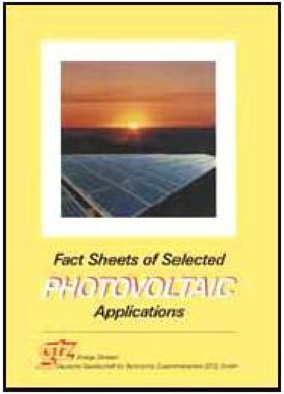

Fact Sheets of Selected Photovoltaic Applications

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Foreword

Much has been written about the prospects of photovoltaic systems for developing countries. A growing number of field trials is being undertak en worldwide and moderate success has been reported concerning the commercial introduction of standardized package units for small-scale purposes.

We in the GTZ are convinced that environmentally sound photovoltaic technology will be of increasing significance for countries of the Third World, given that system costs are expected to further decrease. By commission of the Federal Government, we have started already several years ago with testing and demonstration of photovoltaic applications, thereby taking the first steps toward market introduction.

Such units have in common that they are to serve individual electricity demands ranging from several watts like a Solar Home System to several kilowatts like a village Drink ing W ater Supply. Moreover, these units may differ greatly according to site and their user conditions. This specificity of photovoltaic systems along with continuing pressure from competing conventional energy supplies calls for collecting "facts and figures" about potential photovoltaic applications. Detailed insight into the user's demand and the local conditions including component prices, competitors and solar radiation data forms one of the bases for market development. Such clarification also helps both to cut cost for feasibility assessments and to standardize equipment. Finally, buying a photovoltaic unit is a major venture for a rural household; accordingly, the client ought to be well-informed about the expected financial consequences.

This collection of "Factsheets", compiled after several years of experience in the Philippines, is intended to complement strategic considerations about decentralized energy supplies through the presentation of practice oriented data.

For the example of the Philippines, but most lik ely also for countries with similar weather and climatic conditions and socio-economic structures, the Fact Sheets should help in designing projects and photovoltaic equipment thus serving as an input both for technical cooperation and commercial activities.

G. Oelert E. Biermann
Head of Division Senior Technical Advisor

Content

1. Introduction

Approximately 80 percent of the world's 5.3 billion people live in rural areas of developing countries, most of them with no access to electricity. Sunrise and sunset still mark the beginning and end of the working day.

In the Philippines, an archipelago of some 2,800 inhabited islands, the "urban luxury" of electricity is still far away for 65 percent of the population. Only in a few cases is electric power produced by stand-alone generator sets. Social life in the evenings is usually extended for a couple of hours by a kerosene lamp.

There is no doubt that electricity spurs the social and economic development of rural areas: Often the availability of electric power is decisive for the supply of good drink ing water, the conservation of food, the storage of medical supplies, telecommunications, radio, TV, etc.

It is obvious that along the anticipated path of development, many developing countries will increase their energy consumption. A large part of it will be covered by conventional sources like oil and coal. This will contribute to a steady increase in the world's carbon-dioxide (CO_2) production.

Solar panels are one of the very few CO_2-free energy converters. Today, for a range of applications, they are a technically feasible and economically viable alternative to fossil fuels. A solar cell can directly convert the sun's irradiation to electricity based on a physical process that requires no moving parts. This results in a relatively long service life of solar generators.

At present about 42 Megawatts of solar panels are installed around the globe. 50 Kilowatts are in operation in the Philippines. This may seem quite impressive, but on the other hand one should not forget that a single coal-fired thermal powerplant may have a (day-and-night) capacit y of 600 Megawatt.

Solar radiation provides us at zero cost with 10,000 times more energy than is actually used. Most developing countries receive as much as 50 to 100 percent more insolation than countries in temperate zones. Nevertheles, solar or photo-voltaic (PV) systems do not come for free: The introduction of such a new technology takes time and effort. The financial barrier (especially regarding the initial investment) is too high for many enterprises and families, especially in countries like the Philippines. Adequate financing schemes are a necessary prerequisite if this technology ever is to make serious progress in areas without access to other sources of electricity.

Roughly 10 years after the introduction of photo-voltaics in the Philippines and after a serious local research and development effort, several PV applications are ready for introduction and marketing on a massive scale. Of special interest are relatively simple systems such as Solar Home Systems. They may have a tremendous impact on rural development by supplying minimal amounts of electric power to each individual household. Also for some other applications e.g. telecommunication facilities in remote parts of the country, PV is a viable option. In the immediate future, PV component quality control will be of crucial importance for the successful introduction of this technology.

For all areas which, owing to physical or economic constraints, cannot be reached by conventional power supply systems, PV technology can now be considered an alternative option for rural electrification

This document provides an overview of the potential and the general impact of various PV applications in the Philippines, as well as an indication of the need for additional research and development. The majority of these applications was (field)tested under the recently completed Philippine-German Solar Energy Project (PGSEP), financed by the German Ministry for Economic

Cooperation in Bonn. The energy requirement, technical design, economic analysis of the PV system and its direct conventional competitor, plus an indication of the specific market potential, are presented on separate fact sheets. Each fact sheet covers one application. Some specific country data, relevant energy prices and PV component prices are to be found in the Country Fact Sheet. A coloured overview summarizes all fact sheets. An explanation of all methods (i.c. economic analysis and system design) and assumptions precedes the fact sheets.

This study was conducted by ITW-Consulting Ltd. on behalf of GTZ. Persons involved: P.H.A. de Bakker, K.M. Schulte.

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

2. Method of pv system sizing

In order to discuss the feasibility of a certain application, first a reliable s ystem must be designed. Systems may vary according to requirements regarding their availibility. In the Philippines the (estimated) system design can be based on an average insolation of 5 kWh per m per day.

2.1 Components

Considerations regarding the design of a PV system usually start with the anticipated load. The load and the period in use, meteorological conditions and required availability together determine the size of all system components.

A PV power supply commonly consists of three components:

1. Solar Generator. Photovoltaic cells, encapsulated in transparent material, convert an efficiency-dependent quantity of the absorbed sunlight into electricity. Appropriate serial/parallel connection results in any desired DC voltage and pow er.

2. Battery. Since in most cases not all electrical power will be consumed at once, and energy is required for periods of low or zero insolation (night-time, cloudy days), electricity storage will be needed.

3. The Battery Control Unit (BCU). This device protects the battery from being overcharged or deeply discharged. Both would negatively affect the length of the service life of the battery.

2.2 System Design

A first approximation for the design of a standard PV system can be made based on the average insolation and energy demand data. Because of the modular character of these PV systems, an additional panel can always be added without significant changes in the design.

Assuming constant efficiencies for all system components the des ign is based on:

$$P_{pk\,25} = \frac{W_{el}}{W_r} \frac{1kW}{m^2}$$

where

W_{el}= electrical energy demand in kWh per day
W_r= radiated solar energy in kWh per m per day
P_{pk}= measure of the size of a solar generator in kW peak, definded as the output power of a solar generator at an irradiance of 1 kW/m

If the temperature increases, the efficienc y of the panel will drop (typically 0.4 %/C). Commonly the P_{pk} power is rated at 25C, while the operating temperatures may be close to 50 or even 60C. This means that for real conditions the s ystem design needs to be approx. 10 percent larger:

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$$P_{pk\,25} = 1.1 \frac{W_{el}}{W_r} \frac{1kW}{m^2}$$

Efficiencies of the control unit, batteries, inverters and matching efficiency should be included as well: An inverter has a typical efficiency of 85 % - 95 %. A BCU should have a minimum efficiency of 95%.

It is assumed that all generated power is passed on to the load via batteries. Battery efficiency is assumed to be 80 percent. If an inverter is required as well (to change DC into AC), the size of the generator will be determined by:

$$P_{pk\,25} = 1.1 \frac{W_{el}}{W_r n_b n_{inv} n_m n_{bcu}} \frac{1kW}{m^2}$$

where

nb = battery efficiency (80 %)
ninv = inverter efficiency (90 %)
nm = matching efficienc y (95 %)
nbcu = BCU efficiency (95%)

3. Method of economic analysis

3.1 Dynamic Economic Evaluation

For the calculation of the cost annuity or the cost per unit produced, common economic evaluation methods were applied. The limitations of such calculations are likewise the limitations of all the resulting figures: They do not encompass ecological and socio-economic effects or the effect on the country's economic goals.

The dynamic approach was chosen as it also considers additional investments after the start of operation of a certain project. It takes into account the different periods at which revenues or payments occur. This means that payments are discounted if they come after a certain project is commissioned. Revenues and payments are given a higher value the earlier they f all. in PV systems, additional investments (e.g. replacement of batteries) will often be neces sary.

Inflation is dealt with by computing the real interest rate (i) derived from the assumed mark et interest rate (p) and the inflation rate (a). The discount factor is:

q= a/e

where q = 1 +i/100;

a = 1+p/100;
e = 1+a/100

3.2 Cost Annuity

As no revenues are considered in the analyses, the focus will be on the cost annuity (Ak) which is calculated according to the following formula:

$$A_k = \sum_{t=1}^{T} \left[\left(K_0 q^{-t} \right) RF(i,T) I - L\, RF(i,T)\, i \right] + () \quad (). \quad +$$

where:

A_k= Cost annuity
T = Service lifetime
$\sum$ = Summation

t=1 = Time or period one year after commissioning
K_0= Operating cost
q^{-t}= Discounting factor (1 + i/100)-t
i = Discount rate
t = Time of the payment

RF = Recovery factor $RF(i,t) = \frac{q^t(q-1)}{q^t - 1}$

i = Interest rate
I = Investment cost
L = Liquidation yield at the end of service life

4. Assumptions and remarks

4.1 General Remarks

Every possible application is described by a set of technical and economic criteria. Certain assumptions regarding the different criteria have to be made:

* The interest rate of 9.5 % and the inflation rate of 6 % do not reflect current rates, but are applied to the economic evaluations for long-term projects as recommended by the Asian Development Bank. These rates almost reflect the internationally accepted guideline where a real interest rate of 4 % is used, as against 3 - 3.5 % for the Philippines. For the calculation of short-term financing schemes (3-5 years) a commercial mark et interest rate of 15 % with an inflation rate of 9 % would be more appropriate.

* Some applications are subdivided into different case studies according to different (power) requirements. Based on the required size (e.g. for different sizes of residences) a PV power source may offer an attractive alternative, or not.

* If certain applications are found to be not feasible e.g. because of the high investment, it does not immediately imply that no further research and development activity at all can be undertaken. Maybe an activity partly powered by PV would be more acceptable.

* Assumptions for any PV application discussed always focus on rural areas:

- Only the most essential equipment is driven electrically. Other activities are still performed manually.

- More refined activities or activities which require high energy levels can only be realized in locations where energy is readily available (electrified areas).
- Energy-saving prototype applications are not discussed in the fact sheets. This overview concentrates on appliances readily available on the market. However, research and development work on energysaving prototypes is mentioned.

* The economic comparison of a PV s ystem versus a conventional competitor is usually limited to the choice that people now have;. e.g. for lighting: In a comparison of a PV powered fluorescent tube versus a kerosene high-pressure lamp, the quantity of incident light (lux) is not considered.

* To neutralize any artificially created precision in the system pricing and cost calculations, figures in the fact sheets have been rounded off.

4.2 Lifetime of Components

A very important consideration in the economic analysis is the lifetime of a PV system. Lifetimes of the various components of a PV power supply have been estimated, based on experiences gained over the past few years.

1. Panels. The lifetime of PV panels is estimated at 20 years. Proper encapsulation and the use of low-iron tempered glass ensure a lifetime which may go well beyond.
2. Frames. Galvanized iron frames and anchors are part of most PV systems. Properly galvanized material should last as long as the panels although some maintenance way be required.
3. Batteries. Depending on the character of the charge/discharge c ycles, the average lifetime of the so-called "Solar Batteries", according to experience gained in the Special Energy Program and the previous Philippine German Solar Energy Project, has been set at 4 years.

4. BCUs. Locally produced Battery Control Units are assumed to last at least 5 years, after which they may be repaired or replaced. In computations for these fact sheets it is assumed that they are replaced. imported BC Us for larger power requirements are more expensive, but should also last longer: 10 years.
5. Inverters. Imported inverters are assumed to last for 10 years.
6. General Maintenance. Includes the replenishment of distilled water (available in every local drugstore), replacing parts of destroyed cable, etc. Usually a minimal amount per year is considered sufficient.
7. Load. The service life of fluorescent tubes is to a large extend directly dependent on the quality of the ballast. A good quality tube in combination with a good ballast should last between 3 and 5 years.

4.3 Specific Assumptions/Remarks concerning Factsheets

After these general remarks and assumptions all topics mentioned in the separate fact sheets will be discussed.

4.3.1 Daily Energy Requirement/System Availability

The daily power consumption has been estimated based on a breakdown of the power required for each specific activity (appliance) and the required duration.

In order to discuss the availability of a s ystem, two basic data must be present. The daily insolation (Wr) is the first important factor. Secondly a certain nominal value, defined as the insolation demand (Wrd) is needed. As long as the daily insolation is higher than the demand, (Wrd) is needed. As long as the daily insolation is higher than the demand, there is no problem in satisfying the electrical energy demand: The availability of the s ystem is 100 percent.

For economic reason however, one will usually be satisfied with a lower s ystem availability, similar to or slightly better than its conventional competitors. If a high reliability is required (e.g. in the case of the telecommunication industry) a conventional back-up system may be considered in order to guarantee fully reliable operation, rather than doubling the array of solar panels.

If a s ystem is only partially available (i.e. the demand exceeds the insolation [Wr]) then the availability factor (AF) can be defined by:

$AF(W_{rd}) = W_r/W_{rd}$

The mean availability of a certain system defined as system availability due to the availability of solar radiation will be:

$$a(W_{rd}) = \frac{1}{N}\sum_{i=1}^{N} Afi(W_{rd})$$

in which N = number of days.

This method provides a tool for the quantification of the mean' availability of a PV system, assuming that there is battery storage of only one day. With increasing battery size, the mean PV system availability will increase accordingly.

For the meteodata of the year 1985, as gathered in the PV field laboratory at Dona Remedios Trinidad, Bulacan, the following interpretation was made for the 13.3 kWp PV powerplant.

Wrd (kWh/m2)	a(Wrd)

1.00	100.0%
1.50	99.8%
2.00	99.2%
2.50	98.3 %
3.00	97.0 %
3.50	94.9%
4.00	92.4 %
4.50	89.2%
5.00	85.4 %
5.50	81.1 %
6.00	76.5%
6.50	71.6 %
7.00	66.8%
7.50	62,3 %
8.00	58.4 %

Average daily insolation 4.68 kWh/m

Standard deviation of daily insolation 1.368
(Method and Software: A Wagner, ITW)

How is this table to be interpreted. Under meteorological conditions at Pulong Sampaloc in 1985 a load can be satisfied at all times if the design of the PV system is based on an insolation of not more than 1 kWh/m day.

For an average daily insolation in Pulong Sampaloc, which was relatively low at that year (4.68 kWh/m^2) the s ystems availability (according to linear interpolation) will be around 88 percent. Where there is a battery with a 3-day storage capacity the mean availability will be considerably (approx. 5 percent) higher.

4.3.2 Size of the PV Generator

- The required s ystem availabilit y should also be seen in relation to the performance of possible competitors. Weak points of both the alternative and PV need to be considered: PV must be equal in performance or better.

- The system sizing is based on experience and data gathered at the PV field laboratory in Pulong Sampaloc, concerning the PV power plant with only 1 day battery-storage capacity. The battery storage efficiency has been set in our system designs at 0.8, although this depends very much on the quality of the battery and the depth of the daily discharge (i.e. the size of the battery storage). In the fact sheets a 3-day storage capacity has commonly been assumed. This implies a system availability that is actually somewhat (up to 5 percent) higher than indicated.

- A system availability of 80 % does not directly imply that the s ystem is available for 8 out of 10 days. Neither is that required in many cas es. Example:

A sys tem for industrial or commercial activities (e.g. a cinema) operating for 6 out of 7 days a week requires only approx. 85 % reliabilit y, giving the battery storage 1 day "extra" (without or with low power requirements) to recover.

The actual system availability should in all cases come close to the required availability.

- Another consideration is that conventional diesel gensets are not more available either: 1 genset has an estimated availability of 90 % if spare parts are readily available and the logistics of spare parts and fuel cause no problems. However in most areas of the Philippines this is not the case. Achieving higher reliability, as is required e.g. in the telecom business, commonly takes 3 gensets, which dramatically influences the kWh-cost price.

- Some systems are only us ed seasonally. For example irrigation is mostly needed during the dry season. This phenomenon is allowed for in the analyses by choosing a lower mean system availability (and so a higher required irradiation level). For a system only operating in the dry months, an insolation level of 6 kWh/m day may still be an acceptable standard versus approx. 5 kWh/m day for average "Pulong Sampaloc" conditions. The exact and final design of any system will have to take local irradiation conditions for the desired period into account.

- Calculated s ystem sizes are rounded up, thus somewhat increasing the system availability.

4.3.3 Investment for the PV power supply

- This indicates the initial capital required to purchase and install a specific PV power supply, including panels, frames, cables, batteries, controls, transport and installation.

- For smaller systems (in this case arbitrarily set at a size of 100 Wp and below) it will not be possible to reach the (international) price guideline of $6,-/Wp (C.I.F). At any rate, such Wp-prices are only realistic if no taxes and duties are imposed. Until now, PV panels have entered the Philippines under the banner of various programs and (even commercial) projects. The common expectation for the Philippines is that future imports of PV panels will be tax-exempted or that PV panels will be given a specific heading in the import Tax Code with an import duty of a mere 5 %. For the moment (Sept. 1990) and for the purpose of system price computations, system prices will be based on $ 6.50/VVp (installations over 100 Wp) and $ 7.50/Wp (installations under 100 Wp), in both cases assuming panel sales on an acceptable scale.

- In most fact sheets, battery control units (BCUs) have been included as one of the PV power supply components. A small BCU developed by the PGSEP is now being mass produced. The selling price of such a commercially produced BCU has been estimated at $30 (including materials, labor, profit margin). Where a BCU with a somewhat larger capacity is needed, a BCU for $60 has been included. For larger applications imported control units must be considered.

- Other rough guidelines for pricing of the several components:

Inverters (imported)	$1.50/W
Frames (galvanized)	$ 0.30/Wp
Control Devices	$ 0.50/Wp
Gables (Royal # 12)	$ 0.70/m
Local stationary batteries	$ 100/kWh capacity
Installation and transportation 5 %	of the panel cost

Note: Cost of installation may vary depending on location of the system.

- Many appliances, e.g. TVs, electric fans, radios, are locally manufactured or assembled. The introduction of 12 VDC power supplies will most likely lead to an upswing in the sales of 12 VDC home appliances. The price list of each fact sheet indicates if a certain component is of

local origin or not. The fact that a certain part is locally available does not, however, automatically imply that it is locally produced, although this is true in many cases.

- Some battery control units outside the ordinary range should be made to order. No mass production has yet been achieved (no demand) but local industry is thought to have the capacity to manufacture the appropriate BCU.

- Except for communal applications (e.g. national electrification projects using Solar Home Systems) a commercial mark -up of an estimated 20% of the system price has been included to cover the expenses and profit margin of the distributor (transport and installation are covered separately). The individual prices of the system components manufactured in the Philippines already include commercial mark-ups of the respective manufacturers.

4.3.4 Cost Annuity

Based on the dynamic evaluation method, the cost annuity indicates the equal yearly payments required to finance the power supply, including interest, additional investments, maintenance. Commonly only the economics of the PV power supply are considered. However in some cases (e.g. incubator, irrigation water) the power supply is inseparably connected to the load. In such cases the economics of the complete system have been considered.

4.3.5 Costs (per Unit or Month)

The units produced by a PV application may vary from hatched one-day chickens to cubic meters of irrigation water. In those cases where no other units than "abstract" kWhs are produced, the cost per month is thought to be the best possible indicator for the purpose of comparing PV systems to alternative options.

4.3.6 Competitiveness with Cost Annuity of Conventional System

- In order to indicate the PV systems' competitiveness, the most logical conventional option and direct competitor was analyzed.

- Fuel prices in the rural areas tend to be higher than in urban areas, and may differ from island to island, depending on remoteness and volumes transported.

- Data regarding the operation of different diesel gensets (as competitor for PV) regarding lifetime, fuel consumption, repair and maintenance, etc. were obtained from experience (log-books) the Philippine Telegraph & Telephone Company Inc. gained by operating gensets at its telecom relay stations .

- For those conventional applications that require an operator for the diesel genset(s), a technician, costing $ 1000/year has been included in the economic calculations. This amount covers the monthly salary, insurances and fringe benefits.

- In a few cases (e.g. the economic analys is of kerosene pressure lamps for lighting a school building) only the end product (light) should be considered for analysis. In such cases the analysis of the PV system itself should likewise not be limited to the power supply (electricity) itself but, for the sake of fair comparison, include the investment and operation of the fluorescent tubes.

- In some cases, the PV power supply replaces several kinds of energy input at once, e.g. kerosene and dry cells for household light and a radio. This may mak e the choice between PV and conventional options a bit more complicated, as PV offers an integrated energy system. In such comparisons of PV versus more than one competitor, the competitors have been added up.

- If it is indicated that a certain PV power supply is competitive with a diesel genset, it is certainly competitive with a gasoline powered genset as a gasoline generated kWh tends to be more expensive than a diesel generated kWh, unless the required capacity is under 3 k VA. This is the capacity of the smallest commercially available diesel genset in the Philippines.

4.3.7 Estimated Number of Potential Customers

The number of potential customers is commonly derived from the number of people living in unelectrified areas of the Philippines, their income situation, the competitiveness of the PV alternative and common presence of certain conventionally powered systems in unelectrified areas. However, the resulting figures still remain nothing more (and nothing less) than cautious guesswork for the initial phase of the introduction of PV. Should PV technology ever become a generally accepted technology, the whole group of potential customers might be substantially larger.

4.3.8 Estimated Potential Market

The total estimated market of a certain application is the product of the number of potential customers and the size of the PV generator.

4.3.9 Status of Product Development

This reflects the availability of PV system components in the Philippines and the need for additional research and development for (1) components that condition the (DC) power supply or (2) those that adapt the load to the DC power source.

When a certain application is recommended for immediate marketing it means that the application has been tested and found to be operating acceptably. Many PV power s upplies have not (yet) reached that stage. For all those systems for which there seems to be a market, but not all components are readily available or reliable, or all those applications which have not yet been thoroughly tested, additional R & D is required. For applications with poor prospects, it is proposed that no R & D activities should be considered at present.

4.3.10 Relevant conventional energy prices

Reflects only those energy prices which are in direct competition with the PV system.

4.3.11 Possible local service

Servicing in the field might often be restricted to the ex change of entire components. In such a case only a limited amount of technical know-how is required. The assessment of the possibility of servicing the PV s ystem is based on ITW's experience in the Philipppines:

positive: s ystem can be serviced in the nearest repair shop by anyone who has basic knowledge of electronics repair (radios etc.) or, when a company has its own maintenance personnel, who is assigned to service even the remotest PV power system (e.g. Telecom).

not clear: Possibility of servicing remains questionable due to extreme remoteness or when the repair requires more than fundamental knowledge of electronics.

negative: Whenever a certain PV s ystem can only be serviced by repair facilities that have the appropriate technological know-how, which can only be found in the country's largest commercial centers, the possibility of local service in the rural areas is considered to be negative.

Who is able to service a PV s ystem (and possible DC appliances). In most cases the only components that can be repaired are the battery control unit and the bakery. The small standard BCUs are simple enough for repair by electronics repair shops for transistor radios. Such shops can be found all over the country. For this reason system diagrams should be made available nationwide.

More complicated systems (or loads) will need to be repaired by better qualified technicians who can be found in service centers in the nearest urban area. Depending on remoteness, it may sometimes be necessary to hire technicians (from service centers) for an on-the-spot-job. Bigger (e.g. telecom) companies will have their own personnel. Battery repair (overhaul) facilities may be encountered throughout the Philippines, often in combination with car (jeepney) repair shops, vulcanizing shops, battery charging stations etc. Whether a battery can be repaired (e.g. exchange of plates) depends on the design of the lead-acid battery.

4.3.12

4.3.12
Remarks

In this section all sorts of technical phenomena and assumptions of each application are discussed. Also mentioned are significant impacts that the s ystem may have on the environment, or what precautions should be taken to prevent possible future contamination if disused system components are discarded.

5. Concluding Remarks

The 24 PV applications which were assessed in the individual fact sheets yield an estimated mark et potential of around 11,500 kWp.

By far the largest demand would arise if the technology is successfully introduced for residential applications (Solar Home Systems).

Also some communal PV applications might be worthwhile considering if, one way or the other, financing can be arranged.

Some viable commercial, industrial, agricultural and telecommunication applications which might be feasible in themselves, can support the introduction of PV as a credible and reliable alternative to conventional options.

The geography of the Philippines, which has acted as a barrier to conventional electrification by grid extensions, provides the right conditions for the introduction of decentralized, renewable energy based power supplies. A start can be made on all those islands and islets which are not part of any island electrification plan.

For some selected PV applications additional research and development is recommended on the power conditioning or on the matching of the load to the (DC) power supply.

Some relevant economic key figures on the Philippine situation, Philippine energy prices and selling prices of some PV system components as well as selected DC appliances are presented in the Country Fact Sheet.

The fact sheets for all individual applications are concluded by an overview that summarizes all technical and economic aspects.

Country Sheet: Philippines July 1990

Country Sheet; Philippines July 1990			
Geography / Meteorology			
Landarea:	300,000 km	7,100 islands - approx. 2,800 inhabited islands	
Temperature range:	21 C - 34C	Daily average temperature:	28 C
Rainfall:	2,080 mm Luzon	3,800 mm N.E. Mindanao	
Average daily insolation:	˜5 kWh/m d Bulacan		
Population:	60-65 million 2		
Population density:	211 inhabitants/km		
Urban population:	35 - 40 %		
Population growth rate: 2.5 %			
Urban population growth rate:	3.2 %		
Economy			
Trade balance (1988):	˜-530 million US$		
Total external debt (1989):	˜27,000 million US$		
Energy consumption 106 million Barrels of Fuel Oil			

(1989):	Equivalent (BFOE), oil imports 46 million BFOE		
G.N.P (1989):	˜37,200 million US$		
G.N.P growth (1990): 5,7%			
Annual income/head (1990):	$727		
Inflation rate	1988: 8.8%	1989: 9.5%	1990: 10.8%
Main primary products: Rice,	maize, coconuts, sugar cane, abaca, rubber, tobacco, pineapples, bananas, coffee, timber, fish, copper, chrome, gold, silver, iron, nickel, coal, crude oil.		
Major industries:	Agriculture, food processing, textiles, chemicals, forestry, fishing, mining.		
Main exports:	Electrical goods (semiconductors), clothing, metal ores, coconut oil, sugar, fruit & vegetables, timber, abaca.		

Average manpower costs	Engineer	Technician	Utilit y man
	$200-$250/month	$100-$125/month	$75-100/month

Fuel prices (June 1989) in $/l based on oil price of $16.50/barrel ($1 = P21.50)

	Premium gasoline	**Gasoline**	**Diesel**	**Kerosene**
Official Retail price	0.30	0.27	0.23	0.26
of which: Customs duty 0.001		0.001	0.002	0.003
Value	0.14	0.12	0.05	0.06

Value added tax	0.14	0.12	[illegible]	[illegible]
Hauling charge	0.003	0.003	0.003	0.003
Dealers mark Up	0.01	0.01	0.01	0.01
Retail vice in Buan, Tawi-Tawi	0.75	0.98		
Lube oil: $1.20 - 1.40/1				

Kerosene pressure lamps: $40 - $50		Kerosene wicklamp: $0.50		
- Average service life: 7 - 8 years		- Average service life:	1 year	
- Yearly maintenance: $13				
- Fuel consumption:	0.1 - 0.21/hour - Fuel consumption: 0.01 l/hour			

Dry cell batteries	Size M	Size C	Size D	
$0.20	$0.25	$0.35		

Lead acid (car) batteries 12 V DC, 40 Ah 12 V DC, 75 Ah 12 V DC, 100			Ah	
	$30	$40	$55	

Electricity kWh price: $0,12 (by Decree)
Real cost of grid extensions 7,5/13,5 kV line: $4,000 - $5,000 / km

Diesel gensets	3 kVA	10 kVA
$3,100	$5,000	
30,000-40,000 hours of operation, if overhauled every 8,000 hours		

Gasoline gensets	600 W	1,000 W
	$550	$700
6.000 - 7.000 hours of operation, if overhauled every 2,000 hours		

Commercial prices of selected locally available PV s ystem components (*).

- Panel 53 Wp: approx $400	
- G.I. panel frame (max. 3 panels of 53 Wp):	$35
- Battery C ontrol Unit (12 VDC, 10A):	$30
- Solar battery (12 VDC, 100 Ah):	$50
- DC-DC converter (12-9, 7.5, 6, 4.5, 3 VDC - 1A): $18	
- Cables & Switches:	approx. $0.50 / Wp

Commercial prices of locally available DC appliances (*).

- 12 VDC, 20 W fluorescent tube, incl. holder + ballast	$18
- 12 VDC,10 W/ 15 W/ 20 W Incandescent bulb	$0,50
- 12 VDC B&W TV 12":	$110 (16": $175)
- 12 VDC Videoplayer (Betamax)	$280
- 12 VDC Electric (car) fan:	$20
- Rechargeable NiCd batteries size D (1.25VDC, 2.000mA): $6	

(*) subject to change.
Sources: CIA: World Fact book (1988), WB, ADB, N.C.S.O, B.E.O, B.E.O, IBON, PGSEP.

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<<I>> end01.png Country sheet

<<TOC3>> Summary of Philippine Fact Sheets

Country Sheet : Philippines July 1990

Geography / Meteorology

Landarea :	300,000 km^2	7,100 Islands - approx. 2,800 Inhabited Islands
Temperature range :	21°C - 34°C	Daily average temperature: 28 °C
Rainfall :	2,080 mm Luzon	3,800 mm N.E. Mindanao
Average daily insolation :	~ 5 kWh/m^2d Bulacan	

Population :	60-65 million
Population density :	211 inhabitants/km^2
Urban population :	35 - 40 %
Population growth rate :	2.5 %
Urban population growth rate:	3.2 %

Economy

Trade balance (1988) :	~ -530 million US$
Total external debt (1989) :	~ 27,000 million US$
Energy consumption (1988) :	106 million Barrels of Fuel Oil Equivalent (BFOE), oil imports 46 million BFOE
G.N.P (1988):	~ 37,200 million US$
G.N.P growth (1990):	5,7%
Annual Income/head (1990) :	$727
Inflation rate :	1988 : 8.8% 1989 : 9.5% 1990 : 10.8%
Main primary products :	Rice, maize, coconuts, sugar cane, abaca, rubber, tobacco, pineapples, bananas, coffee, timber, fish, copper, chrome, gold, silver, iron, nickel, coal, crude oil.
Major industries :	Agriculture, food processing, textiles, chemicals, forestry, fishing, mining.
Main exports :	Electrical goods (semiconductors), clothing, metal ores, coconut oil, sugar, fruit & vegetables, timber, abaca.

Average manpower costs	Engineer	Technician	Utility man
	$200 - $250 / month	$100 - $120 / month	$75 - $100 / month

Fuel prices (June 1989) in $/l based on oil price of $16.50/barrel ($1 = P21.60)

		Premium gasoline	Gasoline	Diesel	Kerosene
Official Retail price		0.30	0.27	0.23	0.28
of which :	Customs duty	0.001	0.001	0.002	0.003
	Value added tax	0.14	0.12	0.05	0.09
	Hauling charge	0.003	0.003	0.003	0.003
	Dealers mark up	0.01	0.01	0.01	0.01

Retail price in Buan. Tawi-Tawi		0.75		0.98
Lube oil : $1.20 - 1.40 /l				

Kerosene pressure lamps:	$40 - $50	**Kerosene wicklamp :**	$0.50
- Average service life :	7 - 8 years	- Average service life :	1 year
- Yearly maintenance :	$13		
- Fuel consumption :	0.1 - 0.2 l/hour	- Fuel consumption :	0.01 l/hour

Dry cell batteries	Size AA $0.20	Size C $0.25	Size D $0.35

Lead acid (car) batteries	12 V DC, 40 Ah $30	12 V DC, 75 Ah $40	12 V DC, 100 Ah $55

Electricity kWh price : $0,12 (by Decree)
Real cost of grid extensions 7,5/13,5 kV line ; $4,000 - $6,000 / km

Diesel gensets	3 kVA $3,100	10 kVA $5,000
	30,000-40,000 hours of operation if overhauled every 8,000 hours	

Gasoline gensets	600 W $650	1,000 W $700
	6,000 - 7,000 hours of operation, if overhauled every 2,000 hours	

Commercial prices of selected locally available PV system components (*).

Panel 53 Wp : approx $400	
-- G.I. panel frame (max. 3 panels of 53 Wp) :	$35
-- Battery Control Unit (12 VDC, 10A) :	$30
-- Solar battery (12 VDC, 100 Ah) :	$50
-- DC-DC converter (12-9, 7.5, 6, 4.5, 3 VDC - 1A) :	$18
-- Cables & Switches :	approx. $0.50 / Wp

Commercial prices of locally available DC appliances (*)

12 VDC, 20 W fluorescent tube, incl. holder + ballast	$18	
-- 12 VDC, 10 W/ 15 W/ 20 W Incandescent bulb	$0,50	
-- 12 VDC B&W TV 12" :	$110	(16": $175)
-- 12 VDC Videoplayer (Betamax)	$200	
-- 12 VDC Electric (car) fan :	$20	
-- Rechargeable NiCd batteries size D (1.25VDC, 2,000mA) :	$6	

(*) subject to change. Sources: CIA: World Fact Book (1989), WB, ADB, N.C.S.O, B.E.O, BCN, POSEN.

Fact Sheets of selected PV Applications

Fact sheet # 1-1

Fact sheet PV application: VID EO-CINEMA
Group: Commercial
A commercial "cinema" consisting of a video player and a (B&W or Colour) TV provides the rural population with education and/or entertainment

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution	35/65 %
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990
Relevant conventional energy prices: (urban) / rural	
Diesel/l	($0.21) $0.25
Gasoline/l	($0.28) $0.35

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

SYSTEM INFORMATION System availability:	85 %
Daily energy required: 2 shows/day	
3.5h (video + TV)	245 Wh
1.5 h (2 fl. tubes)	60 Wh
Total:	305 Wh

Possible local service: Average

Competitiveness of PV s ystem:
600 W gasoline gen set ($560/5y)
Generator housing $130, repair & maintenance
$45/y, part-time operator $210/y, fuel & oil $305/y

Costs:	$45/month
Cost Annuity:	$530

Status of product development:
All PV system components locally available.
R&D: Convert 220 VAC videoplayer to 12 or 24 VDC

Estimated number of potential customers:
6.5M households unelectrified
1 video cine / 20,000 households: 3250 video c inemas

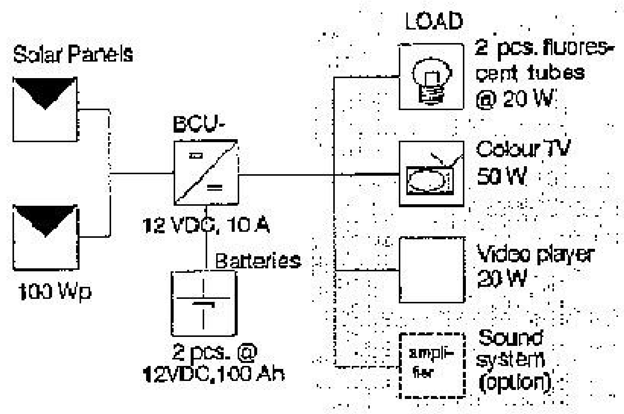
Estimated potential market:
3250 cinemas x 100 Wp = 325 kWp

Present locations known:

Burias Island, Verde Island

TECHNICAL INFORMATION

System diagram



System components	Price (*: import)	Anticipated maintenance

	import)	maintenance & repair:
PV panels 100 Wp x		BCU $30/5y
$7.50/Wp	$750*	Batteries $100/4y
Battery Control Unit	$30	General maintenance
1 frame (G.I.)	$35	$10/y
2 pcs. batteries	$100	
Cables & switches	$20	
Transport & installation	$40	
Profit margin	$200	
(2 pcs. fl. tubes @$18)	($36)	
Initial PV system investment $1170		
Costs: $10/month	Cost annuity: $116	

REMARKS

Compared with a generator set PV offers better picture quality (no voltage fluctuations) and better sound quality (no disturbing generator noise). Video cinema should be offered as a complete system incl. videoplayer (Betamax) and TV. 220 VAC videoplayers can be converted to 12VDC.
220 VAC videorecorders need an inverter.
12 VDC TV & Amplifier locally available.
Safe disposal of fl. tubes & batteries (rec ycling) is recommended. For immediate marketing.
Financing scheme will increase market prospects.

Fact sheet PV application: **VIDEO-CINEMA** Group: **Commercial**

A commercial "cinema" consisting of a video player and a (B&W or Colour) TV provides the rural population with education and/or entertainment

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Diesel/l ($0.21) $0.25

Gasoline/l ($0.28) $0.35

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	85 %
Daily energy required.	2 shows/day
3.5h (video + TV)	245 Wh
1.5 h (2 fl. tubes)	60 Wh
Total :	305 Wh
Possible local service:	Average

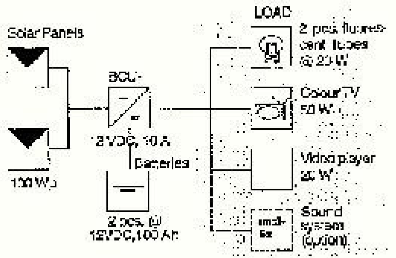
Competitiveness of PV system:

600 W gasoline gen set ($560/5y)

Generator housing $130, repair & maintenance $45/y, part-time generator $210/y, fuel&oil $305/y

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

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Fact sheet #
1-1

Costs:	$45/month
Cost Annuity:	$530

Status of product development:
All PV system components locally available.
R&D: Convert 220 VAC videoplayer to 12 or 24 VDC

Estimated number of potential customers:
6.5M households unelectrified
1 video cine / 20,000 households :
3250 video cinemas

Estimated potential market:
3250 cinemas x 100 Wp = 325 kWp

Present locations known:
Burias Island, Verde Island

PV panels 100 Wp x $7.50/Wp	$760*	BCU $30/5y
Battery Control Unit	$30	Batteries $100/4y
1 frame (G.I.)	$35	General maintenance $10/y
2 pcs. batteries	$100	
Cables & switches	$20	
Transport & installation	$40	
Profit margin	$200	
(2 pcs. fl. tubes @$18)	($36)	
Initial PV system investment	$1170	
Costs: $10/month	Cost annuity:	$115

REMARKS:
Compared with a generator set PV offers better picture quality (no voltage fluctuations) and better sound quality (no disturbing generator noise). Video cinema schould be offered as a complete system incl. videoplayer (Betamax) and TV. 220 VAC videoplayers can be converterd to 12VDC. 220 VAC videorecorders need an inverter.
12 VDC TV & Amplifier locally available.
Safe disposal of fl. tubes & batteries (recycling) is recommended. For immediate marketing.
Financing scheme will increase market prospects.

Factsheet # 1-1

Fact sheet # 1-2
Fact sheet PV application: Restaurant A
Group: Commercial
Restaurants which need a limited amount of power for light, radio & TV can be found throughout the unelectrified areas. Power supply for a refrigerator is excluded.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40
Dry cell Batteries:
Size D: $0.35

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION System availability:	80 %
Daily energy required:	
4 fl. tubes 4h:	320 Wh
Radio 8h:	80 Wh
TV (B&W) 6h:	120 Wh
Total:	520 Wh

Possible local service:	Average

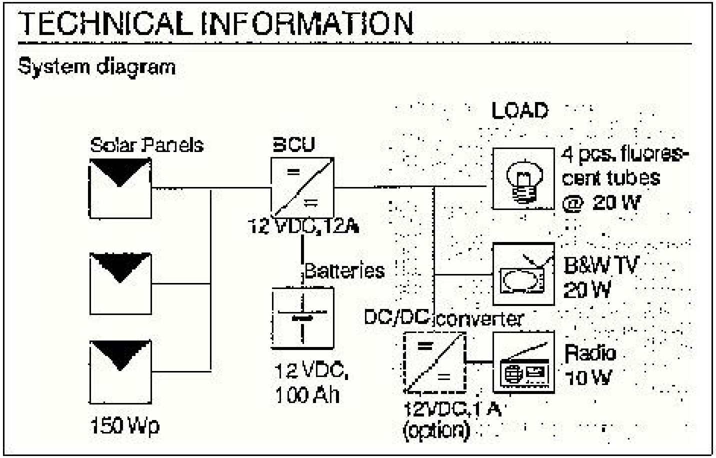
Competitiveness of PV s ystem: Gasoline gee-set 600W, $550/5y Fuel: 4h/d x 365d/y x 0.9(avail) x	
0.751/hx$0.35/l	= $345/y
Oil: $2/m x 12m/y	= $24/ y
Battery	= $50/3y
Gen. Maintenance	= $50/y
Costs:	$49/month
Cost Annuity:	$582/year

Status of product development:
All PV system components locally available.
BCU made to order.
R&D: None

Estimated number of potential customers:
For unelectrified towns & along highways, roughly 500 restaurants interested.

Estimated potential market
500 x 150 Wp = 75 kWp

Present locations known:
None



System components	Price	Anticipated maintenance
	(*: import) & repair:	
PV panels 150Wp		BCU $60/5y
x $6.50/Wp	$975*	Batteries $50/4y
Battery Control Unit	$60*	General maintenance
Battery	$50	$15/y
Frame (G.I.)	$35	
Cables & Switches	$25	
(4 pcs. fl. tubes @$18)	($72)	
Transport & Installation	$60	
Profit margin	$250	
Initial PV system investment $1455		
Costs: $11.25/month	Cost annuity: $135	

REMARKS:
Also cost-competitive with the use of 2 k erosene pressure lamps (5h/d), dry cell batteries (8 pcs/week) and a weekly recharged battery (for TV).
Cost annuity $350 or $30/month.
For immediate marketing.
Safe disposal of fluorescent tubes & batteries (recycling) is recommended.

Fact sheet PV application: **Restaurant A** Group: **Commercial**

Restaurants which need a limited amount of power for light, radio & TV can be found throughout the unelectrified areas. Power supply for a refrigerator is excluded.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline/l : ($0.28) $0.35

Kerosene/l : ($0.26) $0.40

Dry cell Batteries:

Size D : $0.55

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	80 %
Daily energy required:	
4 fl. tubes 4h :	**320 Wh**
Radio 8h :	**80 Wh**
TV (B&W) 6h :	**120 Wh**
Total :	520 Wh
Possible local service:	Average

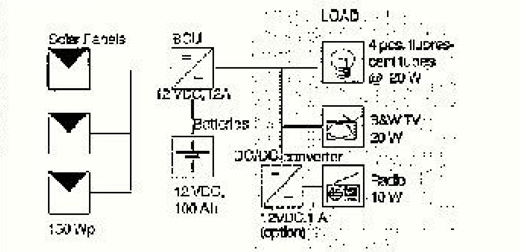
Competitiveness of PV system:

Gasoline gen-set 600W, $550/5y

Fuel: 4h/d x 365d/y x 0.9(avail) x 0.75l/hx$0.35/l = $345/y

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

Oil: $2/m x 12m/y = $24/y		(*: import)	& repair:
Battery = $50/3y	PV panels 150Wp		BCU $60/3y
Gen. Maintenance = $50/y	x $6.50/Wp	$975*	Batteries $50/4y
Costs: $49/month	Battery Control Unit	$60*	General maintenance
Cost Annuity: $582/year	Battery	$50	$15/y
Status of product development:	Frame (G.I.)	$35	
All PV system components locally	Cables & Switches	$25	
available.	(4 pcs. fl. tubes @$18)	($72)	
BCU made to order.	Transport & installation	$60	
R&D : None	Profit margin	$250	
Estimated number of potential customers:			
For unelectrified towns &			
along highways, roughly			
500 restaurants interested.	Initial PV system investment	$1455	
	Costs: $11.25/month	Cost annuity:	$135
Estimated potential market:	REMARKS:		
500 x 150 Wp = 75 kWp	Also cost-competitive with the use of 2 kerosene pressure lamps (5h/d), dry cell batteries (8 pcs/week) and a weekly recharged battery (for TV).		
Present locations known:	Cost annuity $350 or $30/month.		
None	For immediate marketing.		
	Safe disposal of fluorescent tubes & batteries (recycling) is recommended.		
Factsheet # 1.2			

Fact sheet # 1-3

Fact sheet PV application: Restaurant B
Group: Commercial
As Restaurant A, including a refrigerator

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40
Dry cell Batteries:
Size D: $0.35

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION System availability:	85 %
Daily energy required:	
Refrigerator	3000 W/h
Lighting, radio, TV as in Restaurant A	520 Wh
Total:	3520 Wh

Possible local service: Poor	

Competitiveness of PV s ystem: Kerosene refrigerator: fuel (1 l/d) = $146/y. 2 pressure lamps + 8 batteries/week (radio) + 1 battery charge/week	
Costs:	$60/month
Cost Annuity: $782/year	

Status of product development:
BCU made to order.
R&D: efficient 24 VDC refrigerator
& fl. tubes, DC-DC converter

Estimated number of potential customers:
Not Clea

Estimated potential market:
Not Clear

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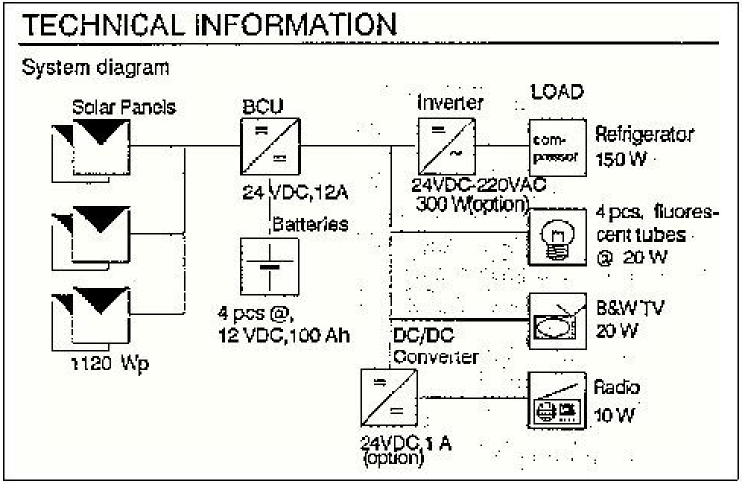
Present locations known: None



System components	Price (*: import)	Anticipated maintenance & repair:
PV	BCU	

PV panels x $6.50/\Np 1120Wp	BCU $150/7y $7280*	Batteries $200/4y
Batterie Control U nit	$150*	General maintenance
4 pcs. batteries @$50	$200	$50/ y
8 Frames (G.I.) @$35	$280	
Cables & Switches	$40	
DC-DC converter	$30	
(4 pcs. fl. tubes @$18)	($72)	
Transport & Installation	$350	
Profit margin	$1500	
Initial PV system investment $9830		
Costs: $60/month	Cost annuity: $785	

REMARKS:
24 VDC s ystem. 24 VDC fluorescent tubes not readily available on Phil. mark et. If only 110/220 VAC refrigerators available, a 300 W inverter is necessary.
PV s ystem not cost-competitive with conventional system with k erosene refrigerator. Initial investment of $10,000 for PV system is unacceptably high.
Safe disposal of old fl. tubes & batteries (recycling) is recommended.

Fact sheet PV application: **Restaurant B** Group: Commercial

As Restaurant A, including a refrigerator

COUNTRY:	Philippines	Relevant conventional energy prices: (urban) / rural	METEOROLOGICAL INFO
Population:	60M	Gasoline/l : ($0.28) $0.35	Average Insolation: 5 kWh/m2d
Urban/rural distribution:	35/65 %	Kerosene/l : ($0.26) $0.40	Seasons:
% electrification:	35 %	Dry cell Batteries:	June-Nov. : wet, 4 kWh/m2d
Currency:	Pesos	Size D : $0.35	Dec.-May : dry, 6 kWh/m2d
Exchange rate:	US$ 1 = P 25		
date:	Sept. 1990		

SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
Refrigerator	3000 Wh
Lighting, radio, TV as in Restaurant A	520 Wh
Total:	3520 Wh
Possible local service:	Poor

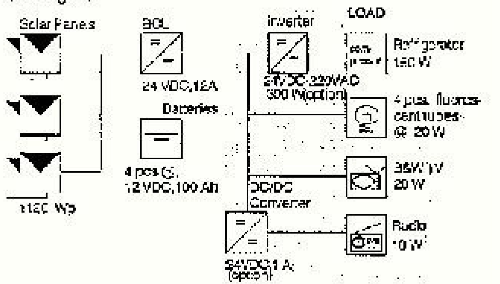
Competitiveness of PV system:

Kerosene refrigerator: fuel (1 l/d) = $146/y.

2 pressure lamps + 6 batteries/week

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

(radio) + 1 battery charge/week (TV)			(* : Import)	& repair:
	PV panels 1120Wp			BCU $150/7y
	x $6.50/Wp		$7280*	Batteries $200/4y
Costs:	$60/month	Batterie Control Unit	$150*	General maintenance
Cost Annuity:	$782/year	4 pcs. batteries @$50	$200	$50/y
Status of product development:		8 Frames (G.I.) @$35	$280	
BCU made to order.		Cables & Switches	$40	
R&D : efficient 24 VDC refrigerator		DC-DC converter	$30	
& fl. tubes, DC-DC converter		(4 pcs. fl. tubes @$18)	($72)	
		Transport & Installation	$350	
Estimated number of potential customers:		Profit margin	$1500	
Not Clear				
		Initial PV system investment	$9830	
		Costs: $60/month	Cost annuity:	$785

Estimated potential market:	REMARKS:
Not Clear	24 VDC system. 24 VDC fluorescent tubes not readily available on Phil. market. If only 110/220 VAC refrigerators available, a 300 W inverter is necessary.
Present locations known:	PV system not cost-competitive with conventional system with kerosene refrigerator. Initial investment of $10,000 for PV system is unacceptably high.
None	Safe disposal of old fl. tubes & batteries (recycling) is recommended.
Factsheet # 1-3	

Fact sheet # 1-4

Fact sheet PV application: Power Supply-Church
Group: Commercial
A 350 Wp electricity supply for sound system & lighting of a church plus residential applications for an adjescent convent.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40
Diesel/l: ($0.21) $0.25

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION

System availability:	90 %
Daily energy required:	
Church:	
Light & amplifier(4h/d)	400 Wh
Convent:	
Light & Radio & TV	620 Wh
Total:	1020 Wh

Possible local service: Positiv

Competitiveness of PV s ystem: Gasoline gee-set 1000W ($700/5y) Fuel: 365 d/y x O.9(avail) x 6h/d	
x 1 I/h x $0.35/1	= $690/y
Oil: $2.50/m x 12m/y = $30/y	
Gen. Maintenance	= $50/y
Costs:	$77/month
Cost Annuity:	$925/year

Status of product development: All components locally available. BCU made to order. R&D: power conditioning for PC computer sys tem

Estimated number of potential customers:

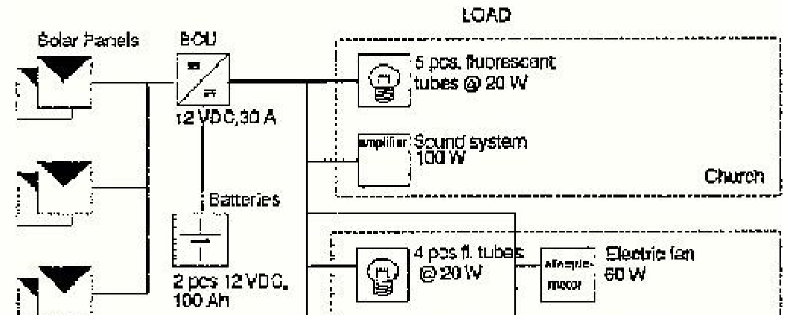
Initial interest estimated at 50 churche

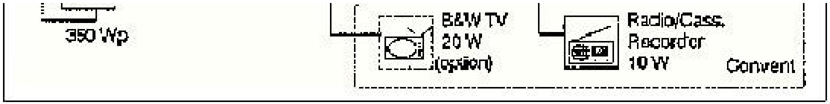
Estimated potential market:
50 x 350 Wp = 18 kW

Present locations known:
None

TECHNICAL INFORMATION

System diagram





System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 350Wp		BCU $90/5y
x $6.50/Wp	$2275*	Batteries $100/4y
Battery Control Unit	$90	General maintenance
2 pcs. batteries @$50	$100	$50/y
3 pcs. frames @$35	$105	
Cables & Switches	$50	
Transport & Installation	$150	
Profit margin	$550	
(9 pcs. fl. tubes @$18)	($162)	
Initial PV system investment $3320		
Costs: $26.25/month	Cost annuity:	$315

REMARKS:
Immediate interest exists from mission outposts as well as regular churches/mosques in unelectrified areas.
Integration of PC computer systems for administrative purposes should be considered (with or without inverters).
Safe disposal of fl. tubes & batteries (rec ycling) is recommended.
Currently the diocese of Masbate province is considering PV systems for all of its 18 churches, as part of the ongoing Burias PV island electrification project.

Fact sheet PV application: Power Supply -Church Group: Commercial

A 350 Wp electricity supply for sound system & lighting of a church plus residential applications for an adjescent convent.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

- Gasoline/l : ($0.28) $0.35
- Kerosene/l : ($0.26) $0.40
- Diesel/l : ($0.21) $0.25

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

- June-Nov. : wet, 4 kWh/m2d
- Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	90 %
Daily energy required:	
Church:	
Light & amplifier(4h/d)	400 Wh
Convent:	
Light & Radio & TV	620 Wh
Total:	1020 Wh
Possible local service:	Positive

Competitiveness of PV system:

Gasoline gen-set 1000W ($700/5y)

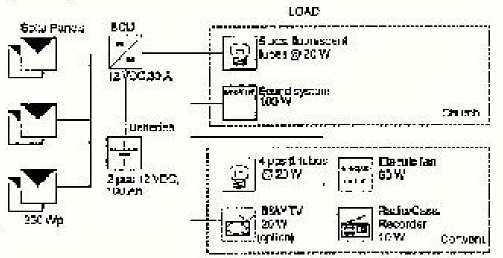
Fuel: 365 d/y x 0.9(avail) x 6h/d

x 1 l/h x $0.35/l = $690/y

Oil: $2.50/m x 12m/y = $30/y

TECHNICAL INFORMATION

System diagram



System components	Price (* : import)	Anticipated maintenance & repair:

Gen. Maintenance = $50/y

Costs: $77/month

Cost Annuity: $925/year

Status of product development:

All components locally available.
BCU made to order.
R&D : power conditioning for
PC computer systems

Estimated number of potential customers:

Initial interest estimated at
50 churches

Estimated potential market:

50 x 350 Wp = 18 kWp

Present locations known:

None

Factsheet # 1-4

PV panels 350Wp x $6.50/Wp	$2275*	BCU $90/5y
Battery Control Unit	$90	Batteries $100/4y
2 pcs. batteries @$50	$100	General maintenance $50/y
3 pcs. frames @$35	$105	
Cables & Switches	$50	
Transport & Installation	$150	
Profit margin	$550	
(9 pcs. fl. tubes @$18)	($162)	
Initial PV system investment	$3320	

Costs: $26.25/month Cost annuity: $315

REMARKS:

Immediate interest exists from mission outposts as well as regular churches/mosques in unelectrified areas.
Integration of PC computer systems for administrative purposes should be considered (with or without inverters).
Safe disposal of fl. tubes & batteries (recycling) is recommended.
Currently the diocese of Masbate province is considering PV systems for all of its 18 churches, as part of the ongoing Burias PV Island electrification project.

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Fact sheet # 2-1

Fact sheet PV application: Electro Repair Shop
Group: Industrial
A repair shop for TV's, Radios, PV system components and other appliances as a new form of income generation.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	US$ 1 = P 25
date:	sept. 1990

Relevant conventional energy prices: (urban) / rural
Dry Cell Batteries:
Size D: $0.35
Charging lead-acid battery +transport: $0.75/charg

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
Soldering iron 5h	75 Wh
Testing 3h	75 Wh
Fl. tube 3h	60 Wh
Total	210 Wh

Possible local service: Positiv

Competitiveness of PV s ystem:
No direct competition: electronics repair shops does not exist in unelectrified areas.
Costs:
Cost Annuity:

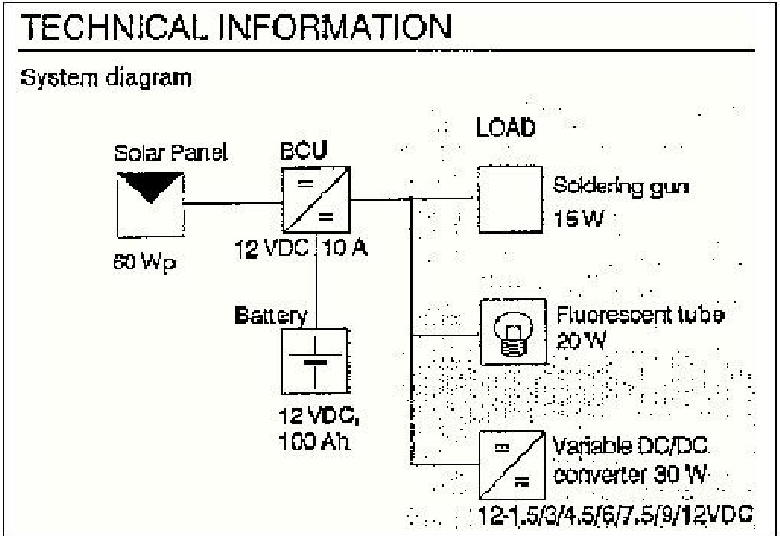
Status of product development:
Variable DC-DC converter made to order.
R&D: none

Estimated number of potential customers:
1 repair shop/ 40,000 inhabitants in unelectrified areas.
1000 repair shops

Estimated potential market:

1000 x 60 Wp = 60 kWp

Present locations known:
Burias Island, Verde Island



System components	Price (*: import)	Anticipated maintenance& repair:
PV panel 60 Wp		BCU $30/5y
x $7.50	$450*	Batteries $50/4y
Battery Control Unit	$30	General maintenance
Battery	$50	$5/y
Frame (G.I.)	$35	
Cables & Switches	$20	
Transport & Installation	$30	
Profit margin	$100	
(fl. tube & holder)	($18)	
Initial PV system investment	$715	
Costs: $5.75/month	Cost annuit y: $69	

REMARKS:
Possible such enterprises can be introduced in combination with PV battery-charging stations. Such repair shops should be an integral part of any PV electrification project in order to provide instant local technical support.

Fact sheet PV application: **Electro Repair Shop** Group: **Industrial**

A repair shop for TV's, Radios, PV system components and other appliances as a new form of income generation.

COUNTRY:	Philippines	Relevant conventional energy prices: (urban) / rural	METEOROLOGICAL INFO	
Population:	60M	**Dry Cell Batteries:**	Average insolation:	5 kWh/m2d
Urban/rural distribution:	35/65 %	**Size D : $0.35**	Seasons	
% electrification:	35 %	**Charging lead-acid battery**	**June-Nov. : wet, 4 kWh/m2d**	
Currency:	Pesos	**+transport : $0.75/charge**	**Dec.-May : dry, 6 kWh/m2d**	
Exchange rate:	US$ 1 = P 25			
date:	Sept. 1990			

SYSTEM INFORMATION

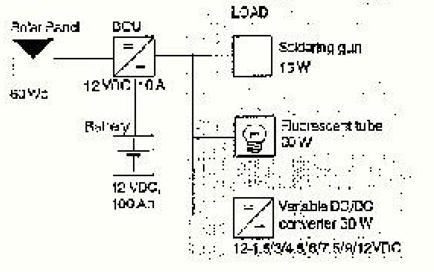
System availability:	95 %
Daily energy required:	
Soldering iron 5h	75 Wh
Testing 3h	75 Wh
Fl. tube 3h	60 Wh
Total :	210 Wh
Possible local service:	Positive

Competitiveness of PV system:

No direct competition: electronics repair shops does not exist in unelectrified areas.

TECHNICAL INFORMATION

System diagram



System components	Price (US$)	Anticipated maintenance & repair

Costs:	PV panel 60 Wp x $7.50	$450*	BCU $30/5y
Cost Annuity:	Battery Control Unit	$30	Batteries $50/4y
	Battery	$50	General maintenance $5/y
Status of product development: **Variable DC-DC converter made to order. R&D: none**	Frame (G.I.)	$35	
	Cables & Switches	$20	
	Transport & Installation	$30	
	Profit margin	$100	
	(fl. tube & holder)	($18)	
Estimated number of potential customers: **1 repair shop/ 40,000 inhabitants in unelectrified areas. 1000 repair shops.**	Initial PV system investment	$715	
	Costs: $5.75/month	Cost annuity:	$69
Estimated potential market: **1000 x 60 Wp = 60 kWp**	REMARKS: **Possible such enterprises can be introduced in combination with PV battery-charging stations. Such repair shops should be an integral part of any PV electrification project in order to provide instant local technical support.**		
Present locations known: **Burias Island, Verde Island**			
Factsheet # 21			

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Fact sheet # 2-2

Fact sheet PV application: Vulcanizing Shop
Group: Industrial
A PV powered compressor for tire repair shops along the unelectrified parts of the national highways.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sent. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION System availability:	90 %
Daily energy required:	
Compressor 1 1/2 h:	375 Wh
Light 5 h:	100 Wh
Total:	475 Wh

Possible local service: Poor	

Competitiveness of PV s ystem:
Competition with handpowered or gasoline powered compressors is unclear. PV compressor will be more comfortable than handpumps.
Costs: n.a.
Cost Annuity: n.a

Status of product development:
24 VDC s ystem, BCU made to order.
24 VDC/250 W electromotor not avail.
R&D: 24 VDC ballasts for fl. tubes, adapt. 220 VAC compressors to 24 VD
.

Estimated number of potential customers:
Not clear

Estimated potential market:
Not clear

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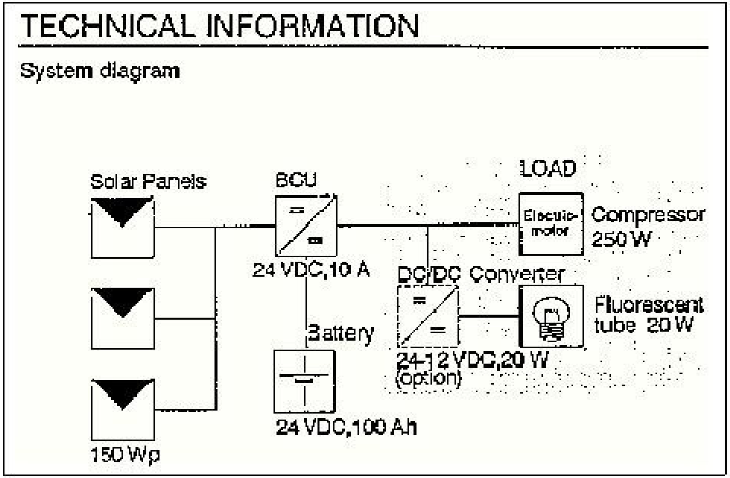
Present locations known:
None



System components	Price (*: import)	Anticipated maintenance & repair:
PV		BCU

PV panel 150 Wp x $6.50	$975*	BOS $90/5y Batteries $100/4y
Battery Control Unit	$90	General maintenance
2 pcs. Batteries @ $50	$100	$20/y
Frame (G.I.)	$35	
Cables & Switches	$25	
Transport & Installation	$100	
Profit margin	$250	
(Compressor)	($250)	
(fl. tube & holder)	($18)	
Initial PV system investment $1575		
Costs: $13.75/month	Cost annuity:	$165

REMARKS
The common price for tire repairs: $0.5 - $1.00 per puncture.
Marketability to these marginal enterprises is questionable.
PV powered compressors might be developed for additional cottage industry activities (e.g. painting etc.).

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Fact sheet PV application: **Vulcanizing Shop** Group: Industrial

A PV powered compressor for tire repair shops along the unelectrified parts of the national highways.

COUNTRY: Philippines

Population:	60M
urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 26
date:	Sept. 1990

Relevant conventional energy prices (urban) / rural

Gasoline/l : ($0.20) $0.35

Kerosene/l : ($0.26) $0.40

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

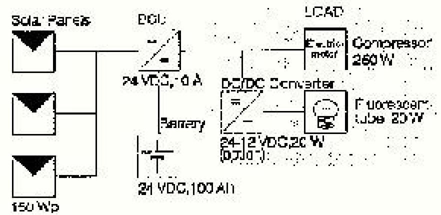
System availability:	90 %
Daily energy required:	
Compressor 1 1/2 h :	375 Wh
Light 5 h :	100 Wh
Total :	475 Wh
Possible local service:	Poor

Competitiveness of PV system:

Competition with handpowered or gasoline powered compressors is unclear. PV compressor will be more

TECHNICAL INFORMATION

System diagram



System components | Price | Anticipated maintenance comfortable than handpumps.

Costs:	n.a.	PV panel 150 Wp x $6.50	$975*	BCU $90/5y
Cost Annuity:	n.a.	Battery Control Unit	$90	Batteries $100/4y
		2 pcs. Batteries @ $50	$100	General maintenance $20/y
		Frame (G.I.)	$35	
		Cables & Switches	$25	
		Transport & Installation	$100	
		Profit margin	$250	
		(Compressor)	($250)	
		(fl. tube & holder)	($16)	
		Initial PV system Investment	$1575	
		Costs: $13.75/month	Cost annuity:	$165

(*: import) & repair:

Status of product development:
24 VDC system, BCU made to order. 24 VDC/250 W electromotor not avail. R&D: 24 VDC ballasts for fl. tubes, adapt. 220 VAC compressors to 24 VDC.

Estimated number of potential customers:
Not clear

Estimated potential market:
Not clear

Present locations known:
None

REMARKS:
The common price for tire repairs: $0.5 - $1.00 per puncture. Marketability to these marginal enterprises is questionable. PV powered compressors might be developed for additional cottage industry activities (e.g. painting etc.).

Factsheet # 2-2

Fact sheet # 3-1

Fact sheet PV application: Small Irrigation System
Group: Agricultural
Power supply for a low head (2-3m) centrifugal pumping system which can displace a maximum of 199 cu.m of water (good for approx. 1-1.5 ha riceland).

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Dry Cell Batteries:
Diesel/l: ($0.21) $0.25
Gasoline/l: ($0.28) $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability: 70 % Daily energy required: Variable: depending on daily demand which varies with the seasons and meteorological conditions. Total:

Possible local service: Poo

Competitiveness of PV s ystem: Example riceland Irrigation: Dry season:	
85d x 100 cu.m	= 8500cu.m
Wet season:	
20d x 100 cu.m	= 2000 cu.m
Total/year 10,500 cu.m at $0.04/cu.m	
Diesel pumped cu.m:	$0.02-$0.03
PV questionable for riceland Irrigation	

Status of product development: 400-500W DC pump units not available. R&D: for testing in combination with high value cash crops.

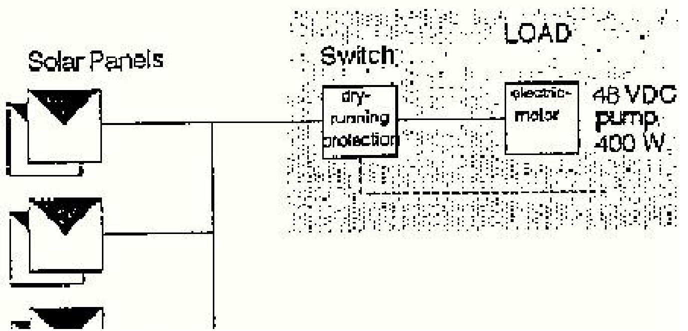
Estimated number of potential customers:
Not clear

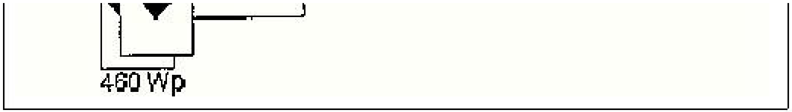
Estimated potential market:
Not clear

Present locations known:
None

TECHNICAL INFORMATION

System diagram





System components	Price (*: import)	Anticipated maintenance & repair:
PV panel 460 Wp		
x $6.50	$2990*	
		General maintenance
3 pcs. frames (G.I.) @$35	$105	$50/ y
Cables & Switches / 10y (incl. dry running protection)	$100	
Transport & Installation	$100	
Profit margin	$650	
(Pumps & Pipes / 10y)	($500)	
Initial PV system investment	$3945	
Costs: $0.04/cu.m	Cost annuit y: $387	

REMARKS:
Pilot applications should concentrate on drip-irrigation of cash crops e.g. vegetables, tobacco etc. Possibly in combination with farm reservoir project of the International Rice Research Institute: PV systems operating year round w/ elevated water storage (reservoirs).
Another option Is the use of surplus energy for household purposes.
Financing schemes should be offered to farmers.

Fact sheet PV application: **Small Irrigation System** Group: Agricultural

Power supply for a low head (2-3m) centrifugal pumping system which can displace a maximum of 199 cu.m of water (good for approx. 1-1.5 ha riceland).

COUNTRY:	Philippines
Population:	60 M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 26
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Dry Cell Batteries:

Diesel/l : ($0.21) $0.25

Gasoline/l : ($0.28) $0.35

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	70 %

Daily energy required:

Variable: depending on daily demand which varies with the seasons and meteorological conditions.

Total :

Possible local service:	Poor

Competitiveness of PV system:

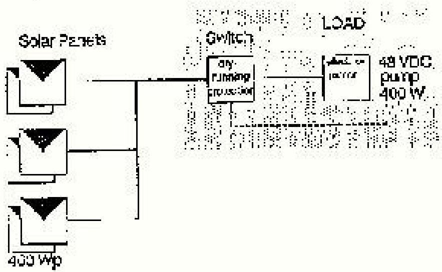
Example riceland irrigation:

Dry season:

85d x 100 cu.m = 8500 cu.m

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

Wet season:		(* : import)	& repair :
20d x 100 cu.m = 2000 cu.m	PV panel 460 Wp		
Total/year 10,500 cu.m at $0.04/cu.m	x $6.50	$2990*	
Diesel pumped cu.m: $0.02-$0.03			General maintenance
PV questionable for riceland irrigation.	3 pcs. frames (G.I.) @$35	$105	$50/y
Status of product development:	Cables & Switches / 10y	$100	
400-500W DC pump units not available.	(incl. dry running protection)		
	Transport & Installation	$100	
R&D: for testing in combination	Profit margin	$650	
with high value cash crops.	(Pumps & Pipes / 10y)	($500)	
Estimated number of potential customers:			
Not clear			
	Initial PV system investment	$3945	
	Costs: $0.04/cu.m	Cost annuity:	$387
Estimated potential market:	REMARKS:		
Not clear	Pilot applications should concentrate on drip-irrigation of cash crops e.g. vegetables, tobacco etc. Possibly in combination with farm reservoir project of the International Rice Research Institute: PV systems operating year round w/ elevated water storage (reservoirs). Another option is the use of surplus energy for household purposes. Financing schemes should be offered to farmers.		
Present locations known:			
None			
Factsheet # 3-1			

Fact sheet # 3-2

Fact sheet PV application: Poultry Incubator
Group: Agricultural
Depending on the size 200-600 chicken or duck eggs can be hatched in a PV powered Incubator.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural: n.a.

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	95 %
Daily energy required:	
Electric	600

fan 24 h Heating element 18 h 540 Wh	Wh
Inc. bulb 1 h	10 Wh
Total:	1,150 Wh

Possible local service: Average	

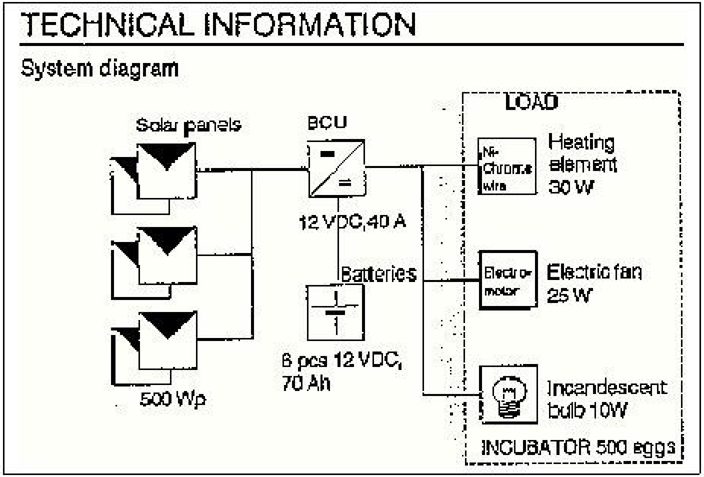
Competitiveness of PV s ystem: Up to now incubators are restricted to electrified areas with generator sets for back-up purposes. Small incubators for unelectrified areas do not (yet) exist.	
Costs:	n.a.
Cost Annuity: n.a.	

Status of product development:
BCU made to order.
R&D: prototype under field testing since 1986.

Estimated number of potential customers:
Off-hand estimate: 50 pc

Estimated potential market:
50 pcs. x 500 Wp = 25 kW

Present locations known:
Infanta (Quezon Prov.)



System components	Price (*: import)	Anticipated maintenance & repair:
PV panel 500 Wp		BCU $90/5y
x $6.50/Wp	$3250	Batteries $240/4y
Battery Control Unit	$90	General maintenance
6	$240	$50/y

[illegible] pcs. Batteries @ $40	[illegible]	[illegible]
3 pcs. frames (G.I.) @$35	$105	
Cables & Switches	$20	
Transport & Installation	$100	
Profit margin	$750	
(Incubator complete) 10y	($200)	
Initial PV system investment	$4555	
Costs: $0.08/chick	Cost annuity: $460	

REMARKS:
This s ystem can produce 16 batches of 600 chick s/year with a 21-day c ycle.
At hatching success rate of 80%: 6400 chicks/y.
Incubator itself can be constructed locally by simple means.
For immediate marketing to farmer cooperatives.
Commercially sold 1-day chicks (layers) In electrified areas:
$0.75 (excluding transport & transport losses).

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Fact sheet PV application: **Poultry Incubator** Group: **Agricultural**

Depending on the size 200-600 chicken or duck eggs can be hatched in a PV powered incubator.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

n.a.

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

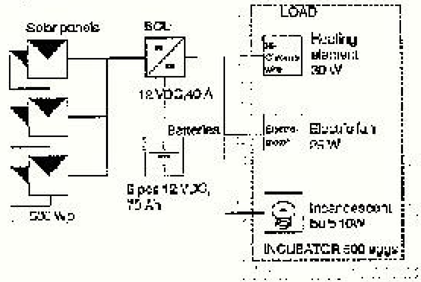
System availability:	95 %
Daily energy required:	
Electric fan 24 h	**600 Wh**
Heating element 18 h	**540 Wh**
Inc. bulb 1 h	**10 Wh**
Total :	**1,150 Wh**
Possible local service:	**Average**

Competitiveness of PV system:

Up to now incubators are restricted to electrified areas with generator sets for back-up purposes.

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

Small incubators for unelectrified areas do not (yet) exist.		(* : import)	& repair:
	PV panel 500 Wp x $6.50/Wp	$3250	BCU $90/5y
Costs: n.a.	Battery Control Unit	$90	Batteries $240/4y
Cost Annuity: n.a.	6 pcs. Batteries @ $40	$240	General maintenance $50/y
Status of product development: BCU made to order.	3 pcs. frames (G.I.) @$35	$105	
	Cables & Switches	$20	
	Transport & Installation	$100	
R&D: prototype under field testing since 1986.	Profit margin	$750	
	(Incubator complete) 10y	($200)	
Estimated number of potential customers: Off-hand estimate : 50 pcs.	Initial PV system investment	$4555	
	Costs: $0.08/chick	Cost annuity:	$460
Estimated potential market: 50 pcs. x 500 Wp = 25 kWp	REMARKS:		
Present locations known: Infanta (Quezon Prov.)	This system can produce 16 batches of 500 chicks/year with a 21-day cycle. At hatching success rate of 80%: 6400 chicks/y. Incubator itself can be constructed locally by simple means. For immediate marketing to farmer cooperatives. Commercially sold 1-day chicks (layers) in electrified areas: $0.75 (excluding transport & transport losses).		
Factsheet # 3.2			

Fact sheet # 3-3

Fact sheet PV application: Ricemill 16 Hp
Group: Agricultural
A "satak e"-type of ricemill is the smallest ricemill currently available on the Philippines. It requires minimally a 16 Hp prime mover.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
data	Sent. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System	85

availability: ally energy required:	%
10hx16Hpx746W/Hp =	120 kWh
Lights:	
pcs. x 10h =	0.8 kWh
Total:	121 kWh

Possible local service

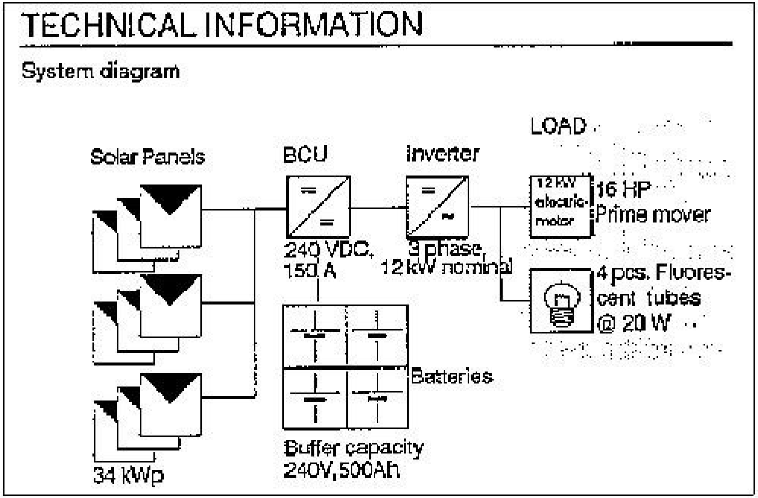
Competitiveness of PV s ystem:
Purchase 16 Hp gasoline prime mover: $1300
Costs:
Cost Annuity:

Status of product development:

Estimated number of potential customers:

Estimated potential market:

Present locations known:



System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 34 kW p		
x $6.50/Wp	$221, 000*	
Initial		

Initial PV system investment Costs:	Cost annuity:	

REMARKS:

For an initial investment of approx. $220,000 in PV panels alone, PV powered ricemills will not be considered.

Therefore any further calculations will prove to be superfluous.

Fact sheet PV application: **Ricemill 16 Hp** Group: Agricultural

A "satake"-type of ricemill is the smallest ricemill currently available on the Philippines. It requires minimally a 16 Hp prime mover.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline/l : ($0.28) $0.35

Kerosene/l : ($0.26) $0.40

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
10hx16Hpx746W/Hp =	120 kWh
Lights:	
4 pcs. x 10h =	0.8 kWh
Total:	121 kWh

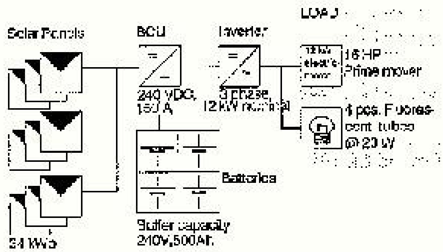
Possible local service:

Competitiveness of PV system:

Purchase 16 Hp gasoline prime mover: $1000

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

		(*: import)	& repair:
Costs: Cost Annuity:	PV panels 34 kWp x $6.50/Wp	$221,000*	
Status of product development:			
Estimated number of potential customers:	Initial PV system investment		
	Costs:	Cost annuity:	
Estimated potential market:	REMARKS:		
	For an initial investment of approx. $220,000 in PV panels alone, PV powered ricemills will not be considered. Therefore any further calculations will prove to be superfluous.		
Present locations known:			
Factsheet 3-9			

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Fact sheet # 4-1

Fact sheet PV application: Telecom Relay Station
Group: Telecom
A small back-to-back transceiver system (2x48W) provides telephone and telegraph link s for (inter-) national communications.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	US$ 1 = P 25
data.	Sept 1990

Relevant conventional energy prices: (urban) / rural
Diesel: ($0.21) $0.25

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	95 %
Daily	

energy Transceivers: 2 pcs x 24h x 48W	
required:	= 2,300 Wh
2 fl. tubes 10h	= 400 Wh
Towerlight 10h	= 200 Wh
Radio 12 h	= 60 Wh
Total:	3 kWh

Possible local service: Positiv

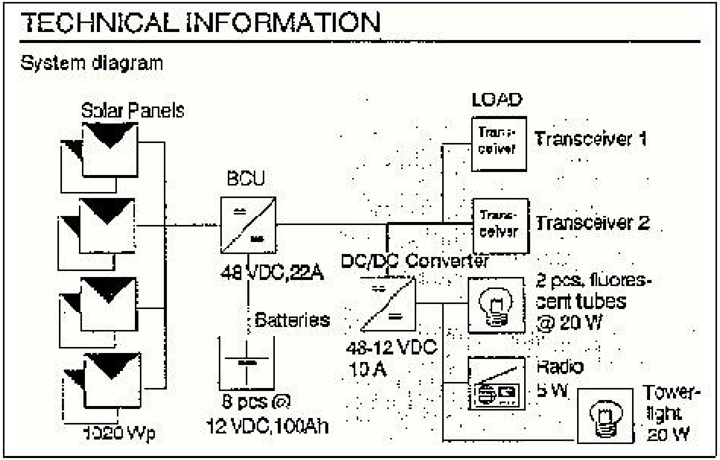
Competitiveness of PV s ystem:
As hybrid system (PV+Diesel back-up) directly cost competitive with conventional system with 2 or 3 gee-sets because of reduced costs of labour, fuel, maintenance & repair.
E.g. 3x3kVA diesel gee-sets:
Cost Annuit $7000 (PTT Zambales

Status of product development: Product ready.
R&D: None

Estimated number of potential customers:
Converting existing relay stations to PV + expans ions of telecom network: 40-60 stations

Estimated potential market:
40 x 1 kWp = 40 kWp
(minimum)

Present locations known:
Zambales (PTT)
Marinduque (RCPI)



System components	Price (*: import)	Anticipated maintenance

PV panels 1020 Wp		maintenance & BCU $510/IO y
x $6.50/Wp	$6630*	repair: Batteries $400/4y
Battery Control Unit		General maintenance
(1020 Wp x $0.5/WP)	$510*	$350/y.
8 pcs Batteries @$50	$400	
7 pcs frames (G.I.) @$35	$245	
DC-DC Converter	$40	
Cables & Switches	$100	
Transport & Installation	$500	
Profit margin	$1600	
Initial PV system investment $10025		
Costs: $100/month	Cost annuity: $1150	

REMARKS:
PV s ystem to be controlled by radio operator.
Hybrid system (PV+Diesel) will have a cost annuity < $2000. PV systems offer less air pollution & noise.
Safe disposal of batteries (recycling) is recommended.
Immediate interest by leading Phil. Telecom companies (PLDT, PTT, RCPI, Eastern, Oceanic Wireless, BUTEL) in converting existing remote relays to PV.
In a few cases a grid extension might be more cost effective. Also larger (40-80kWh/d) stations can be cost effectively operated by PV.

Fact sheet PV application: **Telecom Relay Station** Group: **Telecom**

A small back-to-back transceiver system (2x48W) provides telephone and telegraph links for (inter-) national communications.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Diesel : ($0.21) $0.25

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

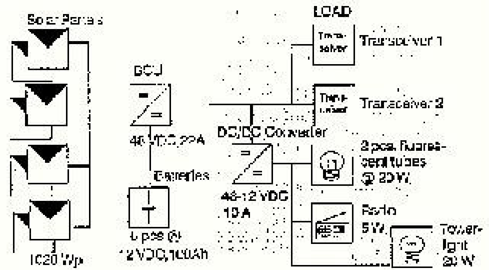
System availability:	95 %
Daily energy required:	
Transceivers: 2 pcs x 24h x 48W	= 2,300 Wh
2 fl. tubes 10h	= 400 Wh
Towerlight 10h	= 200 Wh
Radio 12 h	= 60 Wh
Total:	3 kWh
Possible local service:	Positive

Competitiveness of PV system:

As hybrid system (PV+Diesel back-up) directly cost competitive with conventional system with 2 or 3 gen-sets because of reduced costs of labour

TECHNICAL INFORMATION

System diagram



System components	Price (+ import)	Anticipated maintenance & repairs:

fuel, maintenance & repair.	PV panels 1020 Wp		BCU $510/10y
E.g. 3x3kVA diesel gen-sets:	x $6.50/Wp	$6630*	Batteries $400/4y
	Battery Control Unit		General maintenance
Cost Annuit. $7000 (PTT Zambales)	(1020 Wp x $0.5/Wp)	$510*	$350/y.
Status of product development:	8 pcs Batteries @$50	$400	
Product ready.	7 pcs frames (G.I.) @$35	$245	
	DC-DC Converter	$40	
R&D: None	Cables & Switches	$100	
	Transport & Installation	$500	
Estimated number of potential customers:	Profit margin	$1600	
Converting existing relay stations to PV + expansions of telecom network: 40-60 stations.	Initial PV system investment	$10025	
	Costs: $100/month	Cost annuity:	$1150

Estimated potential market: 40 x 1 kWp = 40 kWp (minimum)	REMARKS: PV system to be controlled by radio operator. Hybrid system (PV+Diesel) will have a cost annuity < $2000. PV systems offer less air pollution & noise, Safe disposal of batteries (recycling) is recommended.
Present locations known: Zambales (PTT) Marinduque (RCPI)	Immediate interest by leading Phil. Telecom companies (PLDT, PTT, RCPI, Eastern, Oceanic Wireless, BUTEL) in converting existing remote relays to PV. In a few cases a grid extension might be more cost effective. Also larger (40-80kWh/d) stations can be cost effectively operated by PV.
Factsheet # 6-1	

Fact sheet # 4-2

Fact sheet PV application: TV Translator
Group: Telecom
An (unmanned) 10W (transmitting power) TV relay strategically situated on or near a mountain top can provide a good quality signal to settlements below.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sent. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System	95

availability:	%
Daily energy required:	
16 hours x 26 W =	416 Wh
Total:	416 Wh

Possible local service: Positive	

Competitiveness of PV s ystem: Competitive with grid extension of > 0.5 km. Competitive with (manned) gasoline-powered electricity supplies. Competitive with daily exchange of charged lead acid batteries incl. hauling.	
Costs:	$30-$40/month
Cost Annuity: $350-$500/year	

Status of product development:
PV power supply ready.
High quality BCU made to order or imported.
R&D: None

Estimated number of potential customers:
Initial interest approx.
25 cities/towns

Estimated potential market:
25 x 200 Wp = 5 kWp

Present locations known:
None

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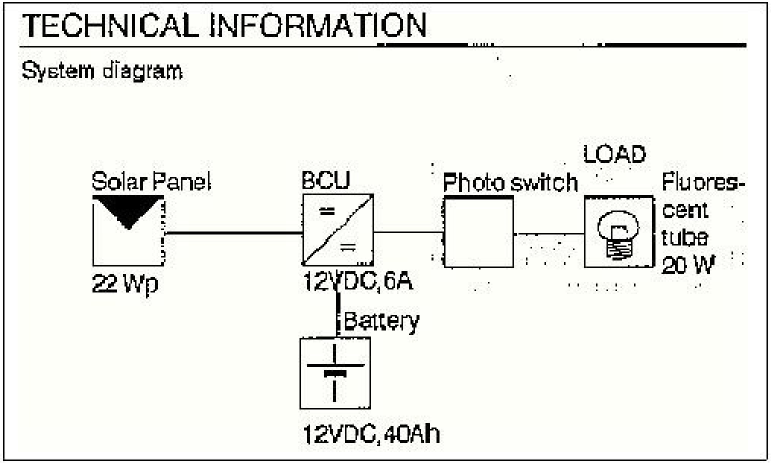

System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 200 Wp		BCU $90/5y
x $6.50	$1300*	Batteries $50/4y
Battery Control Unit	$90	General maintenance
Battery	$50	$100/y
2	$70	

2 pcs frames (G.I.) @$35	$70	
Cables & Switches (autom.) $75		
Transport & Installation	$150	
Profit margin	$350	
Initial PV system investment	$2085	
Costs: $22.50/month	Cost annuity: $270	

REMARKS:
Compared to the hauling of charged batteries PV charged batteries have an extended service life.
Such TV translators can increase the area of coverage of government & commercial TV stations for a relatively low investment. However current interest seems low.
Pilot project should be considered with one of the 4 national TV stations or with a regional TV station.

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Fact sheet PV application: **TV Translator** Group: Telecom

An (unmanned) 10W (transmitting power) TV relay strategically situated on or near a mountain top can provide a good quality signal to settlements below.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline/l : ($0.28) $0.35

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

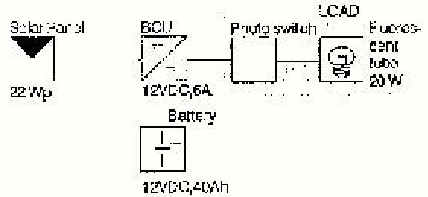
System availability:	95 %
Daily energy required:	
16 hours x 26 W =	416 Wh
Total :	416 Wh
Possible local service:	Positive

Competitiveness of PV system:

Competitive with grid extension of > 0.5 km. Competitive with (manned) gasoline-powered electricity supplies. Competitive with daily exchange of charged lead-acid

TECHNICAL INFORMATION

System diagram



System components	Price (* = import)	Anticipated maintenance & repair :
PV panels 200 Wp		BCU $20/5y

exchange of charged lead acid batteries incl. hauling.

Costs	$30-$40/month
Cost Annuity:	$350-$500/year

Status of product development:

PV power supply ready.
High quality BCU made to order or imported.
R&D : None

Estimated number of potential customers:

Initial interest approx.
25 cities/towns

Estimated potential market:

25 x 200 Wp = 5 kWp

Present locations known:

None

Factsheet # 4.2

PV panels 200 Wp x $6.50	$1300*	BCU $90/5y
Battery Control Unit	$90	Batteries $50/4y
Battery	$50	General maintenance $100/y
2 pcs. frames (G.I.) @$35	$70	
Cables & Switches (autom.)	$75	
Transport & Installation	$150	
Profit margin	$350	
Initial PV system investment	$2085	

Costs: $22.50/month Cost annuity: $270

REMARKS:

Compared to the hauling of charged batteries PV charged batteries have an extended service life.
Such TV translators can increase the area of coverage of government & commercial TV stations for a relatively low investment. However current interest seems low.
Pilot project should be considered with one of the 4 national TV stations or with a regional TV station.

Fact sheet # 4-3
Fact sheet PV application: Lighthouse/Seabuoy
Group: Telecom
An (unmanned) 50Wp PV powered navigational light provides security at sea.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrfication:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
1 lead-acid battery charge (0.5 kWh): approx. $0.75
(incl. transport)

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability: 95 %
Daily

energy required:
10h x 35W x 30% (time switched on) = 105 Wh
Total: 105 Wh

Possible local service: Positive

Competitiveness of PV s ystem:
Competitive with any manned gasoline powered lighthouse.
Competitive with regular exchange of charged batteries, including hauling charges.
Cost Annuity: > $1000

Status of product development:
Product ready, all components locally available,
BCU & controls made to order.
R&D: None

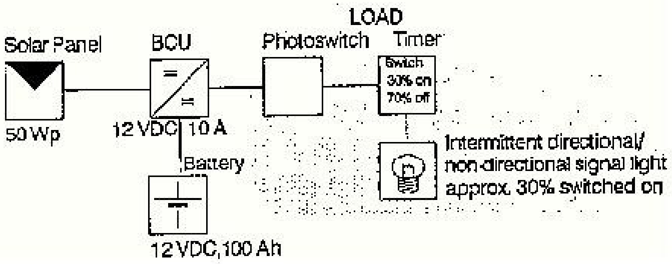
Estimated number of potential customers:
Currently 36 PV lighthouses for 15 years in operation by Phil.
Coastguard. Immediate interest in 40 systems.

Estimated potential market:
40 x 50Wp = 2 kWp

Present locations known:
Throughout Phillipine archipelago

TECHNICAL INFORMATION

System diagram



System components	Price (*: import)	Anticipated maintenance & repair:
PV panel 50 Wp		BCU $60/5y
X $7.50	375*	Battery $60/4y
Battery Control Unit	60	General maintenance
(weatherproof)		$50/y (may vary
Battery	50	according to
Frame	35	location)

Frame (G.I.)	[illegible]	location)
Cables & Switches	$15	
Transport & Installation	$50	
Profit margin	$110	
(bulb + timer + housing)	($100)	
Initial PV system investment $695		
Costs: $10/month	Cost annuity: $117	

REMARKS:
Possibility of larger PV s ystems for stronger light. PV charged batteries have a comparatively long service life. Safe dis posal of batteries recommended. To be marketed as a complete system. Waterproof system can be mounted on sea-buoy. To be marketed through the Philippine Coastguard & municipalities (ports).

Fact sheet PV application: **Lighthouse/Seabuoy** **Group: Telecom**

An (unmanned) 50Wp PV powered navigational light provides security at sea.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline/l : ($0.28) $0.35

1 lead-acid battery charge (0.5 kWh): approx. $0.75 (incl. transport)

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	95 %
Daily energy required:	
10h x 35W x 30% (time switched on)	
	= 105 Wh
Total:	**105 Wh**
Possible local service:	**Positive**

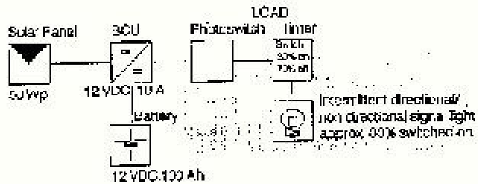
Competitiveness of PV system:

Competitive with any manned gasoline powered lighthouse.

Competitive with regular exchange of charged batteries, including hauling

TECHNICAL INFORMATION

System diagram



System components	Price (if imported)	Anticipated maintenance & repairs

charged batteries, including hauling charges.

Cost Annuity: > $1000

Status of product development:
Product ready, all components locally available. BCU & controls made to order.
R&D: None

Estimated number of potential customers:
Currently 36 PV lighthouses for 15 years in operation by Phil. Coastguard. Immediate interest in 40 systems.

Estimated potential market:
40 x 50 Wp = 2 kWp

Present locations known:
Throughout Phillipine archipelago

Factsheet #4-3

PV panel 50 Wp x $7.50	$375*	BCU $50/5y
Battery Control Unit (weatherproof)	$60	Battery $50/4y
Battery	$50	General maintenance $50/y (may vary according to location)
Frame (G.I.)	$35	
Cables & Switches	$15	
Transport & Installation	$50	
Profit margin	$110	
(bulb + timer + housing)	($100)	
Initial PV system investment	$695	
Costs: $10/month	Cost annuity: $117	

REMARKS:

Possibility of larger PV systems for stronger light.
PV charged batteries have a comparatively long service life. Safe disposal of batteries recommended.
To be marketed as a complete system.
Waterproof system can be mounted on sea-buoy.
To be marketed through the Philippine Coastguard & municipalities (ports).

Fact sheet # 5-1
Fact sheet PV application: NiCd Battery Charger
Group: Consumer
PV recharged Nickel Cadmium batteries (Size AA. C. D) replace the regular purchase of dry cell batteries for torches, radios etc.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Dry cell batteries:
Size AA: $0.20
Size C : $0.25
Size D: $0.35

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION

System availability:	n.a.
Daily energy required:	n.a.
Total:	n.a.

Possible local service:

Competitiveness of PV s ystem:
When the charger is used for 4 batteries/week and 50 weeks/year and batteries + panel lasts for 400 cycles including batteries, price/charge $0.06 v. $0.20-$0.35 per dry cell battery

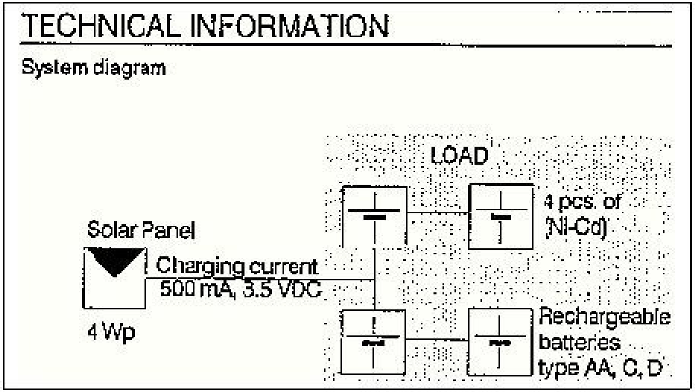
Costs:	n.a.
Cost Annuity:	n.a.

Status of product development:
Product not available

Estimated number of potential customers:
3,5M households unelectrified.
initially 1 charger/500 households: 7000 units, later 1 charger/50 households: 70,000 units

Estimated potential market:
7000 x 4Wp = 28 kWp
(later 70,000 x 4Wp = 280 kWp)

Present locations known:
Burias Island (field test)



System components	Price (*: import)	Anticipated maintenance & repair:
PV panel 4 Wp	$40*	
Casing	$10	
(4 pcs. NiCd Batteries		
Size D)	($24)*	
Profit margin	$10	
Initial PV system investment	$60	
Costs: $0.04/charge	Cost annuity: $9	

REMARKS:
Estimated service life of PV charger: 8 years Possibly to be equipped with A-Si panel.
NiCd batteries economically replace dry cell batteries and heir environmentally unsafe disposal.
For use in all sorts of portable appliances.
NiCd batteries locally available in all sizes.
Controlled disposal of disused NiCd batteries is recommended.

Fact sheet PV application: **NiCd Battery Charger** Group: **Consumer**

PV recharged Nickel Cadmium batteries (Size AA, C, D) replace the regular purchase of dry cell batteries for torches, radios etc.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Dry cell batteries :

- Size AA : $0.20
- Size C : $0.25
- Size D : $0.35

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	n.a.
Daily energy required:	n.a.
Total :	n.a.

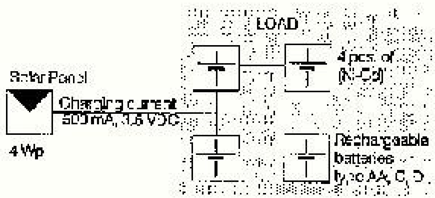
Possible local service:

Competitiveness of PV system:

When the charger is used for 4 batteries/week and 50 weeks/year and batteries + panel lasts for 400 cycles including batteries.

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

price/charge $0.06 v. $0.20-$0.35 per dry cell battery Costs: n.a. Cost Annuity: n.a.	PV panel 4 Wp	$40*	
	Casing	$10	
	(4 pcs. NiCd Batteries Size D)	($24)*	
Status of product development: Product not available	Profit margin	$10	
Estimated number of potential customers: 3,5M households unelectrified. Initially 1 charger/500 households : 7000 units, later 1 charger/50 households : 70,000 units	Initial PV system investment	$60	
	Costs: $0.04/charge	Cost annuity: $9	
Estimated potential market: 7000 x 4Wp = 28 kWp (later 70,000 x 4Wp = 280 kWp)	REMARKS: Estimated service life of PV charger : 8 years Possibly to be equipped with A-Si panel. NiCd batteries economically replace dry cell batteries and their environmentally unsafe disposal. For use in all sorts of portable appliances. NiCd batteries locally available in all sizes. Controlled disposal of disused NiCd batteries is recommended.		
Present locations known: Burias Island (field test)			
Factsheet # 5			

Fact sheet # 5-2

Fact sheet PV application: Portable PV
Group: Consumer
A 10 Wp portable PV power supply for lighting & radio for outdoor activities (camping, trekking, boating).

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Kerosene/l ($0.26) $0.40
Dry Cell Batteries:
Size AA $0.20
Size C $0.25
Size D $0.30

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	65 %
Daily energy required:	
Portable radio 2h	10 Wh
Light 4h	40 Wh
Total:	50 Wh

Possible local service:	Poor

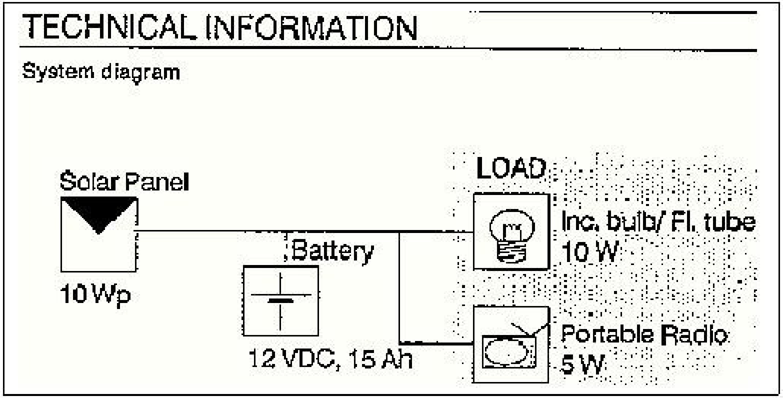
Competitiveness of PV s ystem:
Competitive with the use of kerosene pressure lamps & dry cell batteries.
E.g.: When In use for 60 d/y, PV system replaces 32 dry cell batteries ($11.20) and 241 kerosene ($9.60).
Cost: $20.80/y

Status of product development:
Product not available.
R&D: product manufacture

Estimated number of potential customers:
For pilot marketing: 1000 pcs.

Estimated potential market:
1000 x 10 Wp = 10 kWp

Present locations known:
Non



System components	Price (*: import)	Anticipated maintenance & repair:
PV panel 10 Wp x		Battery $20/5y
$7.50/Wp	$75*	
1 battery	$20	
Cables	$10	

Cables & switches	$10	
Profit margin	$20	
Initial PV system investment	$125	
Costs: n.a.	Cost annuity: $18	

REMARKS:
Estimated lifetime portable PV power supply: 10 y.
Possible use of A-Si PV panels.
PV s ystem easier to operate, replacing the use (and disposal) of dry cell batteries.
For pilot production & marketing.

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Fact sheet PV application: **Portable PV** Group: **Consumer**

A 10 Wp portable PV power supply for lighting & radio for outdoor activities (camping, trekking, boating).

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Kerosene/l ($0.25) $0.40

Dry Cell Batteries :

Size AA $0.20

Size C $0.25

Size D $0.30

METEOROLOGICAL INFO

Average insolation: **6 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	65 %
Daily energy required:	
Portable radio 2h	**10 Wh**
Light 4h	**40 Wh**
Total :	**50 Wh**
Possible local service:	Poor

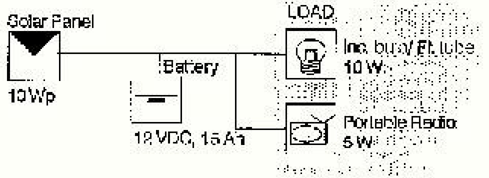
Competitiveness of PV system:

Competitive with the use of kerosene pressure lamps & dry cell batteries.

E.g.: When in use for 60 d/y, PV system replaces 20 dry cell batteries

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

System replaces 32 dry cell batteries ($11.20) and 24 l kerosene ($9.60).

Cost: $20.80/y

Status of product development:

Product not available.

R&D: product manufacture

Estimated number of potential customers:

For pilot marketing:
1000 pcs.

Estimated potential market:

1000 x 10 Wp = 10 kWp

Present locations known:

None

Factsheet #5-2

	(*: import)
PV panel 10 Wp x $7.50/Wp	$75*
1 battery	$20
Cables & switches	$10
Profit margin	$20
Initial PV system investment	$125

& repair:

Battery $20/5y

Costs: n.a. Cost annuity: $18

REMARKS:

Estimated lifetime portable PV power supply: 10 y.
Possible use of A-Si PV panels.
PV system easier to operate, replacing the use (and disposal) of dry cell batteries.
For pilot production & marketing.

Fact sheet # 6-1
Fact sheet PV application: School Lighting
Group: Communal
Providing adequate & trouble-free lighting to e.g. a 6-room school building will facilitate the implementation of night-class programs which seem appropriate for the education of the rural population.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date.	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Kerosene/l: ($0.26) $0.4

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System	85

availability: Daily energy required:	%
4 h (2 fl. tubes/room) x	
6 rooms =	960 Wh
Total:	960 Wh

Possible local service:	Average

Competitiveness of PV s ystem:
Kerosene pressure lamps/classroom ($40/pc.):
12 pcs. x 4h x 0.1 l/h x 5a/week x 40 w/y x $0.40/1 = $384
Maintenance 12 pcs x $13/y = $156/y

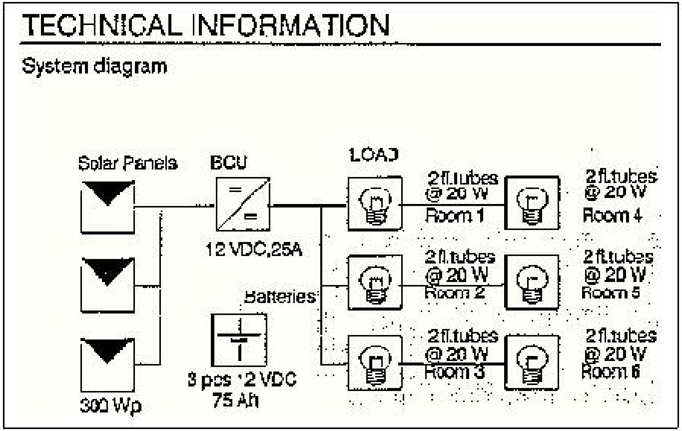
Costs: $52 / month
Cost Annuity: $ 618

Status of product development:
Product ready, components locally available. BCU made to order.

Estimated number of potential customers:
1 night school/50,000 inhabitants: 600 schools

Estimated potential market:
600 schools x 300 Wp = 180 kW

Present locations known: on



System components	Price (*: import)	Anticipated maintenance & repair:
PV panel x 300 Wp		BCU $90/5y
x $6.50	$1950*	Batteries $150/4y
Batterie Control U nit	$90	General maintenance
3 pcs. Batteries @ $50	$150	$35/y
2 pcs. frames (G.I.) @ $35 $70		
Cables	$50	

Cables & Switches	$50	
Transport & Installation	$100	
(Profit margin excl.)	($400)	
(12 pcs. fl. tubes)	($216)	
Initial PV system investment	$2410	
Costs: $22/month	Cost annuity: $260 (incl. tubes)	

REMARKS:
Cost annuity incl. purchase & maintenance of fl. tubes.
PV provides classroom with troublefree and safe lighting no fire hazard) while improving the classroom atmosphere (no fumes).
Safe disposal of fl.tubes & batteries (recycling) is recommended.
For immediate Introduction through rural education programs by both government and N.G.O.'s

Fact sheet PV application: **School Lighting** Group: Communal

Providing adequate & troublefree lighting to e.g. a 6-room school building will facilitate the implementation of night-class programs which seem appropriate for the education of the rural population.

COUNTRY:	Philippines	Relevant conventional energy prices: (urban) / rural	METEOROLOGICAL INFO	
Population:	60M	Kerosene/l : ($0.26) $0.40	Average insolation:	5 kWh/m2d
Urban/rural distribution:	35/65 %		Seasons:	
% electrification:	35 %		June-Nov. : wet, 4 kWh/m2d	
Currency:	Pesos		Dec.-May : dry, 6 kWh/m2d	
Exchange rate:	US$ 1 = P 25			
Exchange date:	Sept. 1990			

SYSTEM INFORMATION

System availability: 95 %

Daily energy required:

4 h (2 fl. tubes/room) x 6 rooms = 960 Wh

Total : 960 Wh

Possible local service: Average

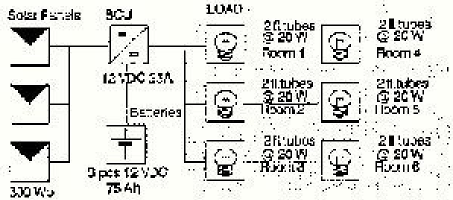
Competitiveness of PV system:

2 Kerosene pressure lamps/classroom ($40/pc.) :

12 pcs. x 4h x 0.1 l/h x 5d/week x

TECHNICAL INFORMATION

System diagram



System components	Price	Anticipated maintenance

40 w/y x $0.40/l = $384
Maintenance 12 pcs x $13/y = $156/y

Costs: $52 / month
Cost Annuity: $ 618

Status of product development:
Product ready, components locally available.
BCU made to order.

Estimated number of potential customers:
1 night school/50,000 inhabitants:
600 schools

Estimated potential market:
600 schools x 300 Wp =
180 kWp

Present Locations known:
none

	(* import)	& repair:
PV panel x 300 Wp x $6.50	$1950*	BCU $90/5y
Batterie Control Unit	$90	Batteries $150/4y
3 pcs. Batteries @ $50	$150	General maintenance $35/y
2 pcs. frames (G.I.) @ $35	$70	
Cables & Switches	$50	
Transport & Installation	$100	
(Profit margin excl.)	($400)	
(12 pcs. fl. tubes)	($216)	
Initial PV system investment	$2410	
Costs: $22/month	Cost annuity:	$260 (incl. tubes)

REMARKS:
Cost annuity incl. purchase & maintenance of fl. tubes.
PV provides classroom with troublefree and safe lighting (no fire hazard) while improving the classroom atmosphere (no fumes).
Safe disposal of fl.tubes & batteries (recycling) is recommended.
For immediate introduction through rural education programs by both government and N.G.O.'s

Fact sheet # 6-2

Fact sheet PV application: Battery Charger I
Group: Communal
A 5 channel (@200 Wp) battery charging station could charge enough batteries to supply up to 70 rural households with the most basic electricity needs for lighting & radio.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Diesel: ($0.21) $0.25
Gasoline: ($0.28) $0.35
1 charge lead-acid battery (0.5kWh) $0.75 (incl. transport)

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM

INFORMATION System availability:	90 %
Daily energy required:	
5 batteries charged/day	
x 0.5 kWh/battery	= 2.5 kWh
Total:	2.5 kWh

Possible local service: Average	

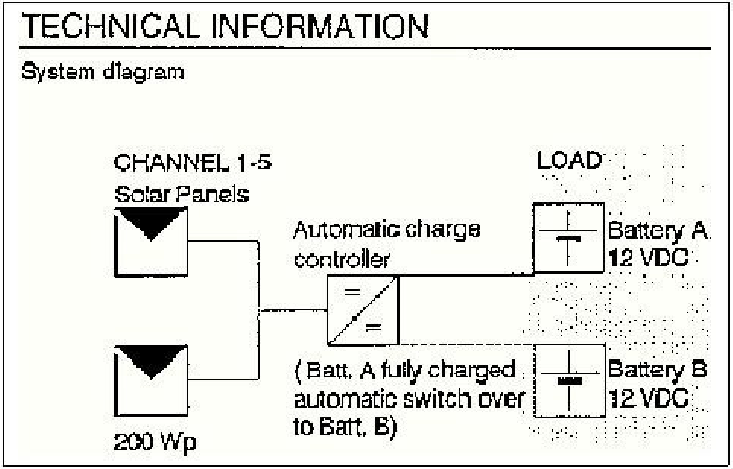
Competitiveness of PV s ystem:
PV battery station charged/y: 5 bats/d x O.9(avail) x O.9(station occupanc y rate) x 365d/y = approx. 1500 batteries/y (750kWh)
Current commercial charging rates vary per area and battery size:
Costs: $0.50-1.50/charge(excl. transp)
Cost Annuity: n.a.

Status of product development:
Functioning automatic charge controller locally produced, made to order.
R&D: improvement charge controllers, durability of batteries.

Estimated number of potential customers:
Initial interest: 500 systems for remote small island communities & mountain settlements

Estimated potential market:
500 x 1000 Wp = 500 kW

Present locations known: Bulacan, Verde Island, Burias Island



System components	Price (*: import)	Anticipated maintenance & repair:
PV		BCU

PV panels: 5 @ 200 Wp @ $6.50/Wp	$6500*	BOS $750/IOy General maintenance
5 pcs autom. Battery channels		$100/y.
Control Units @$150	$750	Salary operator
Frames & Cables $0.50/Wp	$500	$0.10/battery =
Transport & Installation	$500	$150/year
Simple housing	$500	
(Profit margin excl.)	($1750)	
Initial PV system investment $8750		
Costs: $0.6/0.5kWh charge	Cost annuity: $895	

REMARKS:
The relatively low charging currents of this PV s ystem will result in extended service life of the batteries. Such battery charging stations will be t ypically suited for small, remote communities (e.g. fishermen, mountain villages). The remoteness makes battery charging elsewhere impractical, expensive (transport up to $0.5/battery) and unreliable (landslides, rough seas). Batteries used in local PV charging station will live longer (less transport damage). Financing scheme for battery & fl. tube pack age seems appropriate. For introduction through non-profit electrification plans.

Fact sheet PV application: **Battery Charger I** Group: Communal

A 5 channel (@200 Wp) battery charging station could charge enough batteries to supply up to 70 rural households with the most basic electricity needs for lighting & radio.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchang rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Diesel : ($0.21) $0.25

Gasoline : ($0.26) $0.35

1 charge lead-acid battery (0.5kWh) $0.75 (incl. transport)

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasonal:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability: 90 %

Daily energy required:

5 batteries charged/day

x 0.5 kWh/battery = 2.5 kWh

Total : 2.5 kWh

Possible local service: Average

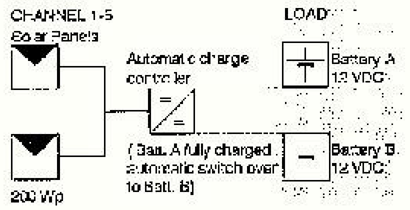
Competitiveness of PV system:

PV battery station charged/y:

5 batt/d x 0.9(avail) x 0.9(station occupancy rate) x 365d/y = approx. 1500 batteries/y (750kWh)

TECHNICAL INFORMATION

System diagram



System components	Price (A : (mood)	Anticipated maintenance & repair :

Current commercial charging rates vary per area and battery size: Costs: $0.50-1.50/charge(excl. transp) Cost Annuity: n.a.	PV panels: 5 channels @ 200 Wp @ $6.50/Wp 5 pcs autom. Battery Control Units @$150 Frames & Cables $0.50/Wp Transport & Installation Simple housing (Profit margin excl.)	 $6500* $750 $500 $500 $500 ($1750)	BCU $750/10y General maintenance $100/y. Salary operator $0.10/battery = $150/year
Status of product development: Functioning automatic charge controller locally produced, made to order. R&D: improvement charge controllers, durability of batteries.			
Estimated number of potential customers: Initial Interest: 500 systems for remote small island communities & mountain settlements.	Initial PV system investment	$8750	
	Costs: $0.6/0.5kWh charge	Cost annuity:	$895
Estimated potential market: 500 x 1000 Wp = 500 kWp	REMARKS: The relatively low charging currents of this PV system will result in extended service life of the batteries. Such battery charging stations will be typically suited for small, remote communities (e.g. fishermen, mountain villages). The remoteness makes battery charging elsewhere impractical, expensive (transport up to $0.5/battery) and unreliable (landslides, rough seas). Batteries used in local PV charging station will live longer (less transport damage). Financing scheme for battery & fl. tube package seems appropriate. For introduction through non-profit electrification plans.		
Present locations known: Bulacan, Verde Island, Burias Island			
Factsheet # 6.2			

Fact sheet # 6-3

Fact sheet PV application: Streetlight
Group: Communal
PV stand-alone lighting system for street, square or compound illumination.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
n.a.

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
fl.	=

... tube Total: 4h	80 Wh

Possible local service: Average

Competitiveness of PV s ystem:
No direct competitio

Cost Annuity

Status of product development:
All components locally available.
R&D: cheap ballasts (miniverters) for energy saving bulbs (7W, 9W & 13W)

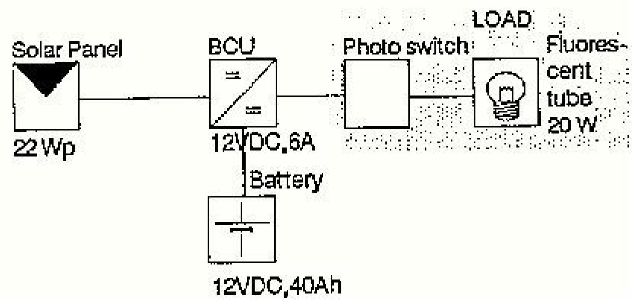
Estimated number of potential customers:
1 streetlight/5000 inhabitants in unelectrified areas: 7500 unit

Estimated potential market:
7500 x 22 Wp = 165 kWp

Present locations known:
Quezon City, Bulacan, Cebu island, Naga City

TECHNICAL INFORMATION

System diagram



System components	Price (*: import)	Anticipated maintenance & repair:
V panel 22 Wp		BCU $30/5y
x $7.50	$165*	Battery $35/4y
Battery Control Unit	$30	General maintenance
Battery	$35	$5/ y
Photos	$5	

Photos	[illegible]	
witch Frame (G.I.)	$35	
Cables	$5	
(fl. tube + holder)	($18)	
Transport & Installation	$20	
(Profit margin excl.)	($50)	
Initial PV system investment	$326	
Costs: $3.40/month	Cost annuity: $40	

REMARKS:
Using a 50 Wp ($375) panel will result in double the hours of operation/night or enable the use of bigger capacity lamps. In order to maximize the output & minimize power consumption, the development of "miniverters" (ballast) for energy saving bulbs is recommended. Such lights would also seem suitable for guardhouses etc.

Fact sheet PV application: **Streetlight** Group: **Communal**

PV stand-alone lighting system for street, square or compound illumination.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

n.a.

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

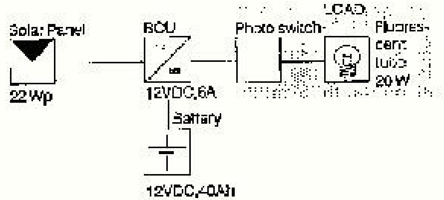
System availability:	95 %
Daily energy required:	
fl. tube 4h	= 80 Wh
Total :	
Possible local service:	Average

Competitiveness of PV system:

No direct competition

TECHNICAL INFORMATION

System diagram



System components	Price (* : import)	Anticipated maintenance & repair :

Cost Annuity:

Status of product development:

All components locally available.

R&D: cheap ballasts (miniverters) for energy saving bulbs (7W, 9W & 13W)

Estimated number of potential customers:

1 streetlight/5000 inhabitants in unelectrified areas: 7500 units

Estimated potential market:

7500 x 22 Wp = 165 kWp

Present locations known:

Quezon City, Bulacan, Cebu Island, Naga City.

PV panel 22 Wp x $7.50	$165*	BCU $30/5y
Battery Control Unit	$30	Battery $35/4y
Battery	$35	General maintenance $5/y
Photoswitch	$5	
Frame (G.I.)	$35	
Cables	$5	
(fl. tube + holder)	($18)	
Transport & Installation	$20	
(Profit margin excl.)	($50)	
Initial PV system investment	$325	
Costs: $3.40/month	Cost annuity: $40	

REMARKS:

Using a 50 Wp ($375) panel will result in double the hours of operation/night or enable the use of bigger capacity lamps. In order to maximize the output & minimize power consumption, the development of "miniverters" (ballast) for energy saving bulbs is recommended. Such lights would also seem suitable for guardhouses etc.

Factsheet # 6.3

Fact sheet # 6-4

Fact sheet PV appilcation: Drinking Water Supply
Group: Communal
A PV powered (336 Wp) jack pump may pump 2000 l/day over a 16 m head. This is sufficient water for approx. 30 families (10 l/person)

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Diesel/l: ($0.21) $0.25
Gasoline/l: ($0.28) $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2

SYSTEM INFORMATION

System availability: 90 % Dally energy required: Variable, depending on required water volume. Total: max 1150 Wh/d

Possible local service: Averag

Competitiveness of PV s ystem: Gasoline powered jackpump: Pump, housing, tank & well $2000 1 Hp prime mover $500/5y Fuel: 4 h/d x 0.9 (avail) x 365 d/y x $0.35/1 = $460/y. Oil $30/y Gen. Maintenance $50/	
Costs:	$1.17 /cu.m.
Cost Annuity:	$775

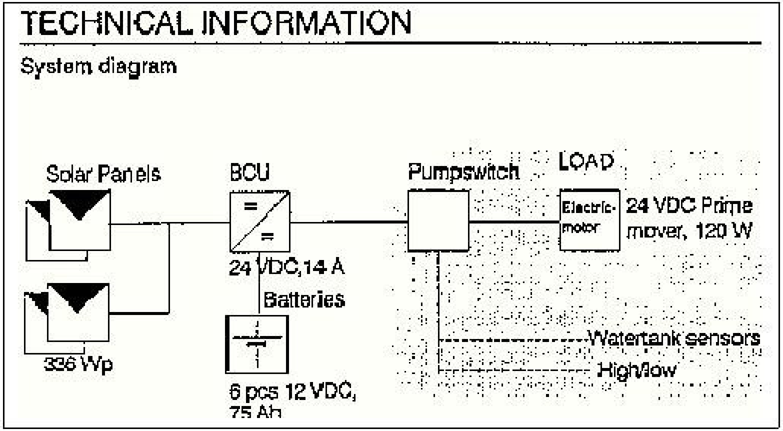
Status of product development: Jackpump technology present. 24 VDC, 120 W electric motor not locally available, pump switch & BCU made to order. R&D: system optimization

Estimated number of potential customers: Barangay - drinking water programs initial estimated interest: 100 system

home.cd3wd.ar.cn.de.en.es.fr.id.it.ph.po.ru.sw

Estimated potential market:
100 x 336 Wp = 34 kW

Present locations known:
Bulaca



System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 336 Wp	$2185	BCU $90/5y
x $6.50		Batteries $210/4y
Battery Control Unit	$90	General maintenance
3 pcs. Frame (G.I.) @$35	$105	$25/y
6 pcs. Batteries @. $35	$210	(General mains.
Cables & autom. switches	$100	pump etc.: $90/y)
Transport & installation	$150	
(Well/pump/housing/tank)	($2000)	
(Profit margin excluded)	($500)	
Initial PV system investment	$2840	
Costs: $0.77/cu.m.	Cost annuit $505 (incl. pump etc.)	

REMARKS:
Watertank (2000 l) for additional reliability. Jack pump type of waterpumps typically suit relatively small volumes and high heads (>15m). In terms of capacity .
Gasoline & diesel powered pumps above the well may pose a hazard to the drinking water qualit y.
PV pumps could possibly fill the niche between handpumps and the much bigger diesel-powered pumps.
Safe disposal of batteries (recycling) is recommended.

Fact sheet PV application: **Drinking Water Supply** Group: Communal

A PV powered (336 Wp) jackpump may pump 2000 l/day over a 15 m head. This is sufficient water for approx. 30 families (10 l/person)

COUNTRY: Philippines

Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Diesel/l : ($0.21) $0.25

Gasoline/l : ($0.28) $0.35

METEOROLOGICAL INFO

Average Insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability: 90 %

Daily energy required:

Variable, depending on required water volume.

Total : max 1150 Wh/d

Possible local service: Average

Competitiveness of PV system:

Gasoline powered jackpump:

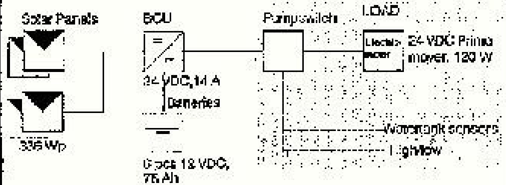
Pump, housing, tank & well $2000

1 Hp prime mover $500/5y

Fuel: 4 h/d x 0.9 (avail) x 365 d/y

TECHNICAL INFORMATION

System diagram



System components	Price (*: import)	Anticipated maintenance & repair :

x $0.35/l = $460/y. Oil $30/y Gen. Maintenance $50/y Costs: $1.17 /cu.m. Cost Annuity: $775	PV panels 336 Wp x $6.50 Battery Control Unit 3 pcs. Frame (G.I.) @$35 6 pcs. Batteries @ $35 Cables & autom. switches Transport & installation (Well/pump/housing/tank) (Profit margin excluded)	$2185 $90 $105 $210 $100 $150 ($2000) ($500)	BCU $90/5y Batteries $210/4y General maintenance $25/y (General maint. pump etc.: $90/y)
Status of product development: Jackpump technology present. 24 VDC, 120 W electric motor not locally available, pump switch & BCU made to order. R&D: system optimization.	Initial PV system investment	$2840	
Estimated number of potential customers: Barangay - drinking water programs Initial estimated interest: 100 systems	Costs: $0.77/cu.m.	Cost annuit	$505 (incl. pump etc.)
Estimated potential market: 100 x 336 Wp = 34 kWp	REMARKS: Watertank (2000 l) for additional reliability. Jackpump type of waterpumps typically suit relatively small volumes and high heads (>15m). In terms of capacity Gasoline & diesel powered pumps above the well may pose a hazard to the drinking water quality. PV pumps could possibly fill the niche between handpumps and the much bigger diesel-powered pumps. Safe disposal of batteries (recycling) is recommended.		
Present locations known: Bulacan			
Factsheet V 6-4			

Fact sheet # 6-5

Fact sheet PV application: PV Pump System
Group: Communal
Example of a high-head (50 m dynamic) PV pumping s ystem with a capacit y of approx. 36 cu.m/day, as will be introduced through a PV pumping dissemination program.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribute 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$1 =D M1.60=P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Diesel/l: ($0.21) $0.25
Gasoline/l: ($0.28) $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2

SYSTEM INFORMATION

System availability:	80 %
Power required:	
for 36 cu.m/d (10,500 cu.m/y):	
P hydr. =	300 m4/h
P el. =	0.82 kW
P gent =	2300 Wp
P p =	3500 Wp

Possible local service: Average

Competitiveness of PV s ystem: 5 kVA diesel genset $5000/7y; el. pump + conn:$1875/10y; controls $1000/7y; piping $2500/10y; genset housing $2000/20y; Install+tank$1000; Fuel+Oil $950/y; Gen. Maint. $600/y; Personnel $350/	
Costs:	$3800
Cost Annuity: $0.36/cu.m	

Status of product development:
Initial s ystems completely imported.
At later stage possibility of integration of locally available components (pumps etc.)

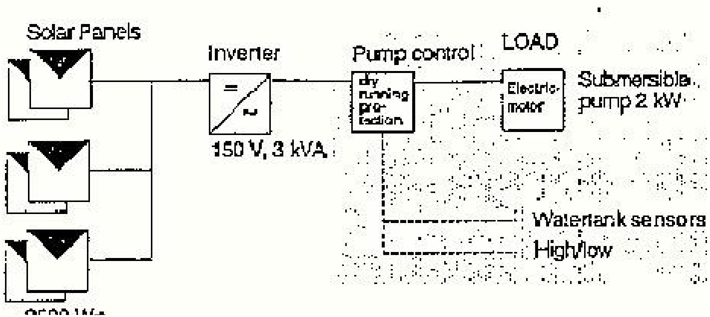
Estimated number of potential customers:
After successful field test 2,5 M people i coastal areas (low head) require 750,000 m4/d. 2 M people in mountain regions (high head) require 4,000,000 m4/d

Estimated potential market:
Not clear: only after successful field test estimate: 9,000 kW

Present locations known:
Field test: Approx. 15 Installations to be realized in 1991 around Cebu.
(GTZ

TECHNICAL INFORMATION

System diagram



3500 Wp

System components	Price (*: import)	Anticipated maintenance & repair:
PV panels	$37500*	Inverter/Controls/
Inverter/Controls/Frames	$6250*	/Frames $6250/10y
Pump unit & connections	$1875*	Pump unit + connect
Piping	$2500	tions $1875/10y
Lightning protection etc.	$3750	Piping $2500/10y
Transport Ger.-Phils.	$1900	General maintenance
Installation incl.		incl. Personnel
foundations etc (estimate) $500	$750/y	
(Profit margin excl.)	($10000)	
(welldrilling & water		
tank excluded)		
Initial PV system investment	$54275	
Costs: $0.48/cu.m	Cost annuity: $5050	

REMARKS:
System designed for an insolation level of 6 kWh/m2d.
In case inverter & pump only last for 5 years, water cost: $0.56/cu.m. Water vendors sell water per 20 l can for $1.00 up to $5.00 per cu.m.
Such water deliveries can be quite irregular.
PV pumping s ystems will be more hygienic compared to water deliveries. PV pump systems will be of special interest to a) coastal communities with fresh water only available in the interior, or b) mountain communities with required pumping heads of approx. 50 m.

Fact sheet PV application: **PV Pump System** Group: Communal

Example of a high-head (50 m dynamic) PV pumping system with a capacity of approx. 36 cu.m/day, as will be introduced through a PV pumping dissemination program.

COUNTRY:	Philippines
Population:	60M
Urban/rural distributi	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$1=DM1.60=P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Diesel/l : ($0.21) $0.25

Gasoline/l : ($0.28) $0.35

METEOROLOGICAL INFO

Average Insolation: 5 kWh/m2d

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	80 %
Power required:	
for 36 cu.m/d (10,500 cu.m/y):	
P hydr. =	300 m4/h
P el. =	0.82 kW
P gen. =	2300 Wp
P p =	3500 Wp

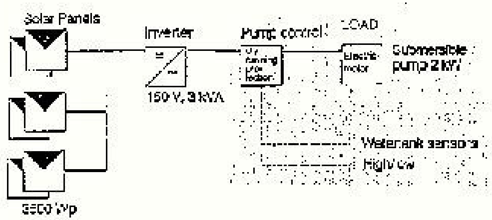
Possible local service: Average

Competitiveness of PV system:

5 kVA diesel genset $5000/7y; el. pump + conn:$1875/10y; controls $1000/7y; piping $2500/10y; genset housing

TECHNICAL INFORMATION

System diagram:



System components | Price | Anticipated maintenance

$2000/20y; Install+tank $1000; Fuel+Oil
$950/y; Gen. Maint. $600/y;
Personnel $350/y

Costs: $3800

Cost Annuity: $0.36/cu.m

Status of product development:

Initial systems completely imported. At later stage possibility of integration of locally available components (pumps etc.).

Estimated number of potential customers:

After successful field test 2,5 M people i coastal areas (low head) require 750,000 m4/d. 2 M people in mountain regions (high head) require 4,000,000 m4/d.

Estimated potential market:

Not clear: only after successful field test estimate : 9,000 KWp

Present locations known:

Field test :
Approx. 15 installations to be realized in 1991 around Cebu.
(GTZ)

Factsheet # 5-5

	(* import)	& repair:
PV panels	$37500*	Inverter/Controls/ /Frames $6250/10y
Inverter/Controls/Frames	$6250*	Pump unit + connections $1875/10y
Pump unit & connections	$1875*	Piping $2500/10y
Piping	$2500	General maintenance incl. personnel $750/y
Lightning protection etc.	$3750	
Transport Ger.-Phils.	$1500	
Installation incl. foundations etc (estimate)	$500	
(Profit margin excl.)	($10000)	
(welldrilling & water tank excluded)		
Initial PV system investment	$54275	
Costs: $0.48/cu.m	Cost annuity:	$5050

REMARKS:

System designed for an insolation level of 6 kWh/m2d.
In case inverter & pump only last for 5 years, water cost : $0.56/cu.m. Water vendors sell water per 20 l can for $1.00 up to $5.00 per cu.m.
Such water deliveries can be quite irregular.
PV pumping systems will be more hygienic compared to water deliveries. PV pump systems will be of special interest to a) coastal communities with fresh water only available in the interior, or b) mountain communities with required pumping heads of approx. 50 m.

Fact sheet # 6-6
Fact sheet PV application: Dental Clinic
Group: Communal
A simple PV powered supply for the most essential power requirements of a dental chair (lighting, drilling. suction/spraying)

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2

SYSTEM INFORMATION

System	95

availabilit y: Daily energy required:	%
Lighting chair 6h:	300 Wh
Motor drill 2h:	170 Wh
Motor suction/	
spraying 2h:	100 Wh
Lighting room 2h:	40 Wh
Total:	610 Wh

Possible local service: Poor	

Competitiveness of PV s ystem: 1000W gasoline genset ($700/5y), gasoline: 6h/day x 6d/w	
40w/y x 11/h x $0.35/1	= $504/ y
Oil 21/mxl2m/yx$1.50/l = $36/y	
Gen. Maintenance:	$50/y
Costs:	$65/month
Cost Annuity:	$780/ year

Status of product development:
PV power supply ready.
BCU made to order, 12 VDC motors not available.
R&D: for testing (pilot project)

Estimated number of potential customers:
50 dental chairs In combination with rural clinic

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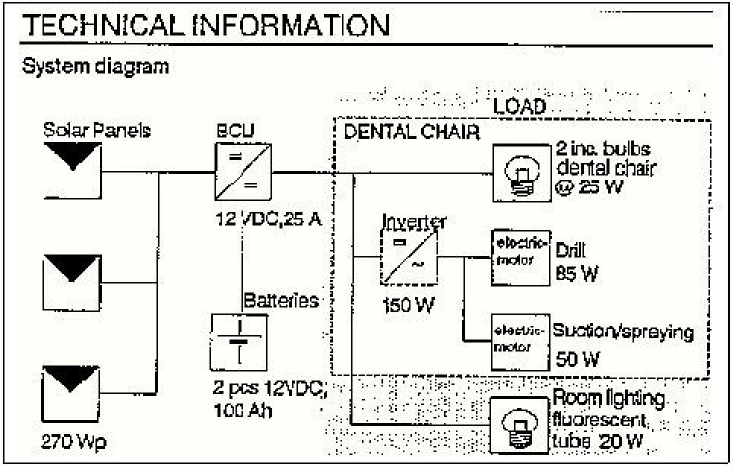
Estimated potential market:
50 x 270 Wp = 14 kW

Present locations known:
Non



System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 270 Wp		BCU $90/5y
x $6.50	$1755*	Batteries $100/4y
Battery Control Unit	$90	General maintenance
2 pcs. batteries @$50	$100	$40/y
2 pcs. frames (G.I.) @$35	$70	
Cables & Switches	$40	
Transport & Installation	$125	
(Profit margin excl.)	($350)	
(fl tube + holder)	($18)	
(dental chair estimate)	($1500)	
Initial PV system investment $2180		
Costs: $18.75/month	Cost annuity: $225	

REMARKS:
If AC equipment is considered an inverter (12 VDC - 220 VAC, 150W, $200) will be necessary.
A modern standard dental chair requires approx. 4 to 6 kWh/day. For a PV powered dental chair the power consumption should be reduced to the most elementary power needs.
PV powered dental chairs will be less mobile and less nois y as dental chairs powered by small gee-sets.

Fact sheet PV application: **Dental Clinic** Group: Communal

A simple PV powered supply for the most essential power requirements of a dental chair (lighting, drilling, suction/spraying)

COUNTRY: Philippines

Population: 60M

Urban/rural distribution: 35/65 %

% electrification: 35 %

Currency: Pesos

Exchange rate: US$ 1 = P 25

date: Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline,l : ($0.28) $0.35

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability: 95 %

Daily energy required:

Lighting chair 6h :	300 Wh
Motor drill 2h :	170 Wh
Motor suction/ spraying 2h :	100 Wh
Lighting room 2h :	40 Wh
Total :	610 Wh

Possible local service: Poor

Competitiveness of PV system:

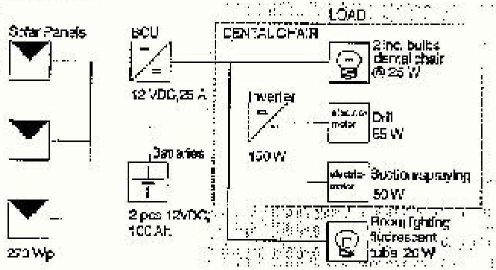
1000W gasoline genset ($700/5y),

gasoline: 6l/day x 6d/w x 40w/y x 1l/h x $0.35/l = $504/y

Oil 2l/mx12m/yx$1.50/l = $36/y

TECHNICAL INFORMATION

System diagram



System components	Price (I : Import)	Anticipated maintenance & repair :

Gen. Maintenance: $50/y

Costs: $65/month

Cost Annuity: $780/year

Status of product development:
PV power supply ready.
BCU made to order, 12 VDC motors not available.
R&D : for testing (pilot project)

Estimated number of potential customers:
50 dental chairs in combination with rural clinics

Estimated potential market:
50 x 270 Wp = 14 kWp

Present locations known:

None

PV panels 270 Wp x $6.50	$1755*	BCU $90/5y
Battery Control Unit	$90	Batteries $100/4y
2 pcs. batteries @$50	$100	General maintenance $40/y
2 pcs. frames (G.I.) @$35	$70	
Cables & Switches	$40	
Transport & Installation	$125	
(Profit margin excl.)	($350)	
(fl tube + holder)	($18)	
(dental chair estimate)	($1500)	
Initial PV system investment	$2180	

Costs: $18.75/month Cost annuity: $225

REMARKS:

If AC equipment is considered an inverter (12 VDC - 220 VAC, 150W, $200) will be necessary. A modern standard dental chair requires approx. 4 to 6 KWh/day. For a PV powered dental chair the power consumption should be reduced to the most elementary power needs.
PV powered dental chairs will be less mobile and less noisy as dental chairs powered by small gen-sets.

Factsheet # 6.6

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Fact sheet # 7-1

Fact sheet PV application: Solar Home System I
Group: Residential
A 50 Wp PV powered supply, satisfies the most basic electricity needs of a rural household (lights. radio & TV or electric fan)

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Kerosene/l ($0.26) $0.40
Dry Cell Batteries:
Size AA $0.20
Size C $0.25
Size D $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d

Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
4 h (fl. tube) =	80 Wh
1 h (incandescent) =	15 Wh
4 h (TV) =	60 Wh
4 h (radio) =	20 Wh
Total:	175 Wh

Possible local service:	Positive

Competitiveness of PV s ystem: Kerosene pressure lamp ($45/7y) 0.5 l kerosene/night, maintenance & repair $13/y, + 8 batteries size D/mont	
Costs:	$10
Cost Annuity:	$115

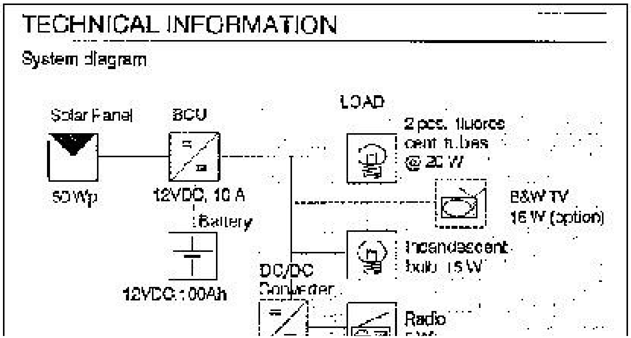
Status of product development: All PV system components locally available. R&D: increase reliability & durabilit y BCU, battery, el. ballas

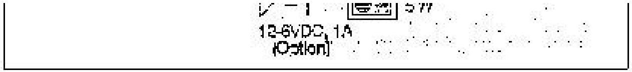
Estimated number of potential customers: 6.5 M households unelectrified

20 % have earnings between
$800-$2000/y 10 % initially interested:
130.000 household

Estimated potential market:
130,000 households x 100 Wp = 6,500 kW

Present locations known:
Rural electrification projects in
Bulacan, Verde Island, Burias Island Cebu Island (Logon





System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 50 Wp x		BCU $30/5y
$7.50/Wp	$375*	Batteries $50/4y
Battery Control Unit	$30	General maintenance
1 frame (G.I.)	$35	$10/y
1 battery	$50	
Cables & switches	$15	
Transport & installation $40		
(Profit margin excluded) ($100)		
(2 pcs. fl. tubes @$18) ($36)		
Initial PV system investment $545		
Costs: $6/month	Cost annuit y: $70 (incl. tubes)	

REMARKS:
Compared with the use of kerosene for lighting PV offers a safer alternative (no fire hazard) while improving the indoor atmosphere and replacing environmentally unsafe disposable batteries. Safe disposal of old fl. tubes & batteries (recycling) is recommended.
12 VDC home appliances (e.g. radio & TV) locally available.
Introduction through rural development projects, electrification projects or consumer cooperatives using financing schemes or through hardware stores on cash-on-delivery basis.

Fact sheet PV application: **Solar Home System I** Group: **Residential**

A 50 Wp PV powered supply, satisfies the most basic electricity needs of a rural household (lights, radio & TV or electric fan)

COUNTRY:	Philippines	Relevant conventional energy prices: (urban) / rural	METEOROLOGICAL INFO	
Population:	60M	Kerosene/l ($0.25) $0.40	Average Insolation:	5 kWh/m2d
Urban/rural distribution:	35/65 %	Dry Cell Batteries :	Seasons:	
% electrification:	35 %	Size AA $0.20	June-Nov. : wet, 4 kWh/m2d	
Currency:	Pesos	Size C $0.25	Dec.-May : dry, 6 kWh/m2d	
Exchange rate:	1 US$ = P25	Size D $0.30		
date:	Sept. 1990			

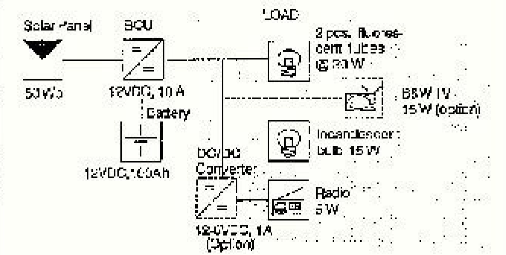
SYSTEM INFORMATION

System availability:	85 %
Daily energy required:	
4 h (fl. tube) =	80 Wh
1 h (incandescent) =	15 Wh
4 h (TV) =	60 Wh
4 h (radio) =	20 Wh
Total :	175 Wh
Possible local service:	Positive

Competitiveness of PV system:
Kerosene pressure lamp ($45/7y)
0.5 l kerosene/night, maintenance & repair $13/y,
+ 8 batteries size D/month

TECHNICAL INFORMATION

System diagram



System components	Price (* : import)	Anticipated maintenance & repairs

Costs: $10 Cost Annuity: $115	PV panels 50 Wp x $7.50/Wp Battery Control Unit 1 frame (G.I.) 1 battery Cables & switches Transport & installation (Profit margin excluded) (2 pcs. fl. tubes @$18)	$375* $30 $35 $50 $15 $40 ($100) ($36)	BCU $30/5y Batteries $50/4y General maintenance $10/y
Status of product development: All PV system components locally available. R&D: Increase reliability & durability BCU, battery, el. ballast	Initial PV system investment:	$545	
Estimated number of potential customers: 6.5 M households unelectrified 20 % have earnings between $300-$2000/y 10 % initially interested: 130.000 households	Costs: $6/month	Cost annuity:	$70 (incl. tubes)

Estimated potential market:
130,000 households x 100 Wp = 6,500 kWp

Present locations known:
Rural electrification projects in Bulacan, Verde Island, Burias Island Cebu Island (Logon)

Factsheet #7

REMARKS:

Compared with the use of kerosene for lighting PV offers a safer alternative (no fire hazard) while improving the indoor atmosphere and replacing environmentally unsafe disposable batteries. Safe disposal of old fl. tubes & batteries (recycling) is recommended.
12 VDC home appliances (e.g. radio & TV) locally available.
Introduction through rural development projects, electrification projects or consumer cooperatives using financing schemes or through hardware stores on cash-on-delivery basis.

Fact sheet # 7-2

Fact sheet PV application: Solar Home System II
Group Residential
Compared with a 50 Wp basic Solar Home System, this system offers more power and a somewhat higher system availability. For marketing to rural upper-middle class households.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l: ($0.28) $0.35
Kerosene/l: ($0.26) $0.40
Dry Cell Batteries:
Size AA $0.20
Size C $0.25
Size D $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:

June-Nov.: wet, 4 kWh/m2d Dec.-May: dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	90 %
Daily energy required:	
2 fl. tubes 5h =	200 Wh
2 inc. bulbs	
(indoor/outdoor)	130 Wh
Radio 8h =	80 Wh
TV 5h =	100 Wh
Total:	510 Wh

Possible local service:	Positive

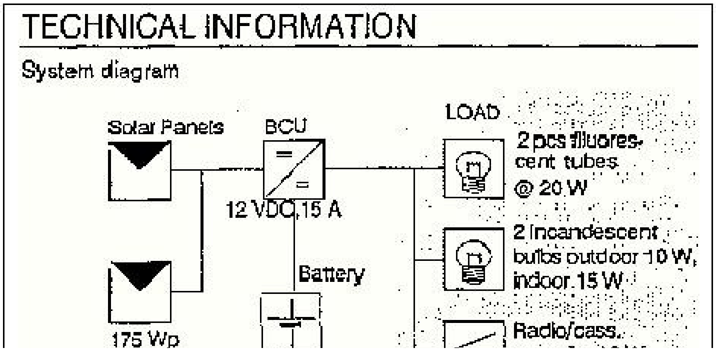
Competitiveness of PV s ystem: Gasoline gee-set 600W, 3h/d + battery storage: Fuel: 365 d/ y x O.9(avail) x 3h/	
x 1 I/h x $0.35/1	= $345/y
011:$2.50/m x 12m/y	= $30/Y
Gen. Maintenance	= $50/ y
Battery $50/3y	= $50/3y
Costs:	$48/month
Cost Annuity:	$570/year

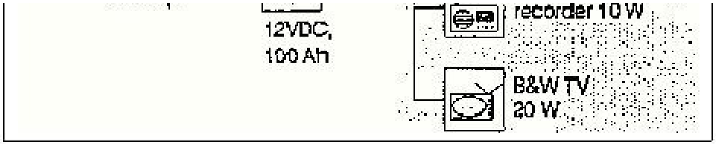
Status of product development: Products ready, BCU made to order. R&D: 12 VDC appliance

Estimated number of potential customers:
3% of 6,500,000 rural households earn $2000-$4000/year.
10% seriously Interested: 20,000 unit

Estimated potential market:
20,000 x 175Wp = 3500kW

Present locations known:
Bulacan, Burias Islan





System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 175 Wp		BCU $60/5y
x $6.50	$1140*	Batteries $50/4y
Battery Control Unit	$75	General maintenance
Battery	$50	$20/y
Frame (G.I.)	$35	
Cables & Switches	$35	
Transport & Installation	$50	
(Profit margin excl.)	($275)	
(2 pcs. fl tubes @$18)	($36)	
Initial PV system investment	$1385	
Costs: $12/month	Cost annuity: $143	

REMARKS:
Immediate interest present. For introduction through rural electrification programs. When profit margin included: Cost annuity $155 or $13/month.
Safe disposal of old fl. tubes & batteries (recycling) is recommended. Compared to the use of a gasoline gee-set the PV system is less noisy and easier to operate.

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Fact sheet PV application: **Solar Home System II** Group: Residential

Compared with a 50 Wp basic Solar Home System, this system offers more power and a somewhat higher system availability. For marketing to rural upper-middle class households.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	US$ 1 = P 25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Gasoline/l : ($0.28) $0.35

Kerosene/l : ($0.26) $0.40

Dry Cell Batteries:

Size AA $0.20

Size C $0.25 Size D $0.35

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2d**

Seasons:

June-Nov. : wet, 4 kWh/m2d

Dec.-May : dry, 6 kWh/m2d

SYSTEM INFORMATION

System availability:	90 %
Daily energy required:	
2 fl. tubes 5h =	**200 Wh**
2 inc. bulbs (indoor/outdoor)	**130 Wh**
Radio 8h =	**80 Wh**
TV 5h =	**100 Wh**
Total :	**510 Wh**
Possible local service:	**Positive**

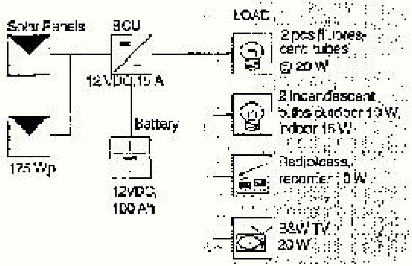
Competitiveness of PV system:

Gasoline gen-set 600W, 3h/d + battery storage: Fuel: 365 d/y x 0.9(avail) x 3h/d x 1 l/h x $0.35/l = $345/y

Oil: $2.50/m x 12m/y = $30/y

TECHNICAL INFORMATION

System diagram



System components | Price (* : Import) | Anticipated maintenance & repair :

Gen. Maintenance = $50/y
Battery $50/3y = $50/3y
Costs: $48/month
Cost Annuity: $570/year

Status of product development:
Products ready,
BCU made to order.

R&D : 12 VDC appliances

Estimated number of potential customers:
3% of 6,500,000 rural households
earn $2000-$4000/year.
10% seriously interested: 20,000 units

Estimated potential market:
20,000 x 175Wp = 3500kWp

Present locations known:

Bulacan, Burias Island

Factsheet # 7.2

PV panels 175 Wp		BCU $60/5y
x $6.50	$1140*	Batteries $50/4y
Battery Control Unit	$75	General maintenance
Battery	$50	$20/y
Frame (G.I.)	$35	
Cables & Switches	$35	
Transport & Installation	$50	
(Profit margin excl.)	($275)	
(2 pcs. fl tubes @$18)	($36)	
Initial PV system investment:	$1385	

Costs: $12/month Cost annuity: $143

REMARKS:

Immediate interest present. For introduction through rural electrification programe. When profit margin included: Cost annuity $155 or $13/month.
Safe disposal of old fl. tubes & batteries (recycling) is recommended. Compared to the use of a gasoline gen-set the PV system is less noisy and easier to operate.

Fact sheet # 7-3

Fact sheet PV application: Solar Home System III
Group: Residential
A 1100 Wp PV generator will supply sufficient power to an upper class rural household.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	1 US$ = P25
date:	sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l ($0.28) $0.3

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2d
Seasons:
June-Nov.: wet, 4 kWh/m2d
Dec.-May: dry, 6 kWh/m2

SYSTEM INFORMATION

System	90

availability:	%
Daily energy required:	Radio 8h 80 W
3 pcs fl. tubes 5h	300 Wh
Color TV & video 5h	350 Wh
Electric fan 2h	100 Wh
Small refrigerator	2000 Wh
3 pcs inc. bulbs	150 Wh
Total:	3000 Wh

Possible local service:	Average

Competitiveness of PV s ystem:
Gasoline gee-set 1000W ($700/5y) + 6 storage batteries ($300/3y) for boost charging.
Fuel: 365d/y x 0.9(avail) x 4h/d x 1 l/h x $0.35/1 = $460/y
Oil: $2.50/month x 12 m/y = $30
General maintenance $50/y

Cost:	$68
Cost Annuity:	$820

Status of product development:
BCU & DC-DC converter made to order
R&D: 24 VDC fl. tubes, convert video to 24 VDC

Estimated number of potential customers:
Not clea

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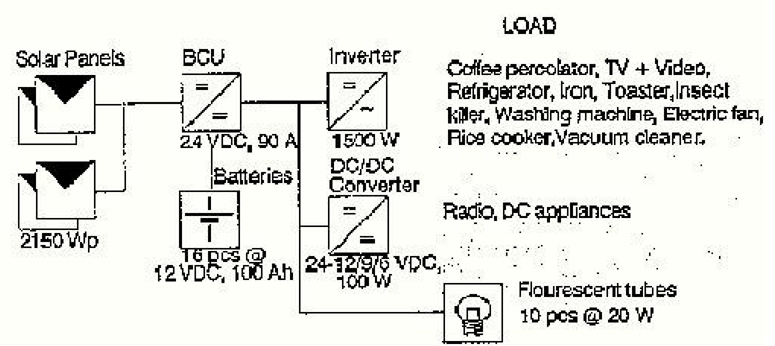
Estimated potential market:
Not clea

Present locations known:
Non

TECHNICAL INFORMATION

System-diagram



System components	Price (*: import)	Anticipated maintenance & repair:
PV panels 1100 Wp x		BCU $120/lOy
$6.50/Wp	$7150*	Batteries $600/4y
Battery Control Unit	$120	General maintenance
12 pcs batteries @$50	$600	$50/y
(inverter)	($250)	
8 pcs frames (G.I.) @$35	$280	
Cables & switches	$100	
Transport & Installation	$350	
Profit margin	$1700	
Initial PV system investment $10300		
Costs: $74/month	Cost annuity:$890	

REMARKS:
An 1100 Wp Solar Home System offers no economical advantage over a gasoline powered gee-set In combination with storage batteries. Possibly other than purely economic motives (e.g. noise/air pollution) might be considered. Recommended for Pilot marketing.

Factsheet PV application: **Solar Home System IV** Group: **Residential**

A luxury home with all common AC appliances powered by a 2160 Wp solar generator.

COUNTRY: Philippines

Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	1US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural

Diesel/l ($0.21) $0.25

METEOROLOGICAL INFO

Average insolation: **5 kWh/m2,d**

Seasons:

June-Nov. : wet, 4 kWh/m2,d

Dec.-May : dry, 6 kWh/m2,d

SYSTEM INFORMATION

System availability: **90 %**

Daily energy required:

AC home appliances + DC lighting estimated at 6 kWh

Total : **6 kWh**

Possible local service: **Poor**

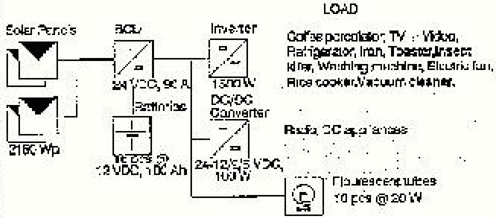
Competitiveness of PV system:

4.5 kVA Diesel gen-set ($4000/7y)

Fuel: 8h/d x 365d/y x 0.75 l/h x $0.25/l = $550/y. Oil: 3l/m x $1.50/l x 12 m/y = $55. General

TECHNICAL INFORMATION

System-diagram



System components	Price (* : import)	Anticipated maintenance & repair :

Maintenance $100/y. Storage batteries 8 pcs $400/4y. Operator $200/y.

Cost: $140

Cost Annuity: $1675

Status of product development:

Product ready.
BCU & inverters imported.
DC-DC converter made to order.
R&D: 24 VDC appliances.

Estimated number of potential customers:

Not clear

Estimated potential market:

Not clear

Present locations known:

None

PV panels 2150 Wp x $6.50/Wp	$13975*	BCU $120/10y
Battery Control Unit	$300*	Batteries $800/4y
16 pcs batteries @$50	$800	General maintenance $150/y
Inverter	$4000*	
DC-DC converter	$60	
15 frames (G.I.) @$35	$525	
Cables & switches	$300	
Transport & installation	$700	
Profit margin	$3500	
Initial PV system investment	$24160	

Costs: $170/month Cost annuity: $1985

REMARKS:

PV system not economically competitive to diesel gen-set operation, but may offer advantages in terms of less pollution, noise and daily power availability (24h/d).
Not recommended for active introduction.

Factsheet # 7[illegible]

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Fact sheet # 7-4

Factsheet PV application: Solar Home System IV
Group: Residential
A luxury home with all common AC appliances powered by a 2150 WP solar generator.

COUNTRY:	**Philippines**
Population:	60M
Urban/rural distribution: 35/65 %	
% electrification:	35 %
Currenc y:	Pesos
Exchange rate:	1US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Diesel/l ($0.21) $0.2

METEOROLOGICAL INFO
Average insolation: 5 kWh/m2,d Seasons: June-Nov.: wet, 4 kWh/m2,d Dec.-May: dry, 6 kWh/m2,

SYSTEM INFORMATION

System	90

availability:	%
Daily energy required:	
AC home appliances + DC lighting	
estimated at	6 kWh
Total:	6 kWh

Possible local service: Poor

Competitiveness of PV s ystem: 4.5 kVA Diesel gee-set ($4000/7y) Fuel: 8h/d x 365d/y x 0.75 l/h x $0.25/1 = $550/y. Oil: 31/m x $1.50/l x 12 m/y = $55. General Maintenance $100/y. Storage batteries 8 pcs $400/4y. Operator $200/y	
Cost:	$140
Cost Annuity: $1675	

Status of product development:
Product ready.
BCU & inverters imported.
DC-DC converter made to order.
R&D: 24 VDC appliances

Estimated number of potential customers:
Not clear

Estimated potential market:
Not clea

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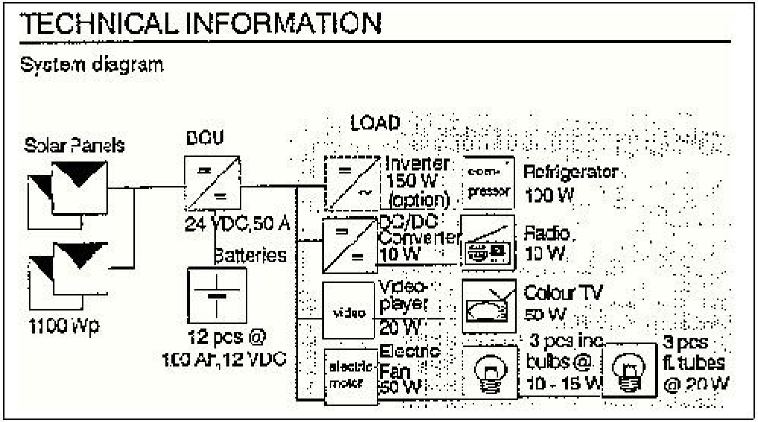
Present locations known:
Non



System components	Price(*: import)	Anticipated maintenance & repair:
PV panels 2150 Wp x		BCU $120/lOy
$6.50/Wp	$13975*	Batteries $800/4y
Battery	$300*	General

Battery Control Unit	$300	General maintenance
16 pcs batteries @$50	$800	$150/y
Inverter	$4000*	
DC-DC converter	$60	
15 frames (G.I.) @$35	$525	
Cables & switches	$300	
Transport & installation $700		
Profit margin 53500		
Initial PV system investment $24160		
Costs: $170/month	Cost annuity: $1985	

REMARKS:
PV system not economically competitive to diesel gee-set operation, but may offer advantages in terms of less pollution, noise and daily power availabilit y (24h/d).
Not recommended for active introduction.

Fact sheet PV application: **Solar Home System III** Group: **Residential**

A 1100 Wp PV generator will supply sufficient power to an upper class rural household.

COUNTRY:	Philippines
Population:	60M
Urban/rural distribution:	35/65 %
% electrification:	35 %
Currency:	Pesos
Exchange rate:	1 US$ = P25
date:	Sept. 1990

Relevant conventional energy prices: (urban) / rural
Gasoline/l ($0.23) $0.35

METEOROLOGICAL INFO

Average insolation: 5 kWh/m2d

Seasons:
June-Nov. : wet, 4 kWh/m2d
Dec.-May : dry, 6 kWh/m2d

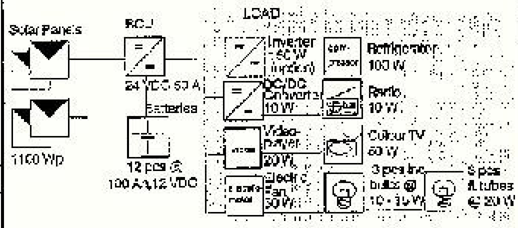
SYSTEM INFORMATION

System availability:	90 %
Daily energy required: Radio 6h	60 Wh
3 pcs fl. tubes 5h	300 Wh
Color TV & video 5h	350 Wh
Electric fan 2h	100 Wh
Small refrigerator	2000 Wh
3 pcs inc. bulbs	150 Wh
Total:	3000 Wh
Possible local service:	Average

Competitiveness of PV system:
Gasoline gen-set 1000W ($700/5y) + 6 storage batteries ($300/3y) for boost charging. Fuel: 365d/y x 0.9(avail) x 4h/d x 1 l/h x $0.35/l = $460/y

TECHNICAL INFORMATION

System diagram



System components	Price (* : import)	Anticipated maintenance & repair:

Oil: $2.50/month x 12 m/y = $30 General maintenance $50/y. Cost: $68 Cost Annuity: $820	PV panels 1100 Wp x $6.50/Wp Battery Control Unit 12 pcs batteries @$50 (Inverter) 8 pcs frames (G.I.) @$35 Cables & switches Transport & installation Profit margin	$7150* $120 $600 ($250) $280 $100 $350 $1700	BCU $120/10y Batteries $600/4y General maintenance $50/y
Status of product development: BCU & DC-DC converter made to order R&D: 24 VDC fl. tubes, convert video to 24 VDC.			
Estimated number of potential customers: Not clear	Initial PV system investment:	$10300	
	Costs: $74/month	Cost annuity: $890	
Estimated potential market: Not clear	REMARKS: An 1100 Wp Solar Home System offers no economical advantage over a gasoline powered gen-set in combination with storage batteries. Possibly other than purely economic motives (e.g. noise/air pollution) might be considered. Recommended for pilot marketing.		
Present locations known: None			
Factsheet # 7-3			