations were selected to demonstrate the economics of mini-hydro facilities: a prospective 550-kW installation in Surigao del Norte, 960-kW installation in Camarines Sur and 1,500-kW installation in Lanao Sur.

Table 3.4
Economics of Mini-Hydro

	HYDRO 1	HYDRO 2	HDYRO 3
Capacity (kW)	550	960	1,500
Location	Loreto, Dinagat Is., Surigao del Norte	Inarihan, Camarines Sur	Malabang, Lanao Sur
Year installed	2001*	1998	1995
Historical investment cost		48,000,000	40,000,000
Present values:			
Investment cost	42,179,534	67,309,170	70,002,747
IC per kW	76,690	70,114	46,668
Annual Costs:			
Operation	1,182,279	1,496,872	1,253,837
Insurance	105,449	168,273	175,007
Maintenance	227,456	1,871,091	2,696,425
Life-cycle cost	85,282,109	144,350,463	153,469,801
LC per kWh	3.78	3.65	1.71

*Scheduled for construction in July 2001.

Economies of scale is evident in large mini-hydro installations. The Matling project in Lanao Sur highlights major cost differential in power generation compared to smaller systems. The levelized cost is estimated at only P1.71/kwh, or more than 50% compared to the proposed Surigao project. For this reason, some large mini-hydro installations are not only competitive against conventional power systems, but can also be sold below grid electricity prices.

3.5 Future Developments in Small Hydro in the Philippines

There is a marked shift towards community-based initiatives in developing hydro resources for power generation in tandem with promoting livelihood projects. This is but a natural offshoot, especially in areas where work has been traditionally carried out manually and without the benefit of electricity. With the rising cost of fuel and the constraints imposed by a ballooning budget deficit that causes delay in grid electrification, communities are pressured to seek alternative and cheaper source of energy. Some of the small hydro projects in the pipeline do not only meet the objectBelow are illustrative cases of innovation to harness the potential of hydro power.

550-kW Hinubasan Minihydro Project in Loreto, Dinagat Island, Surigao del Norte

This project is a typical case of remote island electrification. It is located in Loreto muunicipality, in Dinagat Island, about four hours by pump boat from Surigao City. The Hinubasan project is envisioned to provide 24-hour power supply to 1,686 households of the municipality. Funding has been by the Development Bank of the Philippines, and construction is scheduled to commence in July 2001.

The project involves the installation of two 275-kW Turgo impulse turbines at 162 m. net head and flow of 0.228 cu.m/sec per unit. The turbines including the generators, governors, control panels, transformers will be sourced from China. The project fund requirement amounting to P48.5 million will be provided by the DBP. A loan amounting to P0.95 million was approved by DBP in February 2000 for the conduct of project feasibility study. When operational, the estimated basic power rate is P3.9687/kwh while generation cost for the first year is estimated at P2.96/kwh. Payback period is computed at 5 years.

Romblon Mini-hydro Project

This 900-kW mini-hydro project was the second project of the Development Bank of the Philippines (DBP) under its FINESSE project. A pre-feasibility study had been completed for the site. Technical experts attest to exceptionally good resource potential. The Romblon Electric Cooperative, the principal project proponent, is exploring DBP financing for the construction of the plant. The main project is expected to cost about P55 million.

Bubunawan Hydro Project

This 7-MW mini-hydro project located in Baungon, Bukidnon will generate 37.6MWh of electricity annually. The proponent, the Bubunawan Power Company, Inc. has scheduled commissioning late last year.

Steady Flow Hydro power Plant

A promising innovation in the hydro energy system has been recently developed by Mr. Cornelio Seno of Laguna. Although still at R&D stage, Seno's invention, dubbed as "Steady Flow Hydro System," received a special citation for innovativeness in the Nationwide Contest for New and Renewable Energy Systems sponsored by the Philippine National Oil Company last year. The innovation ensures constant flow rate, rotative speed, frequency and voltage for all operating conditions of head and electrical load, while eliminating problems involving water hammer, surging and silting-up.

The need for a speed governor is eliminated since a synchronous speed is assured by a metering pump at the forebay. The pump delivers fixed water flow rate at negligible head from the forebay through the penstock and to the hydro engine. This set up assures that the latter runs at the synchronous speed of the generator. Since the head of the metering pump is negligible, the pipeworks connecting the forebay and tailrace exerts siphoning effect, and the electric motor is required to surmount mechanical friction only; its power consumption is a small fraction of the total hydropower output. The metering pump and its driver can be conveniently controlled and monitored for performance at the control panel of the generator.

There are other notable innovations in local small hydro facilities that were developed out of necessity to adapt the system to the specificities of local conditions. With proper support, innovations, such as the one developed by Seno, may find commercial applications that will enhance the economic profile of small hydro facilities.

WIND ENERGY SYSTEMS

Wind energy, as a secondary form of solar energy, is considered one of the safest and cleanest forms of renewables. Wind turbines do not generate greenhouse gases albeit there are concerns about its noise and harmful effects on bird life. Moreover, wind energy systems do not pose negative externalities related to decommissioning of obsolete plants. Apart from low operating costs, wind energy system can be used for varied applications. It can be used to reduce cost of production in agriculture and other industries. The system, however, is site-specific requiring areas with wind speed of at least 3 meters per second. It requires storage in terms of batteries or water reservoir due to considerable power supply variations. A back-up system is also recommended for areas where wind supply is low.

Wind farm technology has had more advanced applications in Europe and the US. The Middelgrunden wind farm in Denmark is currently the world's largest offshore wind farm with a capacity of 40 MW. It is the first step towards a batch of other Danish offshore wind farms, each planned to generate 150 MW. In the US, the state of Texas has become the hottest wind energy market, having recently developed a 250-MW wind energy facility. A 500-MW facility is scheduled for construction this year; another 300 MW is being considered. This development occasioned the restructuring of the power sector in Texas. An integral component of the reform is the "Renewable Portfolio Standard" (RPS), *i.e.,* a program to dedicate to renewables about 2,000MW of energy capacity, approximately 3 percent of the state's power supply, by 2009. [1]

In the Philippines, wind energy system is gradually gaining popular advocates following the completion of the wind resource map for the country. The potential sites for wind energy generation have already been identified; majority of them are in the western side of the archipelago. Among the promising areas are: Cuyo Island (5.58mps), Basco, Batanes (5.39mps), Catanduanes (4.15mps), and Tagaytay City (5.0mps). Under current negotiations is a project in Masbate that will showcase wind energy system in the Philippines. BreezElectric Philippines plans to set up 25 units of 750-kW or a 18.75-MW of wind power facility. A similar system is being eyed for installation in the province of Catanduanes.

The Philippine Energy Plan for 1999-2008 forecasts that the contribution of wind energy systems in the country's power supply will reach 5 to 80 MW between year 2004 to 2008. If current plans materialize, off-grid stand-alone wind turbine generators may be able to contribute 36.87 MW to the grid by 2008.

4.1 Technology

Wind energy is derived from kinetic energy of moving air that is converted into power through a mechanism called *rotor*. The kinetic energy produced by the wind in unit time increases with the wind velocity (exponentially, at a power of three). Thus, doubling the wind speed increases the power eight times, while doubling the rotor diameter increases the available power four times. For example, at 3 meters per second wind speed, the wind power per square meter is about 17 watts; while at 6 mps, the power that can be generated per square meter is 136 watts.

In general, wind machines can only extract about 59 percent of the wind kinetic energy. Actual performance efficiency of wind machines varies from 10 to 50 percent depending on the

[1] Renewable Energy World Jan-Feb 2001

aerodynamic quality of the rotor. They are useful at a mean wind velocity of about 2 mps and are safe to operate up to a wind velocity of 25 mps.[2]

Wind energy conversion technologies are classified depending on size and applications. The first is *medium- to large-size grid-connected Wind Turbine Generators (WTG)* that have evolved from 50-kW in the 1980s to about 800-kW in the 1990s. The present generation of commercial wind turbines has gone past the 1000-kW mark. There are different design concepts: three-bladed, stall- or pitch-regulated, horizontal-axis machines operating at near-fixed rotational speed. There are other concepts such as gearless designs and variable rotor speed designs. Modern installation techniques allow commissioning in less than 6 months.

Another group belongs to *intermediate-size wind turbines in hybrid energy systems*. The system is usually combined with other energy sources such as photovoltaics, hydro, and diesel, and used in small remote grids or for special applications such as water pumping and battery charging. These systems may have a capacity between 10 to 500 kW.

The third group is *small stand-alone turbines* for battery charging, water pumping, heating, and the like. These systems have capacity less than 10 kW. In small battery-charging wind turbines, the size can range from 25 to 150 watts. By far, the most common use of wind energy system in the Philippines is the mechanical wind pump.

4.2 Installations and Development Initiatives

Table 4.1 shows the operating wind energy systems in the Philippines. Region III has the most number of installations with 117 wind pumps, while Region VI has the most number of operating wind turbine generators. As of April 2001, there are 241 operating wind pumps, with aggregate capacity of 245,263 cu. m. of water, and 13 operating wind turbines with combined capacity of 63.35 kW.

[2] The Basics of Wind Energy Systems, Alexis T. Belonio, Wind Energy Association of the Philippines.

Table 4.1
Operating Wind Energy Systems in the Philippines
as of 30 April 2001

	Wind pump	Wind Turbine
CAR	6	
I	18	2
II	5	2
III	117	
IV	7	2
V	1	1
VI	46	6
VII	24	
VIII	2	
IX	6	
X	1	
XI	6	
ARMM	2	
Total installations	241	13
Capacity	**245,263.1 cu m**	**63.35 kW**

Source: NESCON; Survey returns.

The typical operating wind pump in the Philippines would have a configuration presented in Table 4.2. It would be noted that horizontal type wind pumps are more popular than vertical type.

Table 4.2
Average Configuration of Operating Wind Pumps

	Vertical type (29 installations)	**Horizontal type** (208 installations)
Years in operation	9.8	9.3
Rotor diameter	less than 5 m	less than 5 m
Storage tank capacity	91.2 cu. m.	790.5 cu. m.
Total head	20.9 m	19.8 m
Tower height	12.0 m	10.4 m

Source: NESCON.

4.2.1 Existing Major WTG Installations

Pagudpud, Ilocos Norte

In March 1996, NPC commissioned a pilot wind turbine in Ayoyo, Pagudpud, Ilocos Norte with support from the Philippine Council for Industry Energy Research and Development (PCIERD). The project demonstrates the technical and economic viability of harnessing wind energy for power generation based on local conditions. The average wind speed at the site was monitored at 7.3 m/sec. The easterly wind blows about 36% of the year, and the equivalent annual wind power density was estimated at 532W/m^2.

The stand-alone system is a horizontal axis, upwind wind energy conversion machine with directional vane. The mini-power plant consists of a 10 kilowatt BWC Excel-R/120 wind turbine installed atop a 24-meter galvanized steel guyed-lattice tower, VCS-10 charge controller, an 800 Amp.DC source center, an 84 kWh/120VDC battery bank (Trojan L-16), and AES 10kW static converter. Its three fiberglass rotor blades turn a special low-speed alternator that converts the rotational energy into electricity. The alternator utilizes permanent magnets and has an inverted configuration in that the outside housing rotates while the internal windings are stationary. The alternator generates electricity whenever the rotor turns. The static inverter system converts the 220 VDC power into 220VAC, 60 hertz, single phase for distribution to the village. It supplies the power needs of 23 households with an estimated daily load demand of 16kwh in a small fishing village in the area. It was originally manned by four technical personnel shifting every eight hours everyday. While its static inverted can be used as battery charger, the system does not have a backup generator.

Plant operation is limited to nighttime for 4-6 hours during the lean wind months of May to September but was available for 24 hours daily during peak wind periods from October to April. In its first year of operations, the plant had an energy surplus since the turbine was generating more electricity than what was needed by the village. Due to the limited capacity of the battery banks, surplus energy has to be dumped. In its first year of operation, no major problem was encountered.

The wind turbine generator including its associated equipment were purchased from the US at about $60,000 (P1,525,112). Local expenditures such as the power house, distribution lines, meters, lamps and house wiring amounted to P581,000. Overall, the project cost was estimated at P2.1 million. The estimated revenue from house billing was estimated at P21,600 per year. The cost of energy was estimated at P42/kwh at 12% discount rate for capital and a capacity factor of 9%. This cost can be reduced to P7.47/kwh if the electricity generated is fully utilized and the cost of capital can be reduced to official loan assistance rate of 3 percent.

The project has been in operation until the battery system, with an estimated useful life of two years, got damaged recently. The acquisition of replacement battery costing about P300,000 has been deferred by the NPC in view of the plan of the Ilocos Norte Electric Cooperative to expand its grid to the village. The capacity factor will increase to 30% if its power output can be fully harnessed. The recommendation of the NPC is to convert the WTG into a grid connected system; the conversion would entail an additional investment of P500,000.

In the meantime, PCIERD has indicated interest to takeover the wind facility but no concrete agreement has yet been forged between NPC and PCIERD.

11.5kW Atulayan Hybrid Remote Area Power System (HRAPS)

The Atulayan NRE system is a hybrid of wind turbine as primary energy generator, and solar panels as secondary energy source. The wind turbine generates power even at low wind speed of 4.5 meters per second. The turbine's patented tilting axis allows power generation even at high wind speeds; and in cases of typhoon, the turbine tower can be lowered for safety. The solar power component has twelve 75Wp panels. An existing 75kVA genset was retrofitted for the purpose. In periods where solar and wind resources are not available, a diesel generator serves as a back up system.

The system provides 36.5kWh/day of electric power to the village's 72 households, a school, street lights, playground and seaweed dryer. It is equipped with 3x5.5kVA sine wave interactive inverter and storage battery bank that allows 24-hour AC power, 220V single phase and 380V three-phase. Synergy Power Philippines, the system's provider, has incorporated safety features that are ideal for remote area operations including automatic controls for easy operation.

4.2.2 Innovations

ANEC-Iloilo KW-Level WTG

A locally-designed and fabricated kilowatt-level wind turbine generator designed by the ANEC-Iloilo is installed in Isla Maahas, Calatagan, Batangas. The rotor has three 10-foot long fiberglass blades with NACA 4412 profile. It is coupled to a 15kVA generator via a two-step belt and pulley transmission that multiplies the rotational speed (rpm) of the rotor to match the rpm of the generator. The protected head assembly is mounted atop a 60-foot tower made up of galvanized pipes.

The power produced by the generator is used to charge a battery bank which stores the energy for a more sustained power availability even in the absence of wind conditions. An inverter is used to convert the DC electricity from the battery bank to 220VAC.

The generator is an induction motor that was slightly modified to work as a generator. The modification was introduced so the generator could operate at variable rotational speeds thus enabling the system to produce electricity even at varying speeds by operating as an asynchronous generator.

The materials used to fabricate the components are all locally sourced. The rotor is composed of three aerodynamically-designed fiberglass blades and is capable of extracting up to 50% of the available energy from the wind. Each blade is 10 feet long and weighs 27 kg. The rotor was designed to have a cut-in wind speed of 5m/sec and a cut-out wind speed of 12m/sec with a minimum operating wind speed of 2.5m/sec.

In addition to the above, the system incorporates an electronic charge controller that automatically controls the power of the generator. Automatic and manual safety features are also included in the system. An off-center, inclined, main hinged vane control mechanism automatically turns the rotor away from the wind direction when the wind speed reaches the cut-off speed of 12m/sec. A manual brake system has been incorporated to lock the rotor during maintenance and repair jobs. The electrical braking system also helps protect the rotor from overspinning at high wind speeds.

The total cost of the system amounted to P725,000 including site survey, installation and capital costs. The system can generate up 25kWhr of energy per day at an average wind speed of 6m/sec.

Aerovolt: NewFendered Bucket Windmill

Aerovolt is a vertical axis windmill apparatus where a movable wind shield covers the backturning buckets. This set up limits the entry of usable wind to prevent over-revolution of the windmill during strong winds. The aerovolt, which is installed in Isla Maahas, Calatagan, Batangas, comprises of six sets of half-rounded buckets that are made of light metals. The wind pushes the buckets to rotate the centrally located vertical shaft connected to the gears and pulleys that drive the synchronous generator assembly. As the intercepted wind is released, the buckets backturn traveling against the flow of the wind. The slamming between the bucket and the wind is prevented by the movable windshield that moves forward to the position of wind scooping buckets.

The estimated investment for a 20 KW typhoon-proof aerovolt windmill is about P716,800. The only imported component would be the generator amounting to P49,000 representing not more than 10% of the total cost. The prototype has produced 50 to 100VAC electric power from a 5kw generator at windspeeds of 4 to 10 meters/second. The overall efficiency of the model was estimated at 30% to 40% and could go up to 70% with improvements. The estimated cost of power generation was P0.22/kwh.

4.3 Fiscal Measures Applicable to Wind Energy Systems

In view of megawatt-size of wind energy systems that are in the pipeline, the relevant fiscal measure is EO 462, as amended by EO 232. This law, also known as the OSW law, mandates the DOE to engage in the assessment, field verification, development and utilization of ocean, solar and wind energy resources through the participation of the private sector under production sharing contracts.

Production sharing contracts shall be applied to project meeting **all** of the following criteria:

(i) It harnesses OSW resources in lands of the public domain and/or offshore waters within the Philippine territory, contiguous zone and exclusive economic zone. All lands or offshore waters covered by contracts granted under this EO shall be subject in public easements established or recognized by existing laws.

(ii) It has a net electric output of more than 1 MW for sale to an electric utility.

A production-sharing contract bestows exclusive privilege to the contractor for the exploration, development and utilization of OSW energy resources in a specified area. Such privilege cannot be transferred to another qualified person without the approval of the Secretary of the DOE.

In case other natural resources are present in the contract area, multiple-use concept will be applied to the extent practicable. If a natural resource-use conflict is not resolved by the concept, the first-come-first-serve basis will be used.

OSW contract areas will be divided by meridional blocks, each an area of about 81 hectares. This will constitute the minimum size of a contract area. The maximum area that can be awarded to wind or solar contractors is 8,100 hectares.

For contract areas on land, an occupation fee of P50 per hectare will be paid by contractors immediately upon award of the contract and yearly thereafter. During the pre-commercial phase of the contract, at least 50 percent of the contract area will be relinquished at the end of every two years subject to the approval of the DOE Secretary. The relinquished area will be of a regular shape consisting of contiguous meridional blocks. The contractor will specify the area that will be retained for commercial phase of the project in the “declaration of commerciality.”

The Pre-Commercial Contract has a maximum duration of 5 years for solar and/or wind projects, and 7 years for ocean or in combination with solar and/or wind. The Commercial Contract involving any of the energy resource or their combination, will have a life of 25 years, renewable for the same number of years.

The DOE and the contractor negotiate on the government share on profits generated from the operation of the facility. The government share will include a signature bonus and production bonus. The production bonus will be given to DOE at the date of signing of the Pre-Negotiated Commercial Contract and upon the latter’s issuance of a “Letter of Confirmation” of the commercial feasibility of the project. The government may opt to waive the signature bonus on the first project to reduce the pre-operating cost burden on the contractor.

The production bonus will be paid to the DOE at the end of each calendar year during the commercial phase of the project and will be applied only after the project has fully recovered its pre-operating expenditures. Moreover, to protect the welfare of electricity consumers, the government share will be limited to the extent that it will not raise the cost of generating electricity higher than the contracted selling rates to electric utility in the area. The production bonus will also not exceed 15 percent of net proceeds, where net proceeds is defined as the difference between gross sales and operating and maintenance costs.

In addition, DOE will assist OSW developers in obtaining all applicable fiscal and non-fiscal incentives, including registration as pioneer industry the BOI, and securing access to lands and/or offshore areas where OSW energy resources will be harnessed. OSW developers may also charge the cost of assessment, field verification and feasibility studies of other sites to its current commercial projects.

It would be noted however that for small-scale wind energy systems, the only pertinent incentives are those provided by the Omnibus Investment Code. To wit, the incentives include among others: (i) 6-year income tax holiday; (ii) exemption from Contractors Tax; (iii) additional deduction for labor expenses; (iv) employment of foreign nationals; and (v) unlimited consignment of machinery and equipment.

Although a menu of incentives, as outlined in the Omnibus Investment Code, is offered to wind energy proponents, in practice, the only relevant incentive is the income tax holiday. Moreover, investors in wind energy system would have to reckon several government regulatory guidelines such as right-of-way provisions, environment compliance certificates, indigenous community permits for sites in ancestral domain or in national protected areas. These hurdles are common to all NRE projects.

4.4 Economics of Wind Power Systems

Tables 4.3 and 4.5 summarize the economics of wind energy systems according to different size and capacities. The cost of wind energy systems vary considerably depending on the design, materials, labor costs related to manufacturing and installation, and the cost of transporting the system to the site. For mechanical wind pumps, prices may range from P30,000 for a small system to P145,000 for a larger model. Investment cost per cubic meter of pumped water decreases as capacities increase. Levelized cost per cubic meter based on a useful life of 10 years and a capital recovery factor of 12% could be as low as P2.00 per cubic meter for systems that could pump as much as 120 cu. meters per day with a rotor diameter of 6 meters.

At present, the local government does not impose a tax in the installation and operation of wind pump since the system is treated like an agricultural machinery.

Table 4.3
Economics of Wind Pump

	WP 1.5	WP 3.5	WP 4.5	WP 6.0
Rotor Diameter	1.5 m	3.5 m	4.5 m	6.0 m
No. of blades	8	18 – 24	18 - 24	24 – 32
Tower height	6 – 10 m	6 – 10 m	6 – 10 m	6 – 10 m
Pumping head	6 m	6 – 10 m	10 – 40 m	10 – 40 m
Typical output*	1 – 5 m^3/day	15 – 30 m^3/day	30 – 70 m^3/day	45 – 120 m^3/day
Investment cost	30,000	68,000	100,000	145,000
IC per cu m	10,000	3,022	2,000	1,758
Ann. operation	4,500	4,500	9,000	9,000
Ann. maintenance	2,500	6,000	9,000	13,000
Life-cycle cost	84,288	160,730	403,381	493,087
LC per cu m	**13.62**	**3.46**	**2.43**	**2.00**

*at 3 m/s wind speed.

Investing in a large windpump would typically involve the following capital expenditures:

Table 4.4
Costs of Selected Components of Wind Energy System

	Component cost
Rotor and blades	10,000
Head Assembly	40,000
Tail and side vanes	15,000
Tower and foundation	45,000
Pump	5,000
Pipes and fittings	15,000
Total Capital Cost	130,000

For wind turbine generators, a 50-watt model utilizing local components would cost P45,000. Annual operating and maintenance expenses would amount to P8,500. Based on estimated useful life of 15 years and capital recovery factor of 12%, levelized cost would amount to P103.40/kwh. A larger system of 500-W would need an investment of P80,000 but levelized cost would decrease to P18.63/kwh. This may be compared with imported systems: a 300-watt aerogenerator costs P65,000 while a 500-watt model, P110,000. A 600-watt model having a rotor diameter of 2.13 meters costs P150,000. An additional investment of P6,000 would have to be made on an inverter.

Table 4.5
Economics of Wind Turbine

	WT 1.0	WT 1.5	WT 2.0
Rotor diameter	1.0 m	1.5 m	2.0 m
No. of blades	2	2	2 or 3
Drive	direct	direct	direct
Power output*	50 W	200 W	500 W
Voltage	12 or 24	12 or 24	12 or 24
Battery	automotive	automotive	automotive
Investment cost	45,000	67,500	80,000
IC per kW	**900,000**	**337,500**	**180,000**
Ann. operation	4,500	4,500	4,500
Ann. maintenance	4,000	6,000	8,000
Life-cycle cost	154,229.87	216,020	277,811
LC per kWh	**103.40**	**36.21**	**18.63**

*at 4 m/sec wind speed.

Table 4.6 illustrates the economics of wind hybrid system coupled to biomass, PV and internal combustion engine. Levelized cost would be lower for wind-biomass hybrid using rice hull gasifier, albeit the difference would be about 3 percent compared to an ICE system. Utilizing a solar module would drive the cost up to P166.12 per kwh on account of the higher cost of solar panels. Investment cost would be higher for wind-biomass hybrid on account of additional investment for fabrication of gasifier, imported generator and purchase of surplus engine.

Table 4.6
Economics of Wind Hybrid Systems

	Wind-Biomass	Wind-PV	Wind-ICE
Technical specification	WT 2.0 (500 W) Generator 3 kW, 220V (China-made) Surplus engine: 4K Toyota or 3-cylinder Suzuki engine 40 cm rice hull gasifier	WT 1.0 (50 W) Solar module 75 W Controller 6 A Inverter 200 W 2 units Car battery 12V	WT 2.0 (500 W) Robin engine generator set with rated output of 1400 W, 220/110V
Capacity (W)	3,500	125	1,900
Investment cost	167,000	99,400	127,000
IC per kW	**47,714**	**795,200**	**66,842**
Ann. operation	11,435	4,500	32,240
Ann. maintenance	14,700	6,170	11,200
Life-cycle cost	529,901	247,778	549,247
LC per kWh	**35.53**	**166.12**	**36.82**

4.5 Future Developments

Two major wind energy installations are currently in the pipeline: the 1,100-kW Batan Island Wind Plant Project and the Masbate Wind Farm.

The Batan project was originally conceptualized as a stand-alone PV-Wind-Diesel hybrid system by the provincial government of Batanes. Due to the high cost of solar panels, the photovoltaic component was eliminated. The plant is envisioned to have an initial capacity of 200KW and will be expanded to 1100 KW over a ten-year period as the demand increases and funds are made available.

The project team would be led by the First Philippine Energy Corporation with the support of the Advanced Energy Systems Ltd. of Australia. The facility will supply power to four towns: Ivan, Uyugan, Mahatao and the capital town of Basco.

The project cost, including the provision for automated diesel control and radio communication hardware, is estimated at P160.4 million. The generation cost of the existing diesel generation system in Batan Island is P12.80/kwh; the wind project is expected to generate power at P4.77/kwh.

Another boost to the wind energy sector is the proposal of the BreezElectric Philippines Corporation to construct a wind farm in Masbate. The project involves developing 18.75-MW of wind power. Annual output is projected to reach 59 to 68 GWh. The details and terms of the proposal are still being worked out with concerned agencies. BreezElectric is however targeting to set up a similar facility in Catanduanes.

PHOTOVOLTAIC SYSTEM

Most off-grid rural electrification programs turn to photovoltaics (PVs) for the arduous task of providing power to widely dispersed population. Indeed, in the Philippines, PVs have found a niche in major electrification programs.

The main advantage of PV over other renewable energy technologies is its virtually inexhaustible source of power, *i.e.*, the sun. PV converts solar radiation directly into electricity.[1] The Philippines is apt to harness solar energy given its relatively high average daily insolation, ranging from 3.5 to 5.2 kWh per square meter, and the low seasonal variation of solar radiation. The solar potential is greatest during the summer months of May, June and July when the sun is positioned over the Northern Hemisphere. Conversely, the months with the weakest sunlight are November, December and January.

In addition, PV systems are modular and can be employed for milliwatt to megawatt power generation. High reliability, long lifetime, low maintenance cost and zero fuel requirement of PV modules have made the technology a viable and cost-effective option in remote site applications where the cost of grid extension and maintenance of conventional power supply systems would be prohibitive.

While PV technology is already considered commercial, costs remain high, as the industry struggles to make its transition from R&D level production to one of large-scale manufacturing. Nonetheless, the interest on PV has not waned; worldwide, research and development activities on the technology have been sustained. Since 1975, much of the work on PVs is focused on increasing the efficiency and stability of different PV cell technologies and on reducing manufacturing costs. In addition, crystalline silicon cells, the dominant PV cell technology, is profiting from huge R&D activities in the semiconductor industry. The upshot is a steady decline in the price of PV module – from US$4.75 per Wp in 1990 to the current price of US$3.50 per Wp. By 2010, the price of PV module is forecast to fall between US$1.50 to US$2.00 per Wp.[2] These developments are boosting the potentials of PV as a technology choice for rural electrification.

5.1 Overview of PV systems

A useful classification of PV systems is by type of applications, namely: stand-alone, hybrid and grid-connected. This classification corresponds to the ways by which PV systems cope with the intermittent nature of its energy source. Thus, for a PV system to deliver stable supply of power, it has to make use of storage or be connected to the electric grid, or be combined with other technologies. To date, only off-grid types are found in the Philippines.

Grid-connected PV plants are largest in the U.S., Japan and Germany where 'PV-on-roof-tops and facades' programmes were initiated since 1995. Other industrialized countries notably Switzerland, Italy, Netherlands, Spain and Australia have also adapted their own 'residential roofs' programmes. While the bandwagon is responsible for the phenomenal growth of the world

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[1] Solar energy can also be converted into electricity by concentrating the radiation in thermal power plants. This would require high incidence of sunshine. Where solar radiation is however diffused as in the Philippines, solar thermal plant is not a relevant option.

[2] Renewable Energy World, July-August 2000, p. 59.

PV market, *i.e.*, from less than 1 MW/year in 1995 to 200 MW in 1999, grid-connected systems are still highly subsidized. The shift away from subsidies may happen in year 2010 if the world PV market can attain its target of 700 MW. By this time, it is expected that the installed cost for grid-connected PV would have dropped from the present US$8.00 per Wp to US$3.00 per Wp.[3]

Off-grid PV applications, stand-alone and hybrid systems, comprise a bigger market than grid-connected PV. This owes to the fact that PV tends to be more competitive relative to other technologies the farther the distance of the site is from the grid.

Stand-alone systems usually operate with the use of battery for storage. They are deployed in remote locations that have no access to a public utility grid. The load can be direct current (DC) or alternating current (AC). For small lighting applications, the standard configuration is a 12/24 V DC system.

The most popular stand-alone applications in rural villages are solar home systems and battery charging system. A solar home system consists of one or several PV modules mounted onto a suitable support structure such as a roof, a battery and a charge controller. The system is designed to supply small amounts of energy in off-grid households. On the other hand, a battery charging system can be a low power Ni-Cd charger or a community charging station.

Other commercial applications include communications (for powering repeaters), cathodic protection of pipelines and remote signaling. There is also demand for refrigeration, specially in rural villages. A PV refrigerator utilizes a PV array of 100 to 300 Wp, a battery and associated charge and compressor controllers, and a 12 or 24 V compressor refrigerator specially designed for photovoltaic power.

Yet a rapidly growing PV application in the Philippines is water pumping. Most PV water pump systems are designed without a battery; the water reservoir itself provides the storage. The system has a power range from 600 Wp to 3.5 kWp. A variable-frequency inverter, directly connected to the PV array, regulates the pump speed to maximize the use of the available PV power. The system is compatible with many off-the-shelf standard AC pumps.

PV may be coupled with other power generating system to provide steady source of power. The more common configurations are: (i) PV-diesel with battery; (ii) PV-diesel with load management; and (iii) PV-wind-diesel with battery. In the first, PV backstops diesel-powered plants in places where transporting diesel is difficult or costly. It is also feasible to combine PV and diesel without battery storage, but such system must have an automated capability to regulate the load. The loads are prioritized according to available generation. Thus apart from saving on storage cost, this configuration permits greater utilization of renewable energy as diesel runs are reduced when solar power is available. Finally, a system that combines PV with wind and diesel can provide 24-hour electricity, but the system is more complex and involves larger upfront capital investment.

5.2 Current installations and major initiatives

By recent inventory, the total PV installations in the Philippines has reached 4,850 units. Although one can find a PV system in every region, the concentration is in Region VIII which has more than one-fifth of the installations. The provinces that have the highest number of PV

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[3] ibid.

systems are Easter Samar (752); Kalinga-Apayao (431); Palawan (358); Lanao del Sur (356); Iloilo (280); and Abra (273).

The diffusion of solar electricity in rural Philippines owes to major socio-economic programs implemented by the National Electrification Administration (NEA) since early 1990s, and recently, by the Department of Interior and Local Government (DILG).

5.2.1 NEA-GTZ Rural Photovoltaic Electrification

With the support of the *Gesellschaft fur Technische Zusammenarbeit* (GTZ), NEA embarked on a program dubbed "Rural Photovoltaic Electrification"(RPE) in 1992. By the end of 2000, the project has installed 2,454 individual solar home systems (SHS), 195 battery charging stations (BCS) and 11 demonstration units. About 60 percent of SHS units is in Luzon, while 78 percent of BCS is in Mindanao. In all, the systems have total capacity of 166.7 kW, providing power to about 2,890 rural households.

Table 5.1
NEA-GTZ Photovoltaic Installations
As of 31 December 2000

	Solar Home System		Battery Charging Stn		Demo Units	
	Units	Capacity*	Units	Capacity*	Units	Capacity*
Luzon	1,465	96,482	38	2,870	4	300
Visayas	529	35,005	5	462		
Mindanao	460	27,440	152	3,632	7	525
Philippines	2,454	158,927	195	6,954	11	825

*in Watt-peak.
Source: National Electrification Administration.

NEA works jointly with the electric cooperatives to implement the program. Concretely, NEA provides loan to the cooperative for installing and managing the solar energy facilities. The SHS, for instance, is rented by the consumer from the electric cooperative for a monthly fee. The consumer shoulders the cost of maintenance. Although the program dabbled with other systems beside SHS and BCS, such as rechargeable lamps and central solar power plants, the program has had more success in SHS because of ease in administration and low maintenance requirement. SHS also eschews the need of setting up a grid in the barangay.

The SHS unit consists of a 75 Wp solar crystalline silicone panel and 100 AH, 12 V solar battery. NEA lends to the electric cooperative P25,000 for each SHS installed to cover the costs of the solar panel, battery charge controller, and some of the auxiliary components. The other components of the system, *e.g.,* battery and converter, estimated to have a value of P5,000, are shouldered by the cooperative and represents the consumer's counterpart.

A BCS unit is designed to cater to the needs of 10 households. It consists of three 75-Wp solar panels. NEA extends P65,000 loan to the electric cooperative for every BCS unit set up in its franchise area. The consumer's counterpart is P5,000.

In the pipeline for year 2001 are 529 SHS units with a funding requirement of P11.225 million. The units will be installed in Benguet, Cagayan, Ilocos Sur, Marinduque and Occidental Mindoro.

5.2.2 Municipal Solar Infrastructure Project

In November 1997, the Department of Interior and Local Governments (DILG) initiated a community development program aimed at providing services to poor communities unconnected to the power grid. The program, known as the Municipal Solar Infrastructure Project (MSIP), is assisted by the Australian Agency for International Development (AusAID) through a mix of loans and grants from the Australian Government and Export Finance and Insurance Corporation.

MSIP works through the Local Government Units (LGUs) in deploying solar packaged systems for use in water pumping, barangay and rural health centers, district hospital, schools, communal light, and municipal and barangay halls. The packages are to be installed in 435 barangays, covering 52 municipalities of 10 provinces in Visayas and Mindanao over a 49-month period, ending December 2001. Yet as of 30 January 2001, the project is almost complete, having installed 1,143 packages of the 1,145 units targetted.

Table 5.2
MSIP Project Allocations

Province	BH/MH	BHC/ RHC	DH	SHW	CL	SCH	WS
Guimaras	6	2			14	6	3
Antique		1			34	7	12
Biliran	7	4			5	12	15
Eastern Samar	175	74	1	1	135	205	128
Southern Leyte	4	11	1	1	46	19	17
Western Samar		2			32	3	39
Surigao del Sur	6	5			2	9	2
Tawi-tawi	8	5	1	1	5	5	7
Sulu	1	6	1	1			25
Bohol		5			16	4	11
DILG						1	
Total	**207**	**115**	**4**	**4**	**289**	**266**	**259**

Legend: BH = barangay hall; MH = municipal hall; BHC = barangay health center; RHC = rural health center; DH = district hospital; SHW = solar hot water; CL = community light; SCH = schools; WS = water system
Source: Department of Interior and Local Government.

The selection of sites has been guided by the Social Reform Agenda (SRA) Program of the government. Thus the beneficiaries are the remote barangays in the identified SRA provinces. A barangay is considered "remote" and thus qualified in the program, when its distance from the public grid is at least 5 kilometers. The program also selects those barangays with existing infrastructure such as municipal and barangay halls, district hospitals, rural and barangay health centers, and schools, where the solar packages may be installed. For PV water pumping, the barangay must not only have a stable water source, but the water should also pass the purity standards of the World Health Organization. The technical design and costs of the solar packages are presented below.

Table 5.3
Technical Specifications and Costs of Solar Packages of MSIP

		Load Capacity	Costs (*in pesos*) Eqpt & Inst.*	Ann. O&M
District hospital	❑	153 light hours per day from 30 low energy AC lights	2,086,100	66,000
	❑	12 fan hours per day from 2 ceiling fans		
	❑	60 watt hours/day for communication		
	❑	Vaccine fridge/freezer able to supply 2 kg ice/day		
	❑	200 liters/day hot water from solar hot water system		
	❑	10,000 liters stored potable water		
Rural health unit	❑	43 light hours per day from 12 low energy AC lights	1,108,919	51,000
	❑	6 fan hours per day from 1 ceiling fan		
	❑	60 watt hours/day for communication		
	❑	Vaccine fridge/freezer able to supply 2 kg ice/day		
	❑	300 watt hour/day 220V 60hz for small appliances		
Barangay health center	❑	18 light hours per day from 4 low energy DC lights	321,068	17,400
	❑	Vaccine fridge/freezer to supply 2 kg ice/day		
Municipal hall	❑	74 light hours per day from 20 low energy AC lights	1,212,458	41,000
	❑	6 fan hours per day from 1 ceiling fan		
	❑	60 watt hour/day for communication		
	❑	1,995 watt hour/day 220V 60hz for small appliances		
Barangay hall	❑	18 light hours per day from 4 low energy DC lights	46,891	3,000
School	❑	32 light hours per day from 8 low energy DC lights	157,783	10,000
	❑	5 TV/Video hours/week for school use		
Community light	❑	12 light hours per day from one 18-watt, DC low energy fluorescent light	146,785	3,100
Water system 10/20	❑	10,000 cu m/day supply for barangay population approx. 350	1,070,523	35,000
Water system 20/20	❑	20,000 cu m/day supply for barangay population approx. 700	1,887,070	42,000
Water system 40/20	❑	40,000 cu m/day supply for barangay population approx. 1400	2,543,195	62,000

*Based on exchange rate of 1 AU$ = Php 25.80
Source: Department of Interior and Local Government.

Notwithstanding the advance implementation of the program, proponents are still concerned about its sustainability. Among the issues raised are the peace and order condition in the identified provinces, delays on the part of LGU units in fulfilling their counterpart activities, and the continued operability of the installed PV systems. On the last issue, the program elicits the participation of the community in managing, operating and maintaining the solar facilities. Thus, an important component of the program is the training of Barangay Technical Teams (BTTs) and organization of solar project management groups (SPMGs) that will have oversight function on the installations. Although the Affiliated Nonconventional Energy Centers (ANEC), the university-based network of the Department of Energy, has been tasked to provide technical support to the communities, the strengthening of BTTs and SPMGs is still critical to the program's long-term success.

A second phase of MSIP, slated for implementation in year 2002-2006, is currently under evaluation by the National Economic and Development Authority (NEDA). The target coverage is broader: 4,663 solar package systems to be installed in 1,158 barangays in 60 municipalities and 16 provinces. Regions in Luzon, specifically Regions IV, V and CAR, are among the target beneficiaries. The project has a budget of US$155 million, of which US$150 million is to be obtained through foreign loan, and the remaining US$5 million represent government counterpart.

5.2.3 Private Initiatives

A number of PV installations in the Philippines were installed through the initiatives of non-government organizations and private individuals. Yet while these are private undertakings, none is known to generate commercial returns.

The more recent installations include the PV-biomass system (3.6 kWp of PV coupled with 6 kW gas generator) of Shell Renewables Philippines Corporation in Alaminos, Madalag, Aklan. Households register with Shell their daily load energy demand, measured in terms of energy unit. One energy unit is equivalent to about 100 watt-hours of daily energy consumption. Shell collects P50 a week from each household who signed up for one-unit energy level consumption. The fee translates to an electricity charge of P71.43 per kWh. Although this price is many times higher compared to grid price, Shell proponents still claim that the fees collected from users are barely enough to cover their operating expenses.

Similarly, in the solar home systems set up by the Philippine Rural Reconstruction Movement (PRRM) in 5 barangays in El Nido, Palawan, the P50 monthly charge to households is only a reimbursement for the cost of maintaining the system.

As most of the PV systems are highly subsidized, the finances for installation and maintenance of the facilities often come from a number of sources. In the case of the PV project in Puerto Princesa, Palawan, the Development Bank of the Philippines (DBP) extended P10.65 million loan to the Local Government Unit to fund the installation of solar home systems in 400 households. In addition to the loan, the Department of Energy has to infuse P800,000 in the project to defray the costs of the system.

Where PV applications may however prove economically viable is in the telecommunications sector. The PV-diesel-battery hybrid has emerged as a cost-efficient alternative to traditional diesel generators for remote communication installations. Among the early adapters of this system are Radio Communication of the Philippines, Inc. (RCPI) and Pilipino Telecommunications, Inc. Recently, it has been reported that the Philippine Long Distance Telephone Co. (PLDT) is exploring the DBP's FINESSE window for its plan to replace the diesel generators that are currently powering its repeater stations.

The PV-diesel-battery hybrid system that the First Philippine Energy Corporation (FPEC) designed for RCPI has the capacity of providing a continuous load of 1,600 watts. The PV component, with a total peak capacity of 9.6 kW, was sized on the assumption of 3.2 kWh/m^2/day daily insolation, while the battery bank, for a 3-day autonomy. The diesel generator is connected to a 400A, 48V rectifier which shortens the charging time of the battery and minimizes the run time of the generator. The generator serves as a back-up to the solar system when the energy production from PV modules is not sufficient or when the battery bank is depleted.

In general, a mix of PV and non-renewable (commonly diesel) energy sources is perceived to be more economical and more reliable power source than a fully PV system. Some of the recent hybrid installations are: PV-hydro system in Dupax del Norte, Nueva Vizcaya; PV-wind turbine systems in Anilao, Iloilo; and PV-Wind-hydro system in Talisay, Negro Occidental.

In Atulayan Island, Sagnay, Camarines Sur, Synergy Power Philippines, Inc. constructed a PV-wind-diesel-battery hybrid that has the capacity to supply an average of 36.5 kWh/day for use of 72 households. The wind turbine acts as primary energy generator; it is designed to produce power at wind speed as low as 4.5 meters per second. The PV system serves as secondary energy source. When energy production from wind and solar are not sufficient, power can be obtained from the diesel generator.

The Atulayan facility, costing US$50,000, was commissioned in September 2000. CASURECO IV manages the facility and charges users P4.35 per kWh plus fuel cost. Nine barangay volunteers were trained to operate and maintain the facility. It is estimated that the first two years of the system will require monthly operating expenses of P6,500 (including P4,000 cost of fuel). Whether the facility will be found economically viable for off-grid rural electrification remains to be seen.

5.3 Fiscal Incentives

Investors of PV systems can avail of the same privileges accorded to BOI-registered firms. As provided in EO 226, the incentives include: (i) income tax holiday; (ii) additional deduction for labor expenses; (iii) exemption from contractor's tax; (iv) deduction of infrastructure expenses from taxable income; (v) unrestricted use of consigned equipment; and (vi) employment of foreign nationals.

Since most PV installations are small and individualized, these privileges have limited use to the proponents. Moreover, PV installations have remained uncompetitive relative to grid-connected power generators. In addition, the systems are often deployed in remote rural areas where consumers' purchasing power is low. Consequently, recovering costs is a hurdle that investors have yet to overcome. Since revenues are not sufficient to cover costs, the provisions as regards to taxable income become moot. Nor is the exemption from contractor's tax applicable to PV investors; it is often the case that the host communities assist in the installation of the system.

The Agriculture and Fisheries Modernization Act (RA 8435) however provides relief to PV investors from paying duties on importation of solar panels for five years beginning 1999. The other major items in PV facilities, such as battery and charge controller, are still levied between 3 to 10 percent.

5.4 Economics of PV systems

As is the case for most renewable energy systems, the biggest hurdle in nurturing the market for PV in rural areas is the large upfront cost. However, the modularity of the system, *i.e.*, it can be sized variably depending on the energy requirement of target users, ease of operation and low maintenance costs make the system appropriate to supply the energy needs of low-income rural households.

In the foregoing, the levelized economic cost of various PV installations are calculated under the following assumptions:

(i) Daily insolation of 5 kWh per sq. m. per day

(ii) Autonomy period of 3 days

(iii) The life of the system coinciding with the life of the PV modules, *i.e.,* 20 years, without salvage value.

(iv) Capital recovery factor of 12 percent.

(v) It is assumed that financing will be needed only for equipment and materials. The installation cost is to be borne by the individual or community, representing the beneficiaries' loan counterpart. Loan is amortized over the life of the system. The cost of financing is 12 percent.

(vi) Replacement of battery after 3 years if the battery is shallow-type (used in automotive) or after 5 years if the battery is deep-cycle. The battery charge controller is replaced every 5 years.

(vii) The installation cost includes only labor. Costs of transporting equipment and materials to the site are excluded since they are too variable.

(viii) Accuracy of the estimates is within ±20 percent margin.

The cost estimates were obtained from major solar equipment suppliers, namely, First Philippine Energy Corporation and Solar Electric. The costs reflect the retail prices in the local market. It is therefore possible to reduce the costs of the system if the components can be purchased in volume. The retail costs of the major components of the PV installations are shown below.

Table 5.4
Retail prices and tariffs of major components in PV system

COMPONENT	TARIFF	PRODUCED LOCALLY?	RETAIL COST	UNIT
PV modules	0	No	$4.2 – 8.0	per Wp
Battery				
Automotive Battery	15	Yes	P25 – 40	per A-hr
Deep-cycle battery	7	No	$2.0 – 5.0	per A-hr
Controller	3	Yes	$4.0 – 7.0	per A
Pump	3	No	$0.8 – 4.0	per W
Pump controller	3	No	$0.4 – 1.0	per W
Hybrid supply controller	3	No	$0.8 - $2.0	per W
Inverter	3	Yes	P30 – 100 $0.6 – 1.6	per W
Converter	3	Yes	P25 – 80 $0.5 – 2.0	per W

5.4.1 Solar Home Systems

A solar home system consists of PV modules and balance of system components, *i.e.*, battery, charge controller and support and wiring. More than half of the investment cost is due to PV modules.

Four solar home systems, with daily generating capacity ranging from 125 Wh to 450 Wh, are configured in Table 5.5. The systems use automotive (shallow-type) battery which is replaced every three years.

Since the system is individualized, no operating cost is imputed. The annual maintenance cost represents the value of time of the person charged to periodically refill the battery with distilled water. In addition, the battery and charge controller are replaced every 3 and 5 years, respectively.

Table 5.5
Investment Costs of Solar Home Systems

	SHS1	SHS2	SHS3	SHS4
Daily load (Wh)	125 – 150	180 – 225	250 – 300	360 – 450
PV (Wp)	50	75	100	150
Battery (A-hr)	70	100	140	200
Controller (A)	5	6	10	12
Typical load	❑ 2 units of 10W lamp at 4 hrs. each ❑ 5W radio at 3 hrs.	❑ 3 units of 10W lamp at 4 hrs. each ❑ 15W radio at 4 hrs. or 30W B&W TV at 2 hrs.	❑ 4 units of 10W lamp at 4 hrs. each ❑ 15W radio at 6 hrs. or 30W B&W TV at 3 hrs.	❑ 4 units of 10W lamp at 5 hrs. each ❑ 15W radio at 4 hrs. ❑ 30W B&W TV at 4 hrs.
Investment cost	**26,000**	**35,000**	**43,200**	**57,500**
PV module	13,500	20,000	25,000	36,000
Battery	2,450	3,500	4,900	7,000
Controller	1,750	2,100	3,500	4,200
Auxilliary	2,300	2,400	2,600	2,800
Installation	6,000	7,000	7,200	7,500
IC per kWh	**520,000**	**466,667**	**432,000**	**383,333**
Ann. operation	0	0	0	0
Ann. maintenance	250	350	500	700
Life-cycle cost	54,563	73,711	93,708	125,520
LC per kWh	**145.55**	**133.51**	**124.99**	**113.68**

The levelized costs per kWh range from P114 to P146; costs fall as capacity of the system increases. Similarly, investment cost per kWh is between P383,000 to P520,000; economies of scale is evidently strong. It is also apparent that the current fees imposed on households, *e.g*,, P50 per month by the Philippine Rural Reconstruction Movement are not designed to cover the costs of the system, but merely to reimburse the maintenance expenses.

5.4.2 PV Street Lighting System

Table 5.6 presents six configurations of PV street lighting systems. The systems are designed to operate for 12 hours daily. Automotive shallow-type battery is used. The sizes of the battery and controller are matched with the capacity of the PV module. No operating cost is imputed since each system is individualized and therefore the operation involves a simple switching on and off. Maintenance of the system only requires periodic water refilling of the battery; thus as in solar home systems, the cost is nominal.

PV street lights, like solar home systems, have levelized costs that are several fold higher than prices of grid connected facilities. The levelized costs range from P125 to P172 per kWh. Strong economies of scale is evident; larger system, i.e., with more lighting load, requires higher upfront investment cost, but is associated with lower investment cost per kW and levelized cost per kWh.

Table 5.6
Investment Costs of PV Street Lighting Systems

	PSLS1	PSLS2	PSLS3	PSLS4	PSLS5	PSLS6
Lighting load W	10	12	16	18	23	25
PV (Wp)	50	50	50	75	100	100
Battery (A-hr)	70	100	100	140	140	200
Controller (A)	5	5	6	6	10	10
Investment cost	**27,000**	**28,500**	**35,000**	**37,000**	**43,500**	**45,000**
PV Module	13,500	13,500	19,000	19,000	25,000	25,000
Battery	2,450	3,500	3,500	4,900	4,900	7,000
Charge Cont.	1,750	1,750	1,750	2,100	3,500	3,500
Auxilliary com.	3,300	3,750	3,750	4,000	2,600	2,000
Installation	6,000	6,000	7,000	7,000	7,500	7,500
IC per kW	**540,000**	**570,000**	**466,667**	**493,333**	**435,000**	**450,000**
Ann. operation	0	0	0	0	0	0
Ann. maintenance	250	350	350	500	500	700
Life cycle cost	56,316	61,947	73,336	81,344	94,234	102,867
LC per kWh	**172.13**	**157.79**	**140.10**	**138.13**	**125.23**	**125.77**

5.4.3 Battery Charging Stations

Among small-scale PV installations, battery charging stations yield the lowest electricity generation cost. The levelized costs per kWh of six battery charging stations are presented in Table 5.7. For comparability, all households served by the stations are assumed to have an average daily load of 150 Wh.

The stations are sized according to the target number of household users. To illustrate, in BCS1, the station has 2 channels for use of 10 households whose batteries have load of 70 ampere-hours. This implies that at any day, 2 households can charge their batteries with power supply sufficient for their 5-day use. Thus, the station can supply energy equivalent to 1.5 kWh per day.

Annual operation costs pertain to the salary of the administrator of the station. No maintenance cost is imputed since the system does not have a battery to maintain. The costs of maintaining the batteries owned by the households are assumed to be on the individual household account.[4] The only replaceable part is the battery charge controller with an expected life of 5 years.

Table 5.7
Investment Costs of Battery Charging Stations

	BCS1	BCS2	BCS3	BCS4	BCS5	BCS6
No. of households served	10	20	40	10	20	40
Daily load (Wh) per household	150	150	150	150	150	150
Battery (A-hr)	70	70	70	100	100	100
Channel Specs						
PV (Wp)	300	300	300	450	450	450
Controller (A)	25	25	25	36	36	36
No. of channels	2	4	8	2	3	5
Investment cost	**220,000**	**440,000**	**880,000**	**325,000**	**487,500**	**812,500**
PV module	150,000	300,000	600,000	225,000	337,500	562,500
Controller	15,000	30,000	60,000	20,000	30,000	50,000
Other mat'ls	5,000	10,000	20,000	5,000	7,500	12,500
Installation	50,000	100,000	200,000	75,000	112,500	187,500
IC per kW	**366,667**	**366,667**	**366,667**	**361,111**	**361,111**	**361,111**
Ann. Operation	6000	6000	6000	6000	6000	6000
Ann. Maintenance	0	0	0	0	0	0
Life-cycle cost	446,374	847,932	1,651,047	635,712	931,160	1,522,055
LC per kWh	**109.15**	**103.67**	**100.93**	**155.45**	**113.85**	**93.05**

Private charging stations impose a fee between P30 to P60 for charging 70 to 100 ampere-hour of battery. This fee is equivalent to an electricity charge of P35 to P60 per kWh. Thus, as the proponents claim, the current fees are insufficient to cover the full cost of the system.

5.4.4 PV Pumping Stations

The various sizes of PV water packages shown in Table 8 can be deployed in rural communities depending on water source and demand. As in other PV installations, smaller systems have higher investment and levelized costs per output unit.

In this system, the pump controller is replaced every 10 years. The design is for submersible pump. It has no battery as the water tank serves as storage. Operation is simple, thus the cost pertains to the honorarium due the administrator.

[4]The situation is different when the battery charging station leases the batteries to the households. In which case, the costs of maintaining the batteries are part of the station's account.

Table 5.8
Investment Costs of PV Pumping Stations

	PVP1	PVP2	PVP3	PVP4
Daily water supply (li)	600 – 750	900 – 1,125	1,800 – 2,250	3,000 – 3,750
Head	30	30	30	30
PV (kWp)	0.10	0.15	0.30	0.50
Pump Controller (A)	10 @ 12 V	12 @ 12 V	30 @ 12 V	50 @ 12 V
Investment cost	**78,000**	**104,000**	**195,000**	**312,000**
PV module	25,000	36,000	75,000	110,000
Pump controller	20,000	25,000	40,000	100,000
Other materials	15,000	19,000	35,000	30,000
Installation	18,000	24,000	45,000	72,000
IC per cu m	**115,556**	**102,716**	**96,296**	**92,444**
Operation	6,000	6,000	6,000	6,000
Maintenance	1,800	2,400	4,500	7,200
Life-cycle cost	201,370	253,018	432,980	677,469
LC per cu m	**109.42**	**91.66**	**78.43**	**73.63**

	PVP5	PVP6	PVP7	PVP8
Daily water supply (kl)	4.8 – 6.0	9.6 – 12.0	18.0 – 22.5	48.0 – 60.0
Head	30	30	30	30
PV (kWp)	0.8	1.6	3.0	8.0
Pump controller	20 @ 48 V	40 @ 48 V	75 @ 48 V	80 @ 120 V
Investment cost	**520,000**	**715,000**	**1,105,000**	**2,080,000**
PV module	180,000	320,000	600,000	1,350,000
Pump controller	188,000	195,000	215,000	215,000
Other materials	32,000	35,000	35,000	35,000
Installation	120,000	165,000	255,000	480,000
IC per cu m	**96,296**	**66,203**	**22,376**	**38,519**
Operation	6,000	6,000	6,000	6,000
Maintenance	12,000	16,500	25,500	48,000
Life-cycle cost	1,106,107	1,483,645	2,240,654	4,117,077
LC per cu m	**75.13**	**50.39**	**40.59**	**27.96**

How does a PV water system compare with a wind pump? The former, of course, is more flexible and reliable as it does not require minimum wind resource, hence can be deployed almost anywhere. In terms of costs, however, wind pump is more economical, requiring lower investment as well as operation and maintenance costs. The economics of the two systems are compared below. Resources permitting, wind pump is clearly preferred to PV water system.

Table 5.9
PV water system vs. Wind pump

	PV	Wind	PV	Wind
Output (cu m)	3 – 3.75	1 – 5	48 – 60	45 – 120
Investment cost	312,000	30,000	2,080,000	145,000
IC per cu m	92,444	10,000	38,519	1,758
Ann. O & M	13,200	7,000	54,000	22,000
Life-cycle cost	677,469	84,288	4,117,077	493,087
LC per cu m	73.63	13.62	27.96	2.00

5.4.5 PV Power Plants

The PV power plants in Table 5.10 are designed to generate electricity of 220 volts. Deep-cycle batteries are used; these are imported and have an expected life of 5 years. The inverter is replaced every 10 years.

The beneficiary community is comprised of households with an average daily energy demand of 200 kWh. Operation cost is relatively higher than other PV installations, since the system will require an engineer as system administrator. Maintenance expenses increase with the size of the plant.

Table 5.10
Investment Costs of PV Power Plants

	PVPP1	PVPP2	PVPP3	PVPP4
Daily load (kWh)	2.4 – 2.7	7.2 – 8.0	12.0 – 13.5	24.0 – 27.0
No. of households served	12	36	60	120
PV (kWp)	1	3	5	10
Battery (kWh)	10	30	50	100
Inverter @ 0.6 DF (kW)	1.4	4.5	7.5	12.5
Investment cost	**455,000**	**1,170,000**	**1,755,000**	**3,250,000**
PV module	200,000	600,000	900,000	1,800,000
Battery	45,000	90,000	187,500	375,000
Inverter	60,000	135,000	187,500	250,000
Other materials	45,000	75,000	75,000	75,000
Installation	105,000	270,000	405,000	750,000
IC per kW	**455,000**	**390,000**	**351,000**	**325,000**
Ann. operation	180,000	180,000	180,000	180,000
Ann. maintenance	4,500	9,000	18,750	37,500
Life-cycle cost	2,242,910	3,601,713	4,820,989	7,801,669
LC per kWh	**322.62**	**173.83**	**138.69**	**112.21**

One may compare the economic viability of installing solar home systems and constructing PV power plant. If solar home systems are installed instead (SHS2 in Table 5.5), the investment cost for 120 household amounts to P4.2 million, higher than the P3.25 million required by a comparable PV power plant (*i.e.*, PVPP4 in Table 5.10). The levelized energy costs are P133.15

per kWh for solar home and P112.21 per kWh for PV power plant. In this case, the PV plant is optimal.

On the other hand, a smaller community of 60 households will require investments of P2.1 million and P1.8 million for solar home and PV plant (PVPP3), respectively. But the life-cycle cost of solar home systems is smaller, *i.e.*, P4.1 million compared to P4.5 million for a PV plant. Corollarily, the levelized cost is lower for solar home, P123.98 per kWh, versus P132.52 for PV plant. Here, solar home system is preferred to PV plant.

Thus, for small-sized communities, as is the case for most remote rural villages, solar home systems are more economical compared to PV power plant. Apart from costs, another consideration is the relative ease of operating and maintaining solar home systems compared to PV plant. This explains the sparseness of investments in PV plants for rural electrification.

5.4.6 Hybrid systems

Since solar is an intermittent source of energy, photovoltaics are often coupled with other systems that rely on other energy resource, such as diesel, wind, biomass and hydro. PV-generated power is often costlier than those of other systems, thus PV is usually sized after the use of other generators is optimized. Thus the contribution of PV to the total system is determined after considering the cost of fuel (diesel, gas or biomass) and availability of other resources (wind speed or water flow).

Table 5.11 considers the economics of five equally sized hybrid systems. The first system, PV-wind, is imported, thus the huge investment cost of P8.8 million. The large life-cycle cost of this system, P16 million, owes in part to the kind of battery included in the system. It is estimated that such battery, costing P1.5 million, has a useful life of 10 years.

The inclusion of battery storage in hybrid systems 2 and 4 increases the upfront investments, but lowers the electricity generation costs. As explained in section 1, a hybrid system without a battery must have an automated load regulator that permits greater utilization of renewable resource.

Of the five systems, it is clear that the PV-wind-diesel-battery combination yields the lowest power cost, but requires the largest investments compared to other local designs. It is interesting to note that this system is similar to the Atulayan facility recently constructed by Synergy Power, Inc.

Table 5.11
Investment Costs of Hybrid PV Systems

	Hybrid1 (PV-Wind)	Hybrid2 (PV-Diesel-battery)	Hybrid3 (PV-Diesel)	Hybrid4 (PV-Wind-diesel-battery)	Hybrid5 (PV-Wind-Diesel)
Daily load (kWh)	55	55	55	55	55
PV (kWp)	16	1	1	1	1
Wind (kW)	9			1	1
Diesel (kW)		8	8	8	8
Battery (kWh)	250	25		25	
Inverter (kW)	8	4	1.5	4	1.5
Investment cost	**8,800,000**	**975,000**	**730,000**	**1,300,000**	**1,040,000**
PV module	3,000,000	200,000	200,000	200,000	200,000
Wind turbine	1,800,000	-	-	250,000	250,000
Diesel generator	-	200,000	200,000	200,000	200,000
Battery	1,500,000	150,000		150,000	
Inverter	250,000	100,000	60,000	100,000	60,000
Others	650,000	100,000	90,000	100,000	90,000
Installation	1,600,000	225,000	180,000	300,000	240,000
IC per kW	**366,667**	**108,333**	**81,111**	**130,000**	**104,000**
O & M	280,000	320,000	410,000	320,000	415,000
Life-cycle cost	18,278,399	4,284,656	4,652,710	5,181,284	5,261,625
LC per kWh	**121.90**	**28.57**	**31.03**	**34.55**	**25.09**

5.5 Future of PV Systems in the Philippines

In the coming years, the popularity of PV systems in the Philippines is expected to be boosted by new socio-economic programs that are currently in the pipeline. One such project is the Solar Power Technology Support (SPOTS) Project of the Department of Agrarian Reform. SPOTS is akin to DILG-MSIP in that both utilize solar energy technologies to push community development programs.

The project, costing US$57 million, will be funded by loan proceeds from the Government of Spain. Some 79 agrarian reform communities (ARCs) in 41 provinces are the target beneficiaries. The program will run in two phases: the first phase is of 18-month duration and expected to commence either in the fourth quarter of 2001 or early part of 2002. During this phase, 37 ARCs are to be selected in 5 regions (IX, X, XI, XII and CARAGA) and 15 provinces.[5] Priority will be given to ARCs where at least 76 percent of land was distributed through the Comprehensive Agrarian Reform Program (CARP).

Working through the farmer cooperatives, SPOTS will install solar packages aimed at raising agricultural productivity and promoting community development. Packages for agricultural

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[5] Target provinces include Zamboanga Norte, Zamboanga Sur, Misamis Oriental, Davao Norte, Davao Sur, Davao Oriental, Sarangani, South Cotobato, Sultan Kudarat, Cotobato, Agusan Sur, Agusan Norte and Surigao Norte.

development include water pumping systems (livestock or drip irrigation) and power supply system for agri-business activities such as egg incubation, chicken hatchery, piggery, bakery and refrigeration. To support community infrastructure, solar packages will be installed in barangay health clinics, barangay halls and schools. PV installations will also be set up for community lighting and potable water supply system.

A noteworthy feature of the program is that the solar installations will be transferred to farmer cooperatives as a grant, thus, DAR does not expect to recover the cost of the project. The subsidy is important in light of the high levelized costs of generating power from the system, which is clearly beyond the means of target beneficiaries. Nonetheless, a user's fee will be collected from direct beneficiaries, but such fee will be used mainly for operating and maintenance expenses. Collections in excess of these expenses will accrue to the farmers' cooperative in support of their capital build-up.

SPOTS project will complement the "Decentralized Energy Systems" (DES) Project of the Philippine National Oil Company-Energy Research and Development Center (PNOC-ERDC). DES promotes all off-grid energy systems. The project has approved funding to Base Corp. and RULEC for installation of PV lighting systems.

In addition, the *O'Ilaw* Rural Electrification Program of the Department of Energy has gained momentum of late. Although the program has no inherent biased on PV, it would be noted that 40 out of 64 projects implemented between December 1999 to December 2000 are PV installations.

Yet the emergence of a true market for PV will depend on the technological developments in the global industry. The major impediment to widespread use of PV remains to be its high costs. Efforts to reduce the costs of the system are not lacking. One track is to increase the efficiencies of solar cells. It is said that the operating efficiencies of present commercial systems are less than half of their laboratory potential and much lower than their theoretical efficiency. Another track is to explore less expensive materials, in particular, producing crystalline thin-film cells on foreign substrates, thus minimizing the use of silicon. Still another is to develop low cost optical concentrating systems to focus sunlight on small high efficiency cells. [6]

The penultimate objective is to reduce the cost of PV systems to the extent that subsidies may be dispensed in favor of market forces. Until such time, PV systems may still be the technology choice for rural electrification given its high availability and minimal maintenance.

[6] Renewable Energy World, "Renewable Prospects in Today's Conventional Power Generation Market," July 1999, p. 42.

Annex 1
NRE Installations in the Philippines

NRE Installation in the Philippines

As of April 30, 2001

Region	Provinces	Wind Pump	Wind Turbine	Micro-Hydro System	Photovoltaic System	Solar Water Heater	Solar Dryer	Biogas System	Biomass Fired Dryer	Biomass Fired Boiler	Gasifiers	Biomass Fired Oven
CAR	Abra	4			273			1				2142
	Apayao				38							
	Benguet	1		100	51	4		6				1
	Ifugao			18	2			1				
	Kalinga-Apayao	1		22	431			3	3			
	Mt. Province			3	12			11				1
1	Ilocos Norte	3	2	1	21			3				4785
	Ilocos Sur	5			154			2				8544
	La Union	7		3	34	3		11	5532		1	61
	Pangasinan	3			8		4	4		1		353
2	Batanes		2		46			1				
	Cagayan				41				5			
	Isabela	4		5	101			12	11	2		3
	Nueva Vizcaya			3	116			3	2			2
	Quirino	1			8			3	3			
3	Bataan	2										3
	Bulacan	7			7	1		44				6
	Nueva Ecija	88		1	24			24	4	3		33
	Pampanga	14			4			34		2	1	6
	Tarlac	1				1		1	2	1		3
	Zambales	5			46			2				
4	Aurora				19							
	Batangas	1			45	3		25		3		
	Cavite	1		3	18	1	1	17				97
	Laguna			3				4	1	2		1
	Marinduque				13			3				

Region	Provinces	Wind Pump	Wind Turbine	Micro-Hydro System	Photovoltaic System	Solar Water Heater	Solar Dryer	Biogas System	Biomass Fired Dryer	Biomass Fired Boiler	Gasifiers	Biomass Fired Oven
	Occidental Mindoro				83							
	Oriental Mindoro			1	2			1				
	Palawan	3	2		358	1		2	124			94
	Quezon			1	5			10		9		1
	Rizal	2				3		5				
	Romblon				54							
5	Albay							2				49
	Camarines Norte				13		1	3	3			30
	Camarines Sur		1	7	34			2	11	2		123
	Catanduanes			1	1							22
	Masbate	1			78							24
	Sorsogon			1								65
6	Aklan		1	3	2	2						57
	Antique		1	1	57			1	1	1		83
	Capiz				25			9		2		63
	Guimaras	2		1	40					2		31
	Iloilo	37	2	1	278			4	1	3	3	157
	Negros Occidental	7	2	7	100	1		2	1	55		28
7	Bohol	6		2	100			2	16			17
	Cebu	4		4	79	71		31	13	15		90
	Negros Oriental	14		6	118		2	16	93	7		42
	Siquijor			1	4				11			
8	Biliran				43				2			1
	Eastern Samar			1	752							18
	Leyte	1		2	8	1		5	41	8	1	14
	Southern Leyte	1		2	100				1		3	1
	Northern Samar				40				20			37
	Western Samar			1	92				1			14
	Southern Samar											

Region	Provinces	Wind Pump	Wind Turbine	Micro-Hydro System	Photovoltaic System	Solar Water Heater	Solar Dryer	Biogas System	Biomass Fired Dryer	Biomass Fired Boiler	Gasifiers	Biomass Fired Oven
9	Basilan			2	1			1	9			1
	Zamboanga del Norte	3			5			15	9			4
	Zamboanga del Sur	3		4	10			8	6		1	327
10	Bukidnon			7	15		1	4	86	6		115
	Camiguin			1	9				89			16
	Misamis Occidental	1			16			2	1055	4		56
	Misamis Oriental				13			3	1169			50
11	Davao del Norte			2	140	3	3	1	16			36
	Davao del Sur	3		3	26	17		21	22	17		123
	Davao Oriental				7			2	1			
	Sarangani								26			
	South Cotabato	1			36							2
	Sultan Kudarat	2			15		1	3	21	1	1	33
12	Lanao del Norte				6		1	1	1092	1		89
	North Cotabato											
	Cotabato			3	10				4	1	1	98
13	Agusan del Norte				106		1	1	1754	27		88
	Agusan del Sur				1				903			25
	Surigao del Norte			1	8				2604			50
	Surigao del Sur				27		1					
ARMM	Lanao del Sur	2		3	356		3	2	190	2	1	131
	Maguindanao				1				8		7	43
	Sulu				35							
	Tawi-Tawi				28							
Total Installations		**241**	**13**	**231**	**4850**	**112**	**19**	**374**	**14966**	**177**	**20**	**18389**

Source: NESCON; SATMP survey.

Annex 2
Tariff Schedules on Capital and Equipment used in NRE Systems

Code	Description	Tariff Rate
84.02	**Steam or other vapour generating boilers (other than central heating hot water boilers capable also of producing low pressure steam); super-heated water boilers.**	
8402.11 00	Watertube boilers with a steam production exceeding 45 t per hour	10
8402.19 00	Other vapour generating boilers, including hybrid boilers	10
84.06	**Steam turbines and other vapour turbines.**	
8406.81 00	Of an output exceeding 40 MW	3
8406.82 00	Of an output not exceeding 40 MW	3
84.10	**Hydraulic turbines, water wheels, and regulators therefor.**	
8410.11 00	Of a power not exceeding 1,000 kW	3
8410.12 00	Of a power exceeding 1,000 kW but not exceeding 10,000 kW	3
8410.13 00	Of a power exceeding 10,000 kW	3
84.12	**Other engines and motors.**	
8412.10 00	Reaction engines other than turbo-jets	3
	Hydraulic power engines and motors:	
8412.21 00	Linear acting (cylinders)	3
8412.29 00	Other	3
	Pneumatic power engines and motors:	
8412.31 00	Linear acting (cylinders)	3
8412.39 00	Other	3
8412.80 00	Other	3
8412.90 00	Parts	3
84.13	**Pumps for liquids, whether or not fitted with a measuring device; liquid elevators.**	
	Pumps fitted or designed to be fitted with a measuring device:	
8413.11 00	Pumps for dispensing fuel or lubricants, of the type used in filling-stations or in garages	3
8413.19 00	Other	3
8413.20 00	Hand pumps, othern than those of subheading No 8413.11 00 or 8413.19 00	10
8413.30 00	Fuel, lubricating or colling medium pumps for internal combustion piston engines	3
8413.40 00	Concrete pumps	3
8413.50 00	Other reciprocating positive displacement pumps	3
8413.60 00	Other rotary positive displacement pumps	3
8413.70 00	Other centrifugal pumps:	
8413.70 10	Centrifugal water pumps, single stage, single suction, horizontal shaft type suitable for belt drive or direct coupling (except pumps with shafts common with prime mover)	10
8413.70 90	Other	3
	Other pumps; liquid elevators	3
8413.81 00	Pumps	3
8413.82 00	Liquid elevators	3
	Parts:	
8413.91 00	Of pumps	
8413.91 10	Of the goods of subheading Nos 8413.20 00 and 8413.70 10	10
8413.91 90	Other	3
8413.92 00	Of liquid elevators	3

84.19	**Machinery, plant or laboratory equipment, whether or nor electrically heated, for the treatment of materials by a process involving a change of temperature such as heating, cooking, roasting, distilling, rectifying, sterilising, pasteurising, steaming, drying, evaporating, vaporising, condensing ot colling, other than machinery or plant of a kind used for domestic purposes; instantaneous or storage water heaters, non-electric.**	
	Instantaneous or storage water heaters, non-electric:	
8419.11 00	Instantaneous gas water heaters	3
8419.19 00	Other	3
8419.20 00	Medical, surgical or laboratory sterilisers	3
	Dryers:	
8419.31 00	For agricultural products	3
8419.32 00	For wood, paper pulp, paper or paperboard	3
8419.39 00	Other	3
8419.40 00	Distilling or rectifying plant	3
8419.50	Heat exchange units:	
8419.50 10	Condensers for air-conditioning machines for motor vehicles	5
8419.50 90	Other	
8419.60 00	Machinery for liquefying air or other gases	3
	Other machinery, plant or equipment:	
8419.81 00	For making hot drinks or for cooking or heating food	3
8419.89 00	Other:	
8419.89 10	Evaporators for air-conditioning machines for motor vehicles	5
8419.89 20	Chemical vapor deposition apparatus for semiconductor production	Free
8419.89 90	Other	3
8419.90	Parts:	
8419.90 10	Parts of chemical vapor deposition apparatus for semiconductor production	Free
8419.90 90	Other	3
84.21	**Centrifuges, including centrifugal dryers; filtering or purifying machinery and apparatus, for liquids or gases.**	
	Centrigues, including centrifugal dryers:	
8421.11 00	Cream separators	3
8421.12 00	Clothes dryers	3
8421.19	Other	
8421.19 10	Spin dryers for semiconductor wafer processing	Free
8421.19 90	Other	3
	Filtering or purifying machinery and apparatus for liquids:	
8421.21 00	For filtering or purifying water	10
8421.22 00	For filtering or purifying beverages other than water	3
8421.23 00	Oil or petrol-filters for internal combustion engines	10
8421.29 00	Other	
	Filtering or purifying machinery and apparatus for gases:	
8421.31 00	Intake air filters for internal combustion engines	10
8421.39 00	Other	3
	Parts:	
8421.91	Of centrigues, including centrifugal dryers:	
8421.91 10	Parts of spin dryers for semiconductor wafer processing	Free
8421.91 90	Other	3
8421.99 00	Other	3

84.81	**Taps, cocksm valves and similar appliances for pipes, boiler shells, tanks,vats or the like including pressure-reducing valves and thermostatically controlled valves.**	
8481.10 00	Pressure-reducing valves	3
8481.20 00	Valves for oleohydraulic or pneumatic transmission	3
8481.30 00	Check valves	7
8481.40 00	Safety or relief valves	3
8481.80	Other appliances:	
8481.80 10	Magnetic valves for closing or opening of doors of buses	3
8481.80 20	Gate valves	7
8481.80 30	Tire valves	3
8481.80 40	Pneumatically controlled valves	3
8481.80 50	Hog nipple waterer	3
8481.80 60	Gas cock/valve whether or not fitted with piezo-electric igniters for stoves and ranges	3
8481.80 90	Other	7
8481.90 00	Parts	3
85.01	**Electric motors and generators (excluding generating sets).**	
8501.31 00	Of an output not exceeding 750 W	3
8501.32 00	Of an output exceeding 750 W but not exceeding 75 kW	3
8501.33 00	Of an output exceeding 75 kW but not exceeding 375 kW	3
8501.34 00	Of an output exceeding 375 kW	3
8501.40 00	Other AC motors, single phase	3
8501.51 00	Of an output not exceeding 750 W	3
8501.52 00	Of an output exceeding 750 W but not exceeding 75 kW	3
8501.53 00	Of an output exceeding 75 kW but not exceeding 375 kW	3
8501.61 00	Of an output not exceeding 75 kVA	3
8501.62 00	Of an output exceeding 75 kVA but not exceeding 375 kVA	3
8501.63 00	Of an output exceeding 375 kVA but not exceeding 750 kVA	3
8501.64 00	Of an output exceeding 750 kVA	3
85.02	**Electric generating sets and rotary converters.**	
8502.11 00	Of an output not exceeding 75 kVA	
8502.12 00	Of an output exceeding 75 kVA but not exceeding 375 kVA	
8502.13 00	Of an output exceeding 375 kVA	
8502.20 00	Generating sets with spark-ignition internal combustion piston engines	
8502.31 00	Wind powered	
8502.39 00	Other	
8502.40 00	Electric rotary converters	
85.03 **8503.00 00**	**Parts suitable for use solely or principally with the machines of heading 85.01 or 85.02**	
85.04	**Electrical transformers, static converters (for example, rectifiers) and inductors.**	
8504.10 00	Ballasts for discharge lamps or tubes	10
8504.21	Having a power handling capacity not exceeding 650 kVA:	
8504.21 10	Step-voltage regulators; instrument transformers (potential and current) with handling capacity not exceeding 5 kVA	3
8504.22	Having a power handling capacity exceeding 650 kVA but not exceeding 10,000 kVA	
8504.22 10	Step-voltage regulators	3
8504.23	Having a power handling capacity exceeding 10,000 kVA:	

8504.23 10	Not exceeding 15,000 kVA	15
8504.31	Instrument potential transformers	3
8504.32	Instrument transformers (potential and current) with handling capacity not exceeding 5 kVA	3
8504.33	Having a power handling capacity exceeding 16 kVA but not exceeding 500 kVA	15
8504.34	Not exceeding 15,000 kVA	15
8504.40	Static converters for automatic data processing machines and units thereof, and telecommunications apparatus	Free
8504.50	Other inductors for power supplies for automatic data processing machines and units thereof, and telecommunication apparatus	Free
8504.90	Parts	3
85.05	**Electro-magnets; permanent magnets and articles intended to become permanent magnets after magnetisation; electro-magnetic or permanent magnet chucks, clamps and similar holding devices; electro-magnetic couplings, clutches and brakes; electro-magnetic lifting heads.**	
	Permanent magnets and articles intended to become magnets after magnetisation:	
8505.11 00	Of metal	3
8505.19 00	Other	3
85.06	**Primary cells and primary batteries.**	
8506.10 00	Manganese dioxide	15
8506.30 00	Mercuric oxide	7
8506.40 00	Silver oxide	7
85.07	**Electric accumulators, including separators therefor, whether or not rectangular (including square).**	
8507.10 00	Lead-acid, of a kind used for starting piston engines	15
8507.20 00	Other lead-acid accumulators	15
85.14	**Industrial or laboratory electric (including induction or dielectric) furnaces and ovens; oter industrial or laboratory induction or dielectric heating equipment.**	
8514.10	Resistance heated furnaces and ovens:	
8514.10 10	Resistance heated furnaces and ovens for the manufacture of semiconductor devices on semiconductor wafers	Free
8514.30	Other furnaces and ovens:	
8514.30 10	Apparatus for rapid heating of semiconductor wafers	Free
85.16	**Electric instantaneous or storage water heaters and immersion heaters; electric space heating apparatus and soil heating apparatus; electro-thermic hair-dressing apparatus (for example, hair dryers, hair curlers, curling tong heaters) and hand dryers; electric smoothing irons; other electro-thermic appliances of a kind used for domestic purposes; electric heating resistors, other than those of heading No. 85.45.**	
8516.10 00	Electric instantaneous or storage water heaters and immersion heaters	10

85.35	**Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, fuses, lightning arresters, voltage limiters, surge supressors, plugs, junction boxes), for a voltage exceeding 1,000 volts.**	
8535.10 00	Fuses	3
8535.21 00	For a voltage of less than 72.5 kV	7
8535.29 00	Other	7
8535.30 00	Isolating switches and make-and-break switches	3
8535.40 00	Lightning arresters, voltage limiters and surge suppressors	3
8535.90	Other:	
8535.90 10	Bushing assembly, tap changer assembly, connectors and terminals for electric distribution and power transformers	3
85.36	**Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets, lamp-holders, junction boxes), for a voltage not exceeding 1,000 volts.**	
8536.10	Fuses:	
8536.10 00	Thermal fuses; glass type fuses	3
8536.2	Automatic circuit breakers:	
8536.20 10	For electro-thermic domestic appliances of heading no 85.16	3
8536.30 00	Other apparatus for protecting electrical circuits	7
8536.41 00	For voltage not exceeding 60 V	3
8536.49 00	Other	3
85.37	**Boards, panels, consoles, desks, cabinets and other bases, equipped with two or more apparatus of heading No. 85.35 or 85.36, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of Chapter 90, and numerical control apparatus, other than switching apparatus of heading No. 85.17.**	
8537.10 00	For a voltage not exceeding 1,000 V	7
8537.20 00	For a voltage exceeding 1,000 V	7
85.41	**Diodes, transistors and similar semiconductor devices; photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light emitting diodes; mounted piezo-electric crystals.**	
8541.30 00	Thyristors, diacs and triacs, other than photosensitive devices	Free
85.44	**Insulated (including enamelled or anodised) wire, cable (including co-axial cable) and other insulated electric conductors, whether or not fitted with connectors; optical fibre cables, made up of individually sheathed fibres, whether or not assembled with electric conductors or fitted with connectors.**	
8544.30	Electrical wiring harness for motor vehicles	20
8544.41 10	Telephone cables; battery cables	20
8544.49	Other:	
8544.49 10	Shielded wire of a kind used in the manufacture of automotive wiring harness	3

90.28	**Gas, liquid or electricity supply or production meters, including calibrating meters therefor.**	
9028.10 00	Gas meters	3
9028.20	Liquid meters:	
9028.20 10	Totalizing water meters	7
9028.30	Electricity meters:	
9028.30 10	Kilowatt-hour meters	7

Source: Tariff and Customs Code of the Philippines, June 2000.

Annex 3
Directory of NRE Suppliers and Organizations

Directory of NRE Suppliers and Organizations

Name of Office	**ABB POWER, INC.**
Contact Person	Thomas Ng
Designation	President
Address	Km. 20 Sucat, Parañaque City
Telephone	821-7777
Fax	824-8442
Company Description	Distributor of individual components of power plant from gas turbines to boilers

Name of Office	**ABRA ELECTRIC COOPERATIVE, INC.**
Contact Person	Atty. Marco Bautista
Address	Bangued, Abra
Telephone	(077) 752-8086
Location	Tineg, Abra
Project Title	53 W Solar Home System

Name of Office	**ACC ENGINEERING**
Contact Person	Antonio Cadullo
Designation	President
Address	372 Lopez Jaena, Jaro, Iloilo City
Company Description	Manufacturer of the ACCE Windpumps (multi-bladed type, horizontal axis) for water pumping and irrigation

Name of Office	**ADRIAN WILSON INTERNATIONAL ASSOCIATES, INC.**
Contact Person	Joven Joaquin
Designation	Chairman/CEO
Address	2/F AWIA Bldg. Libertad cor. Sinag St., Mandaluyong City
Telephone	532-1636
Fax	533-3508
E-mail	awia@info.com.ph
Company Description	Consultants & contractors for mini-hydropower projects

Name of Office	**ADVANCED RENEWABLE ENERGY CONVERSION SYSTEMS CORP.**
Contact Person	Antonio Y. Teves
Address	126 Dr. E. Meciano Rd. Dumaguete City, Negros Occidental
Telephone	(035) 422-9369, 225-4402
Fax	(035) 422-9369, 225-2214
Project Title	Reducing Fuel Costs, Pollution & Production of Low-Cost Electricity by Implementing the Teves Water Fuel Converter System from Ordinary Water

Name of Office	**AFA ELECTRO INDUSTRIAL SYSTEMS, INC.**
Contact Person	Arturo T. Uy
Designation	President
Address	28 Sct. Borromeo St., South Triangle, Quezon City
Telephone	924-1735/924-1729
Fax	924-1729
Company Description	Manufacturer of locally-designed AFA battery control units, ballast, flourescent lamps, flourescent inverter sets and battery chargers for PV systems. AVR/UPS, Emergency Light.

Name of Office	**AGUSAN POWER CORPORATION**
Contact Person	Alberto Rodriguez, Jr.
Designation	President
Address	202 Westwood Cond., 23 Eisenhower St., Greenhills, San Juan, M.M.
Telephone	722-2048, 722-1844
Fax	722-1842
Company Description	Constructor of Lake Mainit NRE project, Agusan

Name of Office	**ALFA-LAVAL PHILS., INC.**
Contact Person	Bien Orgiales
Designation	General Manager
Address	3/F Molave Bldg., 2231 Pasong Tamo, Makati City
Telephone	810-3930
Fax	815-0642
Website	www.alfalaval.com
Company Description	Contractor of sludge dewatering systems, and industrial and municipal sewage treatment systems

Name of Office	ALPHA MACHINERY & ENGINEERING CORPORATION
Contact Person	Ceferino G. Follosco
Designation	Chairman of the Board
Address	1167 CLF Bldg. 1, Don Chino Roces Avenue, Makati City
Telephone	896-5556
Fax	895-3494, 890-7202
E-mail	almech@compass.com.ph
Company Description	Distributor of imported (Japan-made) and locally-fabricated conventional energy and biomass-fired boilers

Name of Office	ALSTOM PHILS., INC.
Contact Person	Waldo Darvin
Designation	Power Plant Division
Address	Km. 20 South Superhighway, Sucat, Parañaque City
Telephone	886-0777
Fax	886-0787
E-mail	philippine@power.alstom.com
Company Description	Supplier of electro-mechanical equipment

Name of Office	ALTERNATIVE ENERGY DEVELOPMENT PHILS., INC.
Contact Person	Laurie B. Navarro
Designation	President
Address	2303 Medical Plaza, Ortigas Cond. 25 San Miguel Ave., Ortigas Center, Pasig City
Telephone	910-3008, 638-5529
E-mail	lnavarro@aed.p.com.ph
Website	www.aedp.com.ph
Company Description	Consultancy

Name of Office	ALVIN'S BAKESHOP
Contact Person	Alma A. Ronquillo
Designation	Proprietor
Address	Brgy. Buray, Oton, Iloilo
Telephone	(033) 337-7915
Company Description	Manufacturer of ricehull-fed bakery ovens

Name of Office	AMBIT TRADING & TECHNICAL SERVICES
Contact Person	Orlando M. Cruz
Designation	President
Address	Unit 410 Cityland Shaw Tower, Mandaluyong City
Telephone	632-1220
Fax	631-2413
E-mail	ambit@pacific.net.ph
Company Description	Installation & erection of power generators

Name of Office	AREA RESEARCH AND TRAINING
Contact Person	Mr. Rene E. Alburo
Designation	ANEC Project Leader
Address	University of San Carlos – Main, P. del Rosario St., Cebu City
Telephone	(032) 253-1000 loc. 207 / 161
Fax	(032) 253-7183/7989/346-7941 PVP
Company Description	Affiliated Nonconventional Energy Center

Name of Office	ASSISTCO ENERGY & INDUSTRIAL CORP.
Contact Person	Pedro O. Enciso
Designation	President/CEO
Address	1st Ave., Bagong Bayan, Manalac Industrial Estate Bicutan, Taguig, Metro Manila
Telephone	838-7315, 838-7316
Fax	838-7441
Company Description	Design, construction, repair and rehabilitation of large and small reactors and biomass furnaces, refractories boilers

Name of Office	ATLANTIC GULF & PACIFIC COMPANY OF MANILA, INC.
Contact Person	Cesar Buenaventura
Designation	President
Address	Dacon Bldg., 2281 Don Chino Roces Ave., Makati City
Telephone	867-3386, 894-2943, 894-2964
Fax	563-0034
Company Description	Fabrication, design and assembly of small (250 kW and below) and large (43,000 to 88,000 kW) bagasse-fired-boilers

Name of Office	**BASE CORP.**
Contact Person	Abraham L. Cu
Designation	President
Address	700 Lerma St., Mandaluyong City
Telephone	532-6753
Fax	532-6667
E-mail	sales@han-gang.com.ph
Company Description	Distribution of MATEC solar products; conducts feasibility study, design, installation and maintenance of Siemens solar energy systems products.

Name of Office	**Bayan Telecommunications, Inc.**
Contact Person	Homer Nantes
Address	234 Roosevelt Ave., San Francisco Del Monte, Quezon City
Telephone	449-3880
Fax	449-3763
Location	Southern Leyte
Project Title	PV/ Diesel Hybrid System of Bayantel Mt Pintuyan

Name of Office	**BENGUET ELECTRIC COOPERATIVE (BENECO)**
Contact Person	Joselito Villarey
Designation	Assistant General Manager
Address	Alapang, La Trinidad, Benguet
Telephone	(074) 422-2848
Fax	(074) 422-5138
E-mail	beneco@skyinet.net
Company Description	Electric Cooperative

Name of Office	**BENGUET STATE UNIVERSITY**
Contact Person	Engr. Edgar Molintas
Designation	ANEC Project Leader
Address	La Trinidad, Benguet
Telephone	(074) 422-2403/309-1314
Fax	(074) 422-2281
Company Description	Affiliated Nonconventional Energy Center

Inventor	**BENITO B. MARAY**
Address	118 Lozada St., Phase 2A, Gatchalian Subd., Sucat, Parañaque City
Telephone	826-3015, 438-6080. 438-2001
Fax	523-1754, 525-6129
E-mail	benmaray@yahoo.com
Location	Guinarona, Dagami, Leyte
Project Title	A NRE system Consisting of a Diesel Generating Set, Electrical Set-up and Fuel Oil Produced by the Anaerobic Fermentation, Electro-magnetization, and Heating Under Pressure of Grated Coconut & Coconut Water

Name of Office	**BICOL HYDROPOWER CORPORATION**
Contact Person	Romeo Y. Tan
Designation	President
Address	Elias Angeles St.,Naga City
Telephone	(054) 811-1703 to 04
Fax	(054) 811-1703
Company Description	Consultants and contractors for mini-hydropower projects

Name of Office	**BIOMASS ENERGY ASSOCIATION OF THE PHILIPPINES (BEAP)**
Contact Person	Celestino Damian
Designation	President
Address	# 1 Lopez Jaena St. Kapasigan, Pasig City
Telephone	641-0286, 641-1794, 916-0701
Fax	641-0286
E-mail	padiscor@edsamail.com

Name of Office	**BP SOLAR PHILIPPINES**
Contact Person	Katrina V. Ignacio
Designation	Country Manager
Address	Suite 71, Zeta Bldg., 191 Salcedo St., Legaspi Village, Makati City
Telephone	8159036 / 37
Fax	8171523
Website	www.bpsolar.com.ph
Company Description	Supply, design, and installation of PV System; affiliate of BP Panels of Australia

Name of Office	**BREEZE ELECTRIC PHILIPPINES**
Contact Person	Nicanor S. Villaseñor
Designation	General Manager
Address	P.O. Box. 13750 Ortigas Center, Emerald Ave., Pasig City
Telephone	438-5678
Fax	438-5466
E-mail	breeze@pacific.net.ph
Company Description	Consultancy and construction of wind energy systems

Name of Office	**BUBUNAWAN POWER CO.**
Contact Person	Crisanto Laset, Jr.
Designation	Vice-President
Address	8/F Strata 100, Emerald Ave., Ortigas Center, Pasig City
Telephone	631-1581 - 84
Fax	631-2901
Company Description	Consultants and contractors for mini-hydropower projects

Name of Office	**CAGAYAN ELECTRIC POWER AND LIGHT COMPANY, INCORPORTED (CEPALCO)**
Contact Person	Ramon Abaya
Designation	Chairman
Address	Suite A, 8th Flr., Strata 100 Building Emerald, Pasig City
Telephone	631-1581 - 84
Fax	631-2901
E-mail	cepl@quickweb/com.ph
Company Description	Consultancy and Construction of mini-hydropower projects

Name of Office	**CAMARINES SUR STATE AGRICULTURAL COLLEGE**
Contact Person	Dr. Yolanda Castroverde
Designation	ANEC Project Leader
Address	Pili, Camarines Sur
Telephone	(054) 361-1411
Fax	(054) 477-3341
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**CAVITE STATE UNIVERSITY**
Contact Person	Dr. Ruperto S. Sangalang
Designation	President & ANEC Project Leader
Address	Indang, Cavite
Telephone	(046) 415-0021 / 415-0010
Fax	(097) 378-3542 / (046) 415-0012
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**CENTER FOR RENEWABLE RESOURCE & ENERGY EFFICIENCY**
Contact Person	Antonio De Castro
Designation	Director
Address	Rm. 204 NEC Bldg., U.P., Diliman, Quezon City
Telephone	436-3663
Fax	436-3663
E-mail	decastro@pacific.net.ph
Company Description	Consultants for NRE projects

Name of Office	**CENTRAL LUZON STATE UNIVERSITY**
Contact Person	Dr. Ireneo C. Agulto
Designation	ANEC Project Leader
Address	Muñoz, Nueva Ecija
Telephone	(044) 456-0688
Fax	(044) 456-0688
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**CENTRAL PHILIPPINE UNIVERSITY**
Contact Person	Engr. Jeriel Militar
Designation	ANEC Project Leader
Address	Jaro, Iloilo
Telephone	(033) 320-3004
Fax	(033) 320-3004
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**CEST INCORPORATED**
Contact Person	Camilo C. Domingo, Jr.
Designation	Senior Executive Assistant
Address	Unit 1404 Prestige Tower, Emerald Ave., Ortigas Center, Pasig City
Telephone	2-633-7946 / 633-7947
Fax	2-631-3080
E-mail	cest@mozcom.com
Website	www.cest-inc.com
Company Description	Consultancy and construction of mini-hydropower

Name of Office	**COLLEGE OF ENGINEERING-UNIVERSITY TAWN**
Contact Person	Engr. Rodolfo S. Yadao
Designation	ANEC Project Leader
Address	University Town, Musuan, Bukidnon
Telephone	(0912) 713-4289 / 711-8260 / (0917) 7180374
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**ISABELA STATE UNIVERSITY-COLLEGE OF ENGINEERING**
Contact Person	Engr. Ramon Velasco
Designation	ANEC Project Leader
Address	Isabela State University, Echague, Isabela
Telephone	(078) 672-2474 / 0912-244-8527
Fax	(078) 672-2474
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**CONDOR HYDRO MARKETING**
Contact Person	Daniel Dorillo
Designation	President
Address	Kamantigue St. Granplane Subd., Jaro, Iloilo City
Telephone	(033) 329-5587/ 509-0672
Fax	(033) 329-5587
Company Description	Manufacturer of the Condor Windpump for water water pumping and irrigation. Cyclone Windpump

Name of Office	**CENTRAL PHILIPPINE UNIVERSITY**
Contact Person	Walden S. Rio
Designation	Vice President, Administration
Address	Central Philippine University, Jaro, Iloilo City
Telephone	(033) 329-1971
Company Description	Developer of the Cyclone Windpumps for water pumping and irrigation

Inventor	**DANILO V. BRILLAS**
Contact Person	c/o Danah B. Sato 126-2 Pelayo St. Davao City
Telephone	(082) 224-3116, 224-3117
Fax	(082) 224-3109
Location	Buda, Marilog District, Davao City
Project Title	Mini Hydroelectric Power Plant

Name of Office	**DCCD ENGINEERING CORPORATION**
Contact Person	Roland Abalos
Designation	Assistant Vice President
Address	SOL Office Condominium Building 112 Amorsolo, Makati City 1229
Telephone	2-892-4586 to 97
Fax	2-810-6142
Website	www.dccd.com
Company Description	Consultants & design for mini-hydropower projects

Name of Office	**DE LA SALLE UNIVERSITY**
Contact Person	Godofredo C. Salazar
Designation	Associate Professor
Address	Mechanical Engineering Department, 2401 Taft Ave., Manila
Telephone	524-4611 loc 299
Fax	524-0563
Company Description	Research and design of NRE systems

Name of Office	**VISAYAS STATE COLLEGE-DEPARTMENT OF AGRICULTURAL ENGINEERING AND APPLIED MATHEMATICS**
Contact Person	Engr. Roque C. De Pedro, Jr.
Designation	ANEC Project Leader
Address	Visayas State College of Agriculture, Baybay, Leyte
Telephone	(053) 335-2624, 325-5448 (0918) 601-2441 (Tuesday & Thursday)
Fax	(053) 335-2624
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**DEVELOPMENT BANK OF THE PHILS.**
Contact Person	Eufemia Mendoza
Designation	Vice President, Window III
Address	DBP Bldg. Sen. Gil Puyat Ave., Makati City
Telephone	893-4444
Fax	893-5380
Company Description	Provides financial assistance to NRE projects

Name of Office	**DON MARIANO MARCOS MEMORIAL STATE UNIVERSITY**
Contact Person	Dr. Arturo M.I. Figueroa
Designation	ANEC Project Leader
Address	Bacnotan, La Union
Telephone	(078) 824-8574
Fax	(078) 824-8574
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**EAST ASIA POWER SERVICES, INCORPORATED**
Contact Person	Jaime Rosa
Designation	President & Chief Operating Officer
Address	20th Floor, OMM-CITRA Condominium San, Pasig City
Telephone	633-1626
Fax	633-1627
Company Description	Consultants & contractors for mini-hydropower projects

Name of Office	**EDWARD KELLER PHILS., INC.**
Contact Person	Andres Brechbuhl
Designation	Asst. Vice President
Address	2723 Chino Roces Ave., Makati City
Telephone	810-0351
Fax	818-3995
Company Description	Supplier for electro-mechanical equipment

Name of Office	**EDWARD MARCS PHILIPPINES, INC.**
Contact Person	Andres S. Cruz
Designation	President & General Manager
Address	2/F Timog Bldg., 28 Scout Albano St., 1103 Quezon City
Telephone	922-1371, 922-1658
Fax	922-1386
Company Description	Supplier of solar, water, heater, thermomax and parts

Name of Office	**ENERGY & AVIATION SUPPORT CORP.**
Contact Person	Rex Ligada
Designation	Manager
Address	Unit 804 Cityland Shaw Tower, Shaw Blvd., Mandaluyong City
Telephone	635-9372
Fax	635-9608
Company Description	Design and development of biomass-fired cogeneration systems

Name of Office	**ENERGY DEVELOPMENT & UTILIZATION FOUNDATION, INC.**
Contact Person	Benjamin Austria
Designation	Executive Director
Address	G/F PHINMA, 166 Salcedo St., Legaspi Village, Makati City
Telephone	840-0317
Fax	818-8206
E-mail	edufi@evoserve.com
Company Description	Consultancy and advocacy group

Name of Office	**ENERGY MANAGEMENT ASSOCIATION OF THE PHILIPPINES**
Contact Person	Raymundo Rafols
Designation	President
Address	Rm. 201 Vica Bldg., cor. Estrella St., Pasong Tamo, Makati City
Telephone	890-7540
Fax	890-7540
Company Description	Association of engineers

Name of Office	**ENERTECH SYSTEMS INDUSTRIES, INC.**
Contact Person	Guillermo Simeon
Designation	President
Address	81 Kaingin Rd., Balintawak, Quezon City
Telephone	362-2161 - 64
Fax	361-1805
E-mail	enertech@compass.com.ph
Company Description	Design, fabrication and installation of biomass-fired boilers (100 to 1000 kw) and pressure vessels.

Name of Office	**ENGINEERING DEVELOPMENT CORPORATION OF THE PHILIPPINES (EDCOP)**
Contact Person	Jose U. Jovellanos
Designation	Chairman of the Board
Address	6th Floor, CLNC Building 259-269 E. Delos Santos, Mandaluyong City
Telephone	724-6878, 727-6811, 727-6792
Fax	725-6277
E-mail	edcop@vasia-com.ph
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**FIRST PHILIPPINE ENERGY CORPORATION**
Contact Person	Ramon Tejero
Designation	Vice President
Address	3/F Benpress Bldg., Exchange Rd. cor. Meralco Ave., Ortigas Center,
Telephone	633-3502
Fax	631-3103
E-mail	fpecorp@skyinet.net
Website	www.fphc.com
Company Description	Supply, design and installation of PV system, SOLAREX Panels of USA

Name of Office	**G.O. ENGINEERING ENTERPRISES**
Contact Person	Rizal A. Obligar
Designation	Proprietor
Address	201 E. Miranda St. Paso De Blas, Valenzuela City
Telephone	432-1302
Fax	432-1302
E-mail	goeng@pworld.net.ph
Company Description	Manufacturer of charcoal stoves

Name of Office	**GEOSPHERE TECHNOLOGIES, INCORPORATED**
Contact Person	Leticia T. dela Cruz
Designation	Manager
Address	19-D, Eisenhower Tower Eisenhower St., Greenhills, Metro Manila 1504
Telephone	724-5665 / 724-5667
Fax	723-4250
E-mail	geosphere@pacific.net.ph
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**GEOTECNICA**
Contact Person	Arthur Saldivar-Sali
Designation	Chairman
Address	23 Avelino St., Loyola Heights, Quezon City
Telephone	426-1078
Fax	426-6641
Company Description	Consultancy and construction of mini-hydropower projects. Engineering consultancy

Name of Office	**GINGOOG POWER AND DEVELOPMENT CORPORATION**
Contact Person	Patrick Chang, Jr.
Designation	President & Chairman of the Board
Address	Suite 502, Fedman Building 199 Salcedo St., Legaspi, Makati City 1229
Telephone	812-0508
Fax	893-7960
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**HEBRON ENGINEERING**
Contact Person	Teofisto S.M. Reyes
Designation	General Manager
Address	5 Gen. Mascardo St., Kalookan City
Telephone	363-5808
Fax	363-6347
Company Description	Contractor of biomass-fired cogeneration systems

Name of Office	**HOT WATER SYSTEMS , INC.**
Contact Person	Jose T. Quimson
Designation	President
Address	3/F JMT Corporate Condo., ADB Ave., Oritigas Center, Pasig City
Telephone	633-5630/98/89
Fax	633-5628
E-mail	hotwater@pworld.net.ph
Company Description	Distributor of solar water heater from Australia

Name of Office	**HYDRO ELECTRIC DEVELOPMENT CORPORATION**
Contact Person	Manuel E. Espallardo
Designation	Liaison Officer
Address	Aboitiz Bldg., 110 Legaspi St., Legaspi Village, Makati City
Telephone	819-3844
Fax	817-9508
Website	www.aboitiz.com
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**HYDRO ELECTRIC DEVELOPMENT CORPORATION**
Contact Person	Mario A. Garcia
Address	214 Ambuklao Rd., Obulan, Beckel, La Trinidad, Benguet
Telephone	(072) 442-6080, 444-7948
Fax	(072) 444-7944
Location	La Trinidad, Benguet
Project Title	Francis Turbine Re-Engineering

Name of Office	**HYDRO SPECIALIST, INC.**
Contact Person	Benjamin Cariaso, Jr.
Designation	Vice President
Address	6/F Twin Cities Condominium, 110 Legaspi St., Legaspi Village, Makati City
Telephone	816-2881 loc. 376, 365, 750-3191
Fax	817-9508
Website	www.aboitiz.com
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**HYDROTERRE INCORPORATED**
Contact Person	Jose B. del Rosario
Designation	President
Address	Suite 602, 6th Floor, Culmat Building 1300 E., Quezon City
Telephone	2-721-8614
Fax	2-723-4225
Company Description	Consultancy and construction of mini-hydropower

Name of Office	**JAMANDRE INDUSTRIES INC.**
Contact Person	Alexis T. Belonio
Designation	President
Address	88 Rizal St., la Paz, Iloilo
Telephone	(033) 329-6574
Fax	(033) 329-6574
Company Description	Manufacturer of paddy-dryers and ricehull-fired palay dryer

Name of Office	**JARDINE SOLUTIONS**
Contact Person	Thomas Geoff
Designation	President
Address	Jardine Davies Bldg., 222 Sen. Gil Puyat Ave., Makati City
Telephone	843-6011
Fax	843-6041
Website	www.jardinedavies.com
Company Description	Contractor of biomass-fired cogeneration systems

Name of Office	**JOVER LIGHT INDUSTRIES**
Contact Person	Hector Jover
Designation	President
Address	Bgy. Tabucan, Cabatuan, Iloilo
Telephone	(033) 522-8789
Company Description	Manufacturer of the Jover Lights Windpumps for water pumping and irrigation applications

Name of Office	**KALINGA-APAYAO STATE COLLEGE**
Contact Person	Amadeo P. Imper
Designation	ANEC Project Leader
Address	Tatuk, Kalinga, Apayao
Telephone	(074) 872-2045 (076) 579-4204
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**KANLAON ENGINEERING CORP.**
Contact Person	Antonio M. Penafiel
Designation	Vice President
Address	115 San Rafael St., Mandaluyong City
Telephone	532-8720, 532-5733
Fax	532-0747
Company Description	Fabricates, installs and repairs biomass-fired boilers of any size and power range.

Name of Office	**L.V. BIOGAS PRODUCTION SYSTEMS PHILS.**
Contact Person	Leonardo D. Villanueva
Designation	Proprietor/Manager
Address	111 Roxas cor. Jacinto Sts. Magsaysay Village, Tondo, Manila
Telephone	254-7474
Fax	254-7474
Company Description	Manufacturer & distributor of household-scale biogas system

Name of Office	**LOS BAÑOS MANUFACTURING & TRADING VENTURES**
Contact Person	Ernesto Lozada
Designation	President
Address	College of Engineering, UPLB Los Baños, Laguna
Telephone	(049) 536-2926
Fax	(049) 536-2873
Company Description	Manufacturer of biomass-fed copra dryers, coconut shell-fired copra and grain dryer

Name of Office	**MADECOR ENVIRONMENTAL MANAGEMENT SYSTEMS, INC.**
Contact Person	Alice Bergonia
Designation	Business Development Manager
Address	10001 Mt. Halcon St., Umali Subd., Los Baños, Laguna
Telephone	(049) 249-2439, 536-0649, 536-0054
Fax	(049) 536-0649
E-mail	memsi@laguna.net
Company Description	Consultancy

Name of Office	**MADISON MAC KENZIE**
Contact Person	Philip Go Apostol
Designation	President
Address	3/F Reposo St., Makati City
Telephone	890-2736
Fax	896-5126
Company Description	Supplier of PV system, of CANNON USA

Name of Office	**MAKATI ACCUMOTION INTERNATIONAL**
Contact Person	Jose Ma. R. Concepcion
Designation	President
Address	30 Melantic, San Lorenzo Village, Makati City
Telephone	817-7468; 819-0192
Fax	813-0713
Company Description	Consultancy, designs and manufacturing furnaces and dryers (industrial and agricultural) using liquid and solid biomass fuels

Name of Office	**MANDALA DEVELOPMENT CORP. (MADECOR)**
Contact Person	Elpidio Del Rosario
Designation	President
Address	Unit 302 Prestige Tower, Emerald Ave., Pasig City
Telephone	638-4187, 638-1600
Fax	638-4185
E-mail	mcgutierrez@madecor.com
Website	www.madecor.com
Company Description	Consultancy on agriculture, education, training, environment

Name of Office	**MARDIZON ENTERPRISES**
Contact Person	Rolando Dizon
Designation	President
Address	804-B Fedman Bldg., 199 Salcedo St., Legaspi Village, Makati City
Telephone	893-4502
Fax	819-3760
Company Description	Supplier of drilling equipment

Name of Office	**MARIANO MARCOS STATE UNIVERSITY**
Contact Person	Engr. Rudy Bareng
Designation	ANEC Project Leader
Address	Batac, Ilocos Norte
Telephone	(077) 792-3125 (COA Office) 0918-217-5432 / 0918-217-5431
Fax	(077) 792-3879/792-3131/3191
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**MASCHINEN & TECHNIK, INC. (MATEC)**
Contact Person	Olegario S. Serafica
Designation	Vice-President
Address	Tech Center, Buencamino St., Alabang, Muntinlupa City
Telephone	850-6450 - 52
Fax	850-3631, 850-8801
E-mail	ossmatec@info.com.ph
Company Description	Supply, design and installation of PV System of SIEMENS, Germany; consultant and contractor of biogas systems.

Name of Office	**MATLING INDUSTRIAL CORPORATION**
Contact Person	Alexander Emlano
Designation	President
Address	3/F Penthouse Ermita Center Bldg., Roxas Blvd., Ermita, Manila
Telephone	521-8673
Fax	521-8680
Company Description	Developer of mini-hydro installed at Malaba, Lanao del Sur

Inventor	**MARIANO S. VENIDA, JR.**
Address	Autumn St., Summer Homes Subd., Concepcion I, Marikina City, Metro Manila
Telephone	941-8727, 816-1522
Fax	817-4789
E-mail	infarmco@pworld.net.ph
Location	Wastewater Treatment Facilities, Consolidated Distillers of the Far East, Inc. Nasugbu, Batangas
Project Title	Integration of a full scale working model of the VENIDA (Value-Engineered and Novel Industrial Digester Activator)

Name of Office	**MERALCO INDUSTRIAL ENGINEERING SERVICES CORPORATION**
Contact Person	Arsenio E. Martin
Designation	Senior Vice President - Electrical Engineering and
Address	Renaissance Tower 1000, Meralco Avenue Ortigas, Pasig City
Telephone	2-633-5123
Fax	2-635-5912
E-mail	aemartin@miescor.com.ph
Company Description	Consultancy, engineering design, construction, construction management and technical services for micro-mini hydro projects. Consultants & contractors for mini hydropower projects

Name of Office	**METS PHILIPPINES, INC.**
Contact Person	Carolino Risos
Designation	General Manager
Address	5/F SMS Bldg., 213 Gil Puyat Ave., Makati City
Telephone	813-1241
Fax	892-9383
Company Description	Contractor of biomass-fired cogenerations systems, compressor and replacement of filter elements

Inventor	**MIGUEL G. ALBERCA**
Address	University of Southern Mindanao, Kabacan, Cotabato
Telephone	(064) 248-2488
Fax	(064) 248-2138
Location	USM, Kabacan, Cotabato (near the dumpsite of Kabacan basura)
Project Title	Recycled (Basura) Degredable Wastes to Generate Power for NRE System

Name of Office	**MINDANAO STATE UNIVERSITY**
Contact Person	Prof. Mangompia U. Angod
Designation	ANEC Project Leader
Address	Marawi City, Lanao del Sur
Telephone	(063) 520-904
Fax	out of order
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**MINDANAO UPLAND MULTI-RESOURCE DEVELOPMENT**
Contact Person	Michael T. Feliciano
Designation	Manager
Address	Door 1, Fabie Apts., Jaruda Rd., Matina, Davao City
Telephone	(082) 300-5694
Fax	(082) 300-5694
Company Description	Contractor of solar installed in Paquibato District, Davao City

Name of Office	**NATIONAL HYDRAULIC RESEARCH CENTER (NHRC)**
Contact Person	Leonardo Q. Liongson
Designation	Professor & Research Fellow
Address	College of Engineering, University of the Philippines, Quezon City 1104
Telephone	927-7149 / 927-7176
Fax	927-7190
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**NORCONSULT INTERNATIONAL, A.S.**
Contact Person	Gloria A. Feliciano
Designation	Representative
Address	101 Paradise, Annex 16, Better Living Subd. Bgy., Parañaque City 1711
Telephone	823-9282
Fax	823-0893
E-mail	olinor@pworld.net.ph
Company Description	Consultants mini & micro-hydropower projects

Name of Office	**NORTHERN MINI-HYDRO CORPORATION**
Contact Person	Jovy P. Batiquin
Designation	Vice-President
Address	110 Legaspi St., Legaspi Village, Makati City
Telephone	750-3191
Fax	817-9508
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**NOTRE DAME UNIVERSITY**
Contact Person	Floriano M. Arañez
Address	9600 ND Ave., Cotabato City
Telephone	(064) 421-2698
Fax	(064) 421-4312
Location	Cotabato City
Project Title	Development of Hydraulic Ram

Name of Office	**ORIENTAL & MOTOLITE CORP.**
Contact Person	Roberto V. Garcia
Designation	President
Address	80-82 Roces Ave., Quezon Ave., Quezon City
Telephone	373-1234
Fax	373-2319
Website	www.sequel.net.~rmcrauto
Company Description	Supply, design and installation of PV system of BP panels of Australia

Inventor	**PABLO B. ESPAÑOLA, JR.**
Address	30-D Delgado St., Iloilo City
Telephone	(033) 508-0248
Project Title	High Power Vertical Axis Wind Turbine

Name of Office	**PASIG AGRICULTURAL DEVELOPMENT & INDUSTRIAL CORP.**
Contact Person	Celestino Damian
Designation	President
Address	# 1 Lopez Jaena St. Kapasigan, Pasig City
Telephone	641-0286, 641-1794, 916-0701
Fax	641-0286
E-mail	padiscor@edsamail.com
Company Description	Designer, fabricator, supplier and contractor of biomass-fired grain dryer (300 to 700 kw), ricemills and grain storage silos complete with bulk materials handling equipment

Name of Office	**PEKO BIOGAS AND FERTILIZER SYSTEMS**
Contact Person	Sin Del Jamorol
Designation	President
Address	1930 B. Lipunan St., Baclaran, Parañaque City
Telephone	833-1942
Company Description	Designs and manufactures modular-type biogas systems (50 sow level and above) and waste recycling systems

Name of Office	**PENTIUM INTERNATIONAL COMPANY, INC.**
Contact Person	Florencio Loh
Designation	Manager
Address	#59 West Capitolio Drive, Bo. Capitolio, Pasig City
Telephone	636-6561 to 64
Fax	638-7211
Company Description	Consultancy on soil drain and arch finishing

Name of Office	**PERT EQUIPMENT & INDUSTRIAL SUPPLY**
Contact Person	Reynaldo R. Espiritu
Designation	General Manager
Address	Rm. 302, MCR Bldg., 495 Boni Avenue, Mandaluyong City
Telephone	532-7273
Fax	532-2071, 532-0805
Company Description	Supplier of construction equipment

Name of Office	**PERTCONSULT INTERNATIONAL**
Contact Person	Homobono C. Pique
Designation	President
Address	Rm. 603 The Excelsor Bldg., Roxas Blvd. Ext. Parañaque, Metro Manila
Telephone	879-8269/71
Fax	879-8251
Company Description	Consultancy on micro- and mini-hydro projects

Name of Office	**PHILIPPINE ASSOCIATION OF SMALL HYDRO POWER DEVELOPMENT, INC. (PASSHYDRO)**
Contact Person	Manuel M. Vergel III
Designation	President
Address	35 Antoinette St., Parkway Village, SFDM, Quezon City
Telephone	362-0950
Fax	362-0950
Company Description	Association of contractors, engineers and NGOs involved in hydropower projects

Name of Office	**PHILIPPINE ELECTRIC CORPORATION**
Contact Person	Roberto Chan
Designation	President & CEO
Address	3/F Benpress Bldg., Exchange Rd. cor. Meralco Ave., Pasig City
Telephone	631-3133
Fax	631-3140
Company Description	Manufacturer of transformer & electrical products

Name of Office	**PHILIPPINE ELECTRIC PLANT OWNERS ASSOCIATION**
Contact Person	Zoilo M. Cortes
Designation	President
Address	8/F Strata 100 Bldg., Emerald Ave., Ortigas Center, Pasig City
Telephone	631-1581 - 84
Fax	631-2901
Company Description	Association of private electric utilities

Name of Office	**PHILIPPINE RURAL ELECTRIC COOPERATIVE ASSOCIATION**
Contact Person	Mr. Rosalino Culalig
Designation	President
Address	4/F Casman Bldg., 372 Quezon Ave., Quezon City
Telephone	374-2538, 374-1198, 374-1199
Fax	374-2513
Company Description	Organization of 119 electric cooperatives

Name of Office	**PHILIPPINE RURAL RECONSTRUCTION MOVEMENT**
Contact Person	Bobby Tañada
Designation	President
Address	56 Sct. Lozano St., Quezon City
Telephone	372-4991, 372-4992
Fax	372-4995
Company Description	NGO; installed solar home systems in El Nido, Palawan

Name of Office	**PHILIPPINE SOLAR ENERGY SOCIETY**
Contact Person	Rowaldo Del Mundo
Designation	President
Address	c/o Solar Laboratory, Diliman, Quezon City
Telephone	434-3660 to 61
Fax	434-36-60
Company Description	Research and development

Name of Office	**PHILIPS LIGHTING**
Contact Person	Mario Hernandez
Designation	Vice President
Address	106 Valero St., Salcedo Village, Makati City
Telephone	810-0161/845-7866
Fax	816-6340
Company Description	Manufacturer of lighting and control devices for solar energy systems

Name of Office	**PNOC COAL CORPORATION**
Contact Person	Florante J. Navarro
Designation	President
Address	PNPC Complex, Merritt Rd., Fort Bonifacio, Makati City
Telephone	893-7119, 893-6001 893-1320
Fax	815-2747
Company Description	Manufacturer of coal briquettes

Name of Office	**PREFERRED ENERGY, INC.**
Contact Person	Grace S. Yeneza
Designation	Managing Director
Address	10/F Strata 100 Bldg., Emerald Ave., Ortigas Center, Pasig City
Telephone	631-3078, 631-2826
Fax	632-7097
E-mail	pei@compass.com
Website	www.peinc-cjb.net
Company Description	Consultancy on renewable energy

Name of Office	**R.S. ARRIETA, INC.**
Contact Person	Roberto Arrieta, Jr.
Designation	President
Address	Arrieta Bldg., Pioneer cor. San Rafael Sts., Pasig City
Telephone	631-1331
Fax	631-3810
Company Description	Design and fabrication of multi-fueled boilers

Inventor	**RAYMUNDO R. CALUGCUGAN**
Address	21 Lilac St., SSS Village, Concepcion, Marikina City
Telephone	933-2003
Fax	948-9899
Location	Calatagan, Batangas
Project Title	Aerovolt: New Fendered Bucket Windmill for Clean Power Generation & Tidavolt: New Machine that ulitizes Tidal & River Currents for Clean Power Generation

Name of Office	**RENEWABLE ENERGY ASSOCIATION OF THE PHILIPPINES**
Contact Person	Vicente O. Roaring
Designation	Executive Director
Address	11 Liamzon St., Midtown, Marikina City
Telephone	645-8167; 646-7319
Fax	645-8167
E-mail	renergy@compass.com.ph
Company Description	Umbrella organization of the renewable energy group

Name of Office	**RENEWABLE ENERGY SOURCES**
Contact Person	Fredie Larona
Designation	General Manager
Address	12 B3 Dacon, Kasibulan, Cainta, Rizal
Telephone	656-7966
Fax	656-7966
Company Description	Supplier of PV System, BP Panels of Australia

Name of Office	**RESOURCE GROUP, INC.**
Contact Person	Vicente O. Roaring
Designation	President
Address	11 Liamzon St., Midtown, Marikina City
Telephone	645-8167; 646-7319
Fax	645-8167
E-mail	resource@compass.com.ph
Company Description	Consultancy and construction of NRE systems

Name of Office REYMILL STEEL PRODUCTS
Contact Person Felipe S. Reyes, Jr.
Designation General Manager
Address Rizal Street, Sta. Rosa, Nueva Ecija
Telephone 0917-6429624
Company Description Manufacturer of the Reymill products for water pumping and irrigation applications

Name of Office ROBARR VENTURES
Contact Person Rodolfo Barreto
Designation General Manager
Address Timex Compound, Ortigas Ave. Ext., Cainta, Rizal
Telephone 655-0330
Fax 655-7372
Company Description Distributor of BP Solar Panels and Motolite batteries

Inventor RODOLFO A. DAYOT
Address RAD Equipment Enterprises, Sapphire St., Sto. Niño Village, Matina, Davao City
Telephone (082) 296-2139
Location Palamas, New Corella, Davao Province
Project Title Water Turbine for Driving Power Generating Unit

Inventor **Rudy N. Lantano**
Address RL Alco Diesel Enterprises DOST Compound, Gen. Santos Ave., Bicutan, Taguig, Metro Manila
Telephone 838-7224, 837-2071 loc 2156
Fax 838-0621
Location RL Alco Diesel Enterprises DOST Compound, Gen. Santos Ave., Bicutan, Taguig, Metro Manila
Project Title Electricity Derived from Super Bunker Formula - L [SBF-L]

Name of Office	**RURAL ELECTRIC CORPORATION (RULEC)**
Contact Person	Thelma Hizon
Designation	President
Address	1-A Masana St. Manotoc Subd., Baesa, Quezon City
Telephone	455-5349; 456-7967, 454-0606
Fax	456-7134
Company Description	Consultancy on NRE projects

Name of Office	**RURAL ELECTRIFICATION MULTI-PURPOSE COOPERATIVE**
Contact Person	Francis Nacienceno
Designation	Chairman
Address	114 Quensland, Green Park Village, Pasig City
Telephone	645-1748
Fax	645-1748
E-mail	stmjr@email.com
Company Description	Supply, design and installation of PV system,MESTA-75 of U.K.

Name of Office	**SCANCON, INC.**
Contact Person	Luz Santiago
Designation	President
Address	118 Sct. Fuentebella St., Quezon City
Telephone	928-8270
Fax	922-5134
Company Description	Designs, fabricates, installs and repairs biomass-fired (ricehull) grains dryers (175-700 kW), biomass heaters, and ricehull-fired palay dryer

Inventor	**SERGIO C. CAPAREDA**
Address	Agricultural Machinery Division, Institute of Agricultural Engineering, College of Engineering, & Agro-Industrial Technology, University of the Philippines, Los Baños, Laguna
Telephone	(049) 536-2792, 536-2860
Fax	(049) 536-2873, 2792, 3606
E-mail	scc@mudspring.uplb.edu.ph
Location	UPLB
Project Title	Recirculated Waste Pyrolyzer

Name of Office	**SHELL RENEWABLES PHILIPPINES CORP.**
Contact Person	Reynaldo A. Reynaldo
Designation	Project Manager
Address	Unit 7 De Mariano's Apt., F. Quimpo Ave., Kalibo, Aklan
Telephone	(036) 268-7305, 816-6065 (Mla. Office)
Fax	(036) 268-7305
Company Description	Contractor and supplier of Shell solar modules, comptrollers, lighting and fixtures

Name of Office	**SIBOL NG AGHAM AT TEKNOLOHIYA (SIBAT)**
Contact Person	Vicky Lopez
Designation	Executive Director
Address	28 Rd. 5 GSIS Hills, Novaliches, Quezon City
Telephone	983-1947, 983-1953
Fax	983-1947
E-mail	sibat@info.com.ph
Company Description	Technical assistance on renewable energy & sustainable agriculture

Name of Office	**SIGMA ENERGY TECHNOLOGIES, INCORPORATED**
Contact Person	Loreta Aguila
Designation	Managing Director
Address	Suite 602-A. Fedman Suites 199 Salcedo St., Legaspi, Makati City 1229
Telephone	2-813-7926 / 813-1434
Fax	2-892-6144
E-mail	sinergy@edsamail.com
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**SMITH BELL RENEWABLE ENERGY SOURCES CORP.**
Contact Person	Ruth Yu-Owen
Designation	Chief Operating Officer
Address	Smith Bell Bldg., 2294 Pasong Tamo Ext., Makati City
Telephone	816-7668, 816-7521, 867-1906
Fax	867-1904
E-mail	ruthowen@smithbell.com.ph
Company Description	Provide Mini-Hydro project

Name of Office	SOLAHART PHILIPPINES
Contact Person	Antenor G. Lopena
Designation	Executive Vice-President
Address	Malago Corporation, #4 Kitanlad St., Quezon City
Telephone	743-6555 loc. 14
Fax	731-6834
Company Description	Distributor of Solahart solar water heaters for domestic/household (189 and 300 liters capacity) and commercial (2500, 3000 and 6500 liters capacities) uses

Name of Office	SOLAR ELECTRIC COMPANY, INC.
Contact Person	Robert L. Puckett
Designation	President
Address	G/F, Gold Building, Unit 1501 Annapolis, Wilshire Plaza, 11 Annapolis
Telephone	724-4812; 726-4322; 724-4812
Fax	724-0223
Company Description	Supply, design and installation of PV system

Name of Office	SOLAR TECH SYSTEMS
Contact Person	Percival Favoreal
Designation	Representative Officer
Address	Delta St., Phase III Villagrande Homes, Concepcion Grande, Naga City
Telephone	(054) 475-1305
Fax	(054) 475-1305
E-mail	euz@mozcom.com
Company Description	Manufacturing of photovoltaic system in Brunei

Name of Office	SPARKS SOLAR CORPORATION
Contact Person	Gordon Sparks
Designation	General Manager
Address	Rm. 500 Cityland I, Herrera St., Legaspi Village, Makati City
Company Description	Assembly and marketing of Sparks Solar System (Australia)

Name of Office	**STATE POLYTECHNIC COLLEGE OF PALAWAN, ABORLAN,**
Contact Person	Engr. Bernardo Ocampo
Designation	ANEC Project Leader
Address	c/o Mrs. Ericka dela Peña, SPCI-IMS, Sta. Monica Tiniguiban, Puerto Princesa City
Telephone	(048) 433-4480
Fax	433-4367
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**SULTAN KUDARAT STATE POLYTECHNIC COLLEGE**
Contact Person	Dr. Nelson T. Binag
Designation	ANEC Project Leader
Address	Barrio 2, Tacurong, Sultan Kudarat
Telephone	(064) 200-4253/200-4261
Fax	(0918) 450-6398 Dr. Bong Genova (064) 200-4261
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**SUMITOMO CORPORATION**
Contact Person	Kojiro Shimbo
Designation	President
Address	10th Flr., BPI Building Ayala Avenue cor. Paseo de Roxas, Makati City
Telephone	810-0351
Fax	818-8168
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**SYNERGY POWER PHILIPPINES, INCORPORATED**
Contact Person	Elizabeth G. Peralta
Designation	Managing Director
Address	5th Floor,OPPEN Building 349 Sen. G. Puyat, Makati City
Telephone	2-897-1692
Fax	2-890-5679
E-mail	synergy@pacific.net.ph
Website	www.synergypowercorp.com
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**TCGI ENGINEERS**
Contact Person	Jose R. Jimenez, Jr.
Designation	President
Address	6th Floor, 150 JAKA II Building Legaspi St., Makati City 1229
Telephone	2-840-4764 / 817-8311
Fax	2-815-2410
Company Description	Consultancy and construction of mini-hydropower projects

Name of Office	**TECHNOLOGY DEVELOPMENT EXTENSION GROUP, INC.**
Contact Person	Angelito V. Angeles
Designation	Consulting Engineer & Professor
Address	52 Don Gregorio St., Don Antonio Heights, Quezon City
Telephone	931-5932
Fax	931-5932
Company Description	Consultancy on renewable energy systems

Inventor	**TITO L. PASTRANO, Ph.D**
Address	P.N. Roa Subd., Cala-anan Valley, Canito-an, Cagayan De Oro City
Location	Cala-anan Valley, Cagayan De Oro City
Project Title	Louvered-vane Turbine

Name of Office	**TOTAL SOLUTIONS TECHNOLOGY, INC.**
Contact Person	Ronald O. Diola
Designation	President & CEO
Address	Suite 506 Cebu Holdings Center, Cebu Business Park, Cebu City
Telephone	(032) 231-5599
Fax	(032) 231-5599
Company Description	Distributor of Solarex and Kyocera panel systems

Name of Office	**TRANS ACCESS CORPORATION**
Contact Person	Lito D. Fider
Designation	General Manager
Address	Penthouse, Gold Loop Tower, Amber Avenue, Ortigas Center, Pasig City
Telephone	633-8562
Fax	633-5197
Company Description	Distributor of boilers and various refinery equipment

Name of Office	**UNITED POWERLINK SPECIALISTS CORP.**
Contact Person	Delfin A. Villafuerte, Jr.
Designation	General Manager
Address	2/F Isaura Bldg., 216 Gen. Luis St., Novaliches, Quezon City
Telephone	920-1703, 419-5453, 419-8575
Fax	455-5800
Company Description	Installation and erection of power generators

Name of Office	**SILIMAN UNIVERSITY-EXTENSION PROGRAM**
Contact Person	Dr. Nichol R. Elman
Designation	ANEC Project Leader
Address	Siliman University, Dumaguete City
Telephone	(035) 225-4535 / 225-2414 loc. 236
Fax	(035) 225-4768/422-7207
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**UNIVERSITY OF EASTERN PHILIPPINES -UNIVERSITY TAWN**
Contact Person	Dr. Pedro Destura
Designation	President
Address	Catarman, Northern Samar
Telephone	(055) 354-1347/49, 0917-3732965
Fax	(055) 354-1347
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**UNIVERSITY OF SOUTHERN PHILIPPINES**
Contact Person	Engr. Fulton U. Yap
Designation	ANEC Project Leader
Address	Davao City
Telephone	(082) 221-1636
Fax	(082) 221-1636
Company Description	Affiliated Nonconventional Energy Center

Inventor	**VALENTINO M. TIANGCO, Ph.D**
Contact Person	c/o Engr. Eulito Bautista Philippine Rice Research Inst., Maligaya, Muñoz, Nueva Ecija
Address	Energy Technology Development Division, California Energy Commission, 1516 Ninth St., Sacramento, CA 95814
Telephone	(044) 456-0113 c/o Engr. Eulito Bautista (PhilRice)
Fax	843-5122
Location	Philippine Rice Research Institute (PhilRice), Maligaya, Muñoz, Nueva Ecija
Project Title	Biomass Gasification and Engine System for Shaft and Power Applications

Name of Office	**VERGEL 3 CONSULT**
Contact Person	Manuel M. Vergel III
Designation	President
Address	35 Antoinette St., Parkway Village, SFDM, Quezon City
Telephone	362-0950
Fax	362-0950
Company Description	Consultancy and construction of micro- and mini-hydropower projects

Name of Office	**VOEST ALPINE TECH INT'L**
Contact Person	Mario G. Toral
Designation	Project Development Manager
Address	Rm. 401 Golden Rock Bldg., 168 Salcedo St., Legaspi Village, Makati City
Telephone	817-4392
Fax	817-4674
Company Description	Supplier for Electro-Mechanical Equipment

Name of Office	**WIND ENERGY ASSOCIATION OF THE PHILIPPINES (WEAP)**
Contact Person	Alexis T. Belonio
Designation	President
Address	88 Rizal St., la Paz, Iloilo
Telephone	(033) 329-6574
Fax	(033) 329-6574
Company Description	Manufacturer of paddy-dryers and ricehull-fired palay dryer

Name of Office	**WESTERN MINDANAO STATE UNIVERSITY**
Contact Person	Prof. Felizardo S. Rebollos
Designation	ANEC Project Leader
Address	Zamboanga City
Telephone	(062) 991-5897
Fax	(062) 991-3065
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**WHITE TRILLIUM PHILS., INC.**
Contact Person	Rafael M. Valdez
Designation	President & CEO
Address	66 Don Vicente Quintas St., Malasiqui, Pangasinan
Telephone	(075) 536-5126
Fax	(075) 536-4587
Company Description	Supply, design and installation of PV system

Name of Office	**WINROCK INTERNATIONAL - REPSO PHILIPPINES**
Contact Person	Inocencio Bulo
Designation	Field Director
Address	11/F Strata 100 Bldg., Emerald Ave., Ortigas Center, Pasig City
Telephone	632-7323
Fax	631-2809
Company Description	Provides financial assistance to NRE projects

Name of Office	**XAVIER UNIVERSITY-COLLEGE OF AGRICULTURE**
Contact Person	Engr. Alejandro S. Villamor
Designation	ANEC Project Leader
Address	Xavier University, Cagayan de Oro City
Telephone	(08822) 724-096
Fax	(08822) 722-994
Company Description	Affiliated Nonconventional Energy Center

Name of Office	**YAMOG RENEWABLE ENERGY DEVELOPMENT GROUP, INC.**
Contact Person	Nazario R. Cacayanan
Designation	Project Director
Address	JL 2-A Denia Apartment, Juan Luna St., Davao City
Telephone	(082) 227-4031
Fax	(082) 227-4031
E-mail	yamog@interasia.com.ph
Company Description	Consultancy and construction of NRE systems