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D7 State of the art of Solar Energy applications in Indonesia

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The RENDEV project

The RENDEV project aims to explore ways to link microfinance and access to renewable energy, bringing a positive contribution in rural development and poverty alleviation in Bangladesh and Indonesia by increasing access to solar energy, the development of micro enterprise, and the provision of microfinance mechanisms tailored for low income people's needs.

The project started in January 2007 and will last until December 2009. RENDEV is financed by the European Commission under its Intelligent Energy line.

The main objectives of the RENDEV project are:






-  To promote development of income generating activities with renewable energy supply;
-  To identify measures justifying involvement of Small and Medium Sized Enterprises in the solar energy sector;
-  To build synergies between the microfinance sector, the renewable energy sector and the micro enterprises in Bangladesh and Indonesia;
-  To better inform stakeholders providing pro-poor sustainable renewable energy services;
-  To bring a positive impact on the quality of life in rural districts.

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Executive Summary

This report presents a state of the art of the application of photovoltaic systems in Indonesia including the typology of the solar energy uses, technical solutions marketed, and breakdown of the selling prices for each system.

Indonesia is an archipelago consisting of about 17,000 islands; there are 5 big islands, namely Java, Sumatera, Kalimantan, Sulawesi and Papua (Irian Jaya).

The majority of the population (80%) lives on two islands; Java (59%) and Sumatra (21%). The rest are in the other main islands, Kalimantan, Sulawesi and Irian Jaya. Apart of those, there are 3 smaller archipelagos, Maluku, West Nusatenggara and East Nusatenggara. They are also inhabited, and around 6,000 of the islands are not inhabited.

Renewable energy sources are quite abundant in Indonesia. These are, bio-ethanol as substitution for gasoline, bio-diesel for diesel oil, geothermal, micro-hydro, wind energy and solar energy to generate electricity. Unfortunately, the development of those renewable energy sources are not growing as expected. There are some constraints slowing the growth, among other, site specific problems and high investment costs. The dependency on the oil is still high, while the domestic capability to produce oil is limited. The target of the government policy regarding national energy supply is to achieve the optimum energy mix in the year of 2025 (Presidential Decree No 5/2006).

Viewing the percentage of energy usage, mentioned in the Presidential Decree No 5/2006, the application of photovoltaic system should be about 800 MWp in the year 2025. It means that the number of photovoltaic that should be installed is about 40 MWp per year. At the moment, the installed capacity up to 2007 is about 20 MWp.

The market of photovoltaic system in Indonesia can be divided into three segmentations: First, market came from the Government through the village electrification project. Second is a retail market, especially in the village outside Java and Bali island, and the third is considered as a 'commercial' market, where the demand for alternative energy comes from urban and industrial areas.

The rural electrification program using the photovoltaic system is still continuing. In the fiscal year 2009 approximately 5 MWp PV systems will be installed. These systems consist of SHS, Hybrid system and PV centralized stand-alone system.

The only financial institution, namely BRI KUPEDES PLTS has the credit facility for the SHS; however the scheme is still not dedicated to the low income people. They are still practicing a normal banking system, which requires a collateral.

The available manufacturing of PV system component in Indonesia is limited to the Balance of System (BOS) such as battery charge controllers (BCR), DC lamps, small battery. The company who is laminating and framing PV modules is available locally; however, solar cell kits are still imported.

The implementation of various policies and programs on the renewable energy by the government of Indonesia proved that there is an increased awareness of the importance the renewable energy in a sustainable energy system. However, the strategy of national policy on the application of solar energy, especially for rural electrification program needs to be become clearer and more intensive.

List of Abbreviations

ASEAN	Association of South East Asian Nations
APSURYA	Association of Photovoltaic Systems and Suppliers
BAKOREN	National Energy Coordinating Board, Indonesia
BAPEDAL	Environment Management Agency, Indonesia
BAPPEDA	Regional Planning Board, Indonesia
BAPPENAS	National Planning Board, Indonesia
BI	Central Bank of the Republic of Indonesia
BPPT	Agency for Assessment and Application of Technology, Indonesia
B2TE	Energy Technology Laboratory, under BPPT
BCR	Battery Charge Regulator
CHC	Community Health Centre (Indonesia: PUSKESMAS)
CHP	Combined Heat and Power (also known as co-generation)
CO2	Carbon Dioxide
CRME	Centre for Research on Material and Energy, Indonesia
DGEEU	Directorate General for Electricity and Energy Utilization, Indonesia
DJLPE	Direktorat Jenderal Listrik dan Pemanfaatan Energi, Indonesia
DSM	Demand Side Management
DSN	Indonesian Standardization Body
ESCO	Energy Service Company
FKMHE	Communication Forum of Energy Efficiency Society
FO	Fuel Oil
GHG	Greenhouse Gas
GOI	Government of Indonesia
IMF	International Monetary Fund
ISB	Independent Supervisory Body (for electricity market)
IRES	Indonesian Renewable Energy Society
KEPPRES	Presidential Decree
KUBE	General Policy on Energy (Kebijakan Umum Bidang Energi)
LIPI	National Institute of Science
MJ	Mega-Joule
MNLH	Minister of State for Living Environment
MNRT	Minister of State for Research and Technology
MOA	Minister of Agriculture
MOC	Minister of Communication
MOD	Minister of Defense
MOFE	Minister of Forestry and Estate
MOIT	Minister of Industry and Trade
MPR	People's Consultative Assembly
MW	Mega Watt
NRSE	New and Renewable Sources of Energy
PERTAMINA	State Oil Company
PLN	State Electricity Company
PROPENAS	Five-year National Development Program
PSK Tersebar	Distributed Small Power Generation
PUSKESMAS	Community Health Center (see also CHC)
PV	Photovoltaic
PVP	Photovoltaic Pump
RAPS	Remote Area Power Supply
RE	Renewable Energy

RIPEBAT	Master Plan for Utilization of New and Renewable Source of Energy
RP	Indonesian Rupiah (Indonesian currency unit)
RPP	Rancangan Peraturan Pemerintah (Government regulation Draft).
SHC	Sub Health Centre
SHS	Solar Home System
SNI	Indonesian National Standard
SWH	Solar Water Heater
USD	United States Dollar
TWh	Tera Watt hour
W	Electric Power (Watt)
Wp	Peak Watt of Photovoltaic Panel
Wth	Thermal Power (Watt)

I. Introduction

I.1. The RENDEV project

Renewable energy is one of the most important ingredients required to alleviate poverty, realize socio-economic and human development. However, in Bangladesh and Indonesia, efficient utilization of renewable energy resources is yet to assume commercial dimensions and widespread acceptance. As a result, reinforcing provision of sustainable energy services through training and capacity building provision and rational policy dissemination remains a priority in order to achieve poverty reduction strategies and sustainable development in the two countries.

Bangladesh and Indonesia happen to be ideal sites for solar energy production and utilization because of their geographical locations. Moreover, some remote areas are among the best sites to develop small scale solar electric generating plants. Hence the two countries should exploit this natural resource to their advantage and work together with the international donor community to gain the means and knowledge necessary for developing sustainable energy technologies.

Most rural areas of Bangladesh, where 76% of the population live, are seriously deprived of any type of electricity facilities. Also, Indonesia has been able to extend electrical power to nearly 60 percent of its population of which most live on remote islands in Indonesia's huge archipelago of some 39,000 villages. Despite Indonesia's quest to raise rural standards of living through electrification, the government recognizes it cannot afford to supply conventional energy sources to rural areas over vast distances despite knowing that, with inaction its large and growing rural population will consume increasing amounts of inefficient forms of energy such as fossil fuels that pollute and emit greenhouse gases.

This project proposes to enlarge the outreach for rural electrification usage and to develop more renewable energy services in Bangladesh and Indonesia in order to usher a qualitative change in the economic and social life of the populations living in these areas.

The innovation in this approach is that, not only it offers integrating micro-finance services with renewable energy technologies but also allows for a bottom up development approach through incorporating the poor located in remote areas that can benefit to a remarkable extent from poverty reduction. This approach is simultaneously increasing market opportunities for renewable energies, and producing a sustainable development in these two emerging countries.

Objectives

Bangladesh and Indonesia are selected as pilot areas. The main targets are summarized as follow:

1. To promote development of income generating activities with renewable energy supply.
2. To build a bridge between national contexts, microfinance, micro-enterprise development, poverty and access to electricity through solar energy systems.
3. To identify measures justifying involvement of SME in the solar energy sector.
4. To create synergies among stakeholders.
5. To promote "solar energy citizenship" mobilising local energy actors.

6. To better inform stakeholders providing pro-poor sustainable renewable energy services.
7. To bring a positive impact on the quality of life in rural districts.
8. To achieve the objectives of the MDGs through sustainable energy provision.

Today, all major stakeholders involved in the field of development recognize the effectiveness of microfinance as a powerful tool in the poverty reduction strategy in rural zones. Consequently to achieve the main objectives of the project, strategic plans should focus on the identification of the key actors and develop innovative renewable energy financial business model, whilst simultaneously developing awareness of the sector and involvement of the community through provision of training and capacity building tools. This is in order to ensure a coherent and widespread understanding of the sector across all segments of the population in rural areas throughout Bangladesh and Indonesia.

The work focuses primarily on the realisation of the following tasks:

- Define a collaborative institutional framework in Bangladesh as well as in Indonesia gathering all the stakeholders who should play relevant roles for the promotion of renewable energy linked to microfinance mechanisms, micro enterprise (ME) and rural development.
- Develop solar energy action plans for ME development and rural development from need assessment tools with a focus on poverty implications.
- Build ME capacity and the ability to capture know-how and benefits from renewable energy resources available in terms of developing new products; operational management, optimizing energy use for business development and management.
- Speed up the rural electrification plan for the improvement of quality of life for low income people in these countries.
- Create innovative microfinance instruments and recommendations toolkits for MFI attracted by solar energy linked micro credit (MC) programmes that tackle the needs of rural population.
- Follow up activities recommendations and reports to maintain awareness for integrated renewable energy policy and incentives for MFI involvement for rural electrification and sustainable development.

Expected key results

The core result of the project will be:

Positive contribution towards national development in Bangladesh and Indonesia and particularly rural development and poverty reduction with solar energy mixed with micro enterprise development and microfinance mechanisms tailored for low income people's needs.

To achieve the objectives expectation in the project, several tools will be created:

1. Need assessment tools: market demand survey, feasibility study and gap analysis.
2. Development of financial model adapted for the linkage between microfinance mechanisms, ME development, solar energy demand, local energy providers and other involved partners in these countries.
3. Microfinance for solar energy toolkit (microfinance new product development).
4. Manual summarizing guidelines for solar energy end-users and micro entrepreneurs.
5. Monitoring and evaluation tools for solar energy system management.

6. Rural electrification action plan for different identified rural districts in Bangladesh and Indonesia.
7. Training and information dissemination material for the social awareness campaign and capacity building programmes on the benefit of the solar energy resources available in terms of developing new products; operational management, optimizing energy use for business development and management.

1.2. State of the renewable energy market

Indonesia is an archipelago consisting of about 17,000 islands; there are 5 big islands, as shown in Figure 1, namely Java, Sumatera, Kalimantan, Sulawesi and Papua (Irian Jaya).



Figure 1. Map of Republic of Indonesia

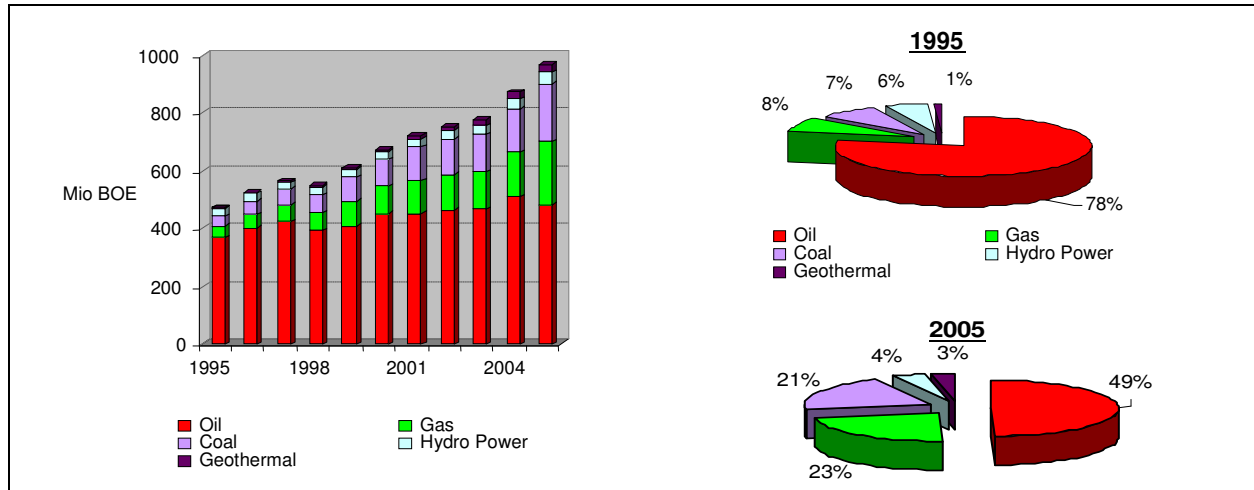
The majority of the population (80%) lives on two islands; Java (59%) and Sumatra (21%). The rest are in the other main islands, Kalimantan, Sulawesi and Irian Jaya. Apart of those, there are 3 smaller archipelagos, Maluku, West Nusatenggara and East Nusatenggara. They are also inhabited, and around 6,000 of the islands are not inhabited.

Inhabitants	245 million (growing by 3 million per year)
Natural resources	Petroleum, natural gas, tin, nickel, timber, bauxite, copper, coal, gold and silver
Main exports	Oil, gas, plywood, textiles, rubber, palm oil
GDP per capita	3500\$
People living in rural areas	54.47%
People living on < 2\$/day	55.3%

The country went out of the characteristic excessive debt of the 1990s, although the remaining national and external debt is sensitive to the effects of the depreciation of the rupiah. Politically the still widespread corruption slows down the progress of the structural reforms.

Electricity production (2004)	120.2 TWh
Electricity generation capacity (2004)	25218 MW
Electricity consumption (2004)	105.4 TWh (demand growing by 8% per year)
Electricity consumption per capita	415 kWh/year
Electrification rate (2006)	56%

Indonesia has abundant renewable energy sources, however the energy mix consumption is still not in balance. As shown in Figure 2, the dependency on the oil is still high, while the domestic capability to produce oil is limited.



Source MARKAL Study, BPPT 2008.

Figure 2. Development of primary energy supply and ratio energy use in Indonesia, in the year of 1995 to the year of 2005

The target of the government policy regarding national energy supply is to achieve the optimum energy mix in the year of 2025 (Presidential Decree No 5/2006).

The share of energy sources in this optimum energy mix is as follows:

Oil is less than 20 %, (2) Gas is more than 30%, (3) Coal become more 33%, (4) Biofuel become more than 5%, (5) Geothermal more than 5%, and (6) nuclear and renewable energies, especially hydro, wind and solar will be more than 5%.

Renewable energy sources are quite abundant in Indonesia. These are, bio-ethanol as substitution for gasoline, bio-diesel for diesel oil, geothermal, micro-hydro, wind energy and solar energy to generate electricity. Unfortunately, the development of those renewable energy sources are not growing as expected. There are some constraints slowing the growth, among others site specific problems and high investment costs.

The table below represent the potential and the installed capacity of renewable energy in Indonesia.

Renewable Energy	Potential	Installed capacity
Hydro	75,67 GW	4,2 GW
Geothermal	27 GW	0,8 GW
Mini/Microhydro	458,75 MW	84 MW

Biomass	49,81 GW	0,3024 GW
Solar Energy	4,8 kWh/m ² /day	0.008 GW
Wind Energy	3 – 6 m/second	0,0005 GW
Uranium (Nuclear)	24112 Ton e.q. 3 GW for 11 years	

Source: Blue Print PEN, (National Blue Print Electricity and Energy Utilization 2006)

Viewing the percentage of energy usage mentioned in the Presidential Decree No 5/2006, the application of photovoltaic system should be about 800 MWp in the year 2025. It means that the number of photovoltaic that should be installed is about 40 MWp per year. At the moment, the installed capacity up to 2007 is about 20 MWp. Therefore, it is going to be a tough challenge for Indonesia to achieve this target.

Most photovoltaic projects in Indonesia are governmental projects. Projects were executed by central government as well as local government. The aim of the government through installing photovoltaic systems is to increase the rate of electrification in the country. This is as a tool to give access to electricity for those who live in the remote and inaccessible areas, where there are no grid lines passing to their villages.

The market of photovoltaic system in Indonesia can be divided into three segmentations: First, market came from the Government through the village electrification project. Second is a retail market, especially in the village outside Java and Bali island, and the third is considered as a 'commercial' market, where the demand for alternative energy comes from urban and industrial areas.

This paper presents a state of the art of the application of photovoltaic systems in Indonesia, including the typology of the solar energy uses, technical solutions marketed, and breakdown of the selling prices for each system.

II. Application of solar energy

The research on the application and utilization of solar energy in Indonesia has started since 1979 as R & D activity. In those days there were a long term and intensive co-operation for the utilization of Solar Energy, funded by the German Government. The German Government was represented by Federal Ministry for Education, Science, Research and Technologies (BMBF) and the Indonesian Government was represented by The State Ministry for Research and Technology.

The BMBF has then appointed TUV Rheinland to carry out the project, and the Indonesian Ministry of Research appointed The Agency for the Assessment and Application of Technology (BPPT). The initial project of this co-operation is called "Solar Village Indonesia". The project was carried out until 1984. The application of photovoltaic system in this project was to cover basic requirements of a specific village.

Stand alone PV system was installed in the coastal area. The system was used to supply drinking water through desalination of sea water, preparing ice to preserve fish, and aid navigation through the illumination of sea buoys. Village television was also installed for entertainment and getting information for village communities.

The co-operation has continued with the project, so called "Renewable Energies Indonesia" (REI) from 1985 to 1996. In this project, more applications were introduced, such as medical refrigerator, remote TV relay and direct pumping systems for remote villages.

Benefits of this project were the gain in individual experiences and technologies. Apart from that, capability of designing and testing PV components in laboratory was also developed.

In 1987, cooperation with Dutch Government was established. R&S Renewable Energy Systems BV of the Netherlands represented the Dutch Government, and BPPT represented Indonesian Government. In this project individual Solar Home Systems (SHS) were introduced in the village of Sukatani, West Java. The system consisted of 80 Wp PV generator, 100 Ah battery storage and battery charge regulator. The main idea was to provide the necessary lighting in the household of remote villages, where they usually used kerosene candle light. The Solar Home Systems in Sukatani village were then inaugurated by the President of Republic of Indonesia 1989.

Having success in the village of Sukatani, The President of Republic of Indonesia announced the project so called "The President Aid Project" in the year 1990. Some 3,300 SHS were deployed and funded by the Presidential aid Project for 15 provinces in Indonesia. The capacity of PV was slightly reduced from 80 Wp to 50 Wp. The reduction of PV capacity was based on the observation of the amount of energy required for lighting during the night. Since then, it has been proved that the SHS with 50 Wp PV modules were the solution for remote village electrification.

Following the Presidential Aid Project, The Government of Indonesia through BPPT announced a 50 MWp program of PV Systems in the year of 1991. The program was based on the electricity needs for 1 million houses located in remote villages. In this program, the Indonesian Government invited International donor countries to sponsor the program.

The first large deployment of SHS was sponsored by Australian Aid (AUSAID) in 1997. 36,400 units of SHS, with the capacity of 50 Wp, and 70 Ah battery were distributed throughout the country. Along with SHS deployment, AUSAID has also sponsored the funding of 14 PV Hybrid Systems in the island of Sulawesi.

Still in the same year, there was an installation of 1 000 SHS and 1 PV-Diesel Hybrid System under the E7 program (E7 is the cooperation of seven international electricity companies).

In the following year, the French protocol program financed 4 PV-Diesel Hybrid System in Kalimantan and Sulawesi island.

Since this period, both SHS and PV hybrid systems were acknowledged as appropriate solutions for remote electrification, however; the budget from the Government stopped and the 50 MWp program also terminated

The program of photovoltaic systems started again in the year of 2004, but not in the name of 50 MWp program. In the period of year 2004 to 2007, several Departemens in the country have been installed more than 80 000 units of SHS . Additionally, 4 PV-Diesel Hybrid Systems, and 5 units of PV centralized systems were installed. To provide drinking water for remote villagers, 8 units of 1.6 kWp unit of Photovoltaic Pump (PVP) have been installed. All these PV applications were funded from the Government budget.

The Government budget allocation for Photovoltaic systems in the year of 2008 is about 800 billion Rp. This budget is split in all government institutions such as Department of Mine and Energy, Ministry of Disadvantage Village, Department of Ocean and Fishery, and Local Governments.

In view of above PV deployment, it is clear that most of the implementation of Photovoltaic Systems is still in the Government area, and a very small part executed by the private sector to fulfill the private demand.

Manufacturing company producing the photovoltaic systems and components in Indonesia is limited to the Solar Home Systems and components, while the components of hybrid system are still imported. An assembly line of PV module, with framing and laminating, has been carried out by PT LEN Industry.

The availability of test laboratory for the Solar Home System and component is required to protect the quality product for the customers. The Energy Technology Centre (B2TE) BPPT, certified with ISO 17025, is ready to serve. There is also a laboratory run by the Institute of Technology Bandung which is doing testing for small inverter for lamps.

The Certification or standardization body in Indonesia is produced by the National Agency for Standardization (BSN).

Since the market is growing, more suppliers and installers were established. The supplier and installer companies are united in the Association of Photovoltaic System and Suppliers (APSURYA).

The training for the application of Photovoltaic system is widely executed by many institutions. The Energy Technology Laboratory (B2TE) of BPPT is one of the institutions that have a regular program for delivering training. While operators who run the systems usually come from the local people and are trained by the supplier.

III. Typology of Solar Energy uses for rural electrification

The rural electrification program using the photovoltaic which has been launched by the Government of Indonesia has several objectives such as to increase the accessibility of the poor people to the electricity, to speed-up the rate of electrification rate, and to increase the quality of life for the poor. The selection criteria for the location of implemented systems are: remote villages, villages that do not have potential for micro-hydro, and villages where the people have a commitment to maintain the system.

There are two types of Photovoltaic systems for this program, namely central photovoltaic system with additional grids, and individual Solar Home System (SHS). Most of the systems installed are SHS.

The approaches of the Government of Indonesia on the program are social approach and semi commercial approach.

The social approach aimed at the real poor people and the semi commercial approach for the people who are relatively rich; however most of the programs are using the social approach. The study of semi-commercial approach was done by the World Bank in the year of 1997 to 2000, and the result was that: only one Bank which is Bank Rakyat Indonesia (BRI) has the credit facility for the SHS; however the scheme is still not dedicated to the low income people. They are still practicing a normal banking system, which requires a collateral.

Most of the photovoltaic systems installed in Indonesia are Solar Home System (50 Wp) the other systems are PV-Diesel Hybrid system, photovoltaic water pumping system, refrigerator for vaccine storage for remote health clinic, communication system, street lighting, buoy for the ship navigation aid, and grid tied system.

All the photovoltaic systems were supplied by the Association of Photovoltaic System Suppliers (APSURYA), which consist of more than 10 companies (see table below).

No	Company name	Agent of	Address	Contact person	e-mail/ telp.
1	AZET SURYA LESTARI	BP SOLAR	Jl Merpati raya No 44 Kp Sawah Baru Bintaro Tangerang 15413	Abdul Kholik	grage@indosat.net.id
2	CITRAKATON DWITAMA	Elsol, China	Metro Sunter Plaza Blok Q No 25 Jl Metro Kencana VII-JAKUT	Roy Samuel	021-6522006
3	LEN INDUSTRI	-	Jl. Soekarno Hatta No 442-Bandung	Darman Mappangara	darman@len.co.id
4	MAMBRUK ENERGY INTERNATIONAL		Jl. RC Veteran no 5B Bintaro-Jaksel	RM Sudjono Respati	jonres@meisolar.com
5	MITRA MUDA BERDIKARI INDONESIA	Kyocera, Japan	Jl Borobudur no 15 Bumi Bekasi Baru Utara Blok IV Bekasi	Alexander MM	alexander_atmawan@yahoo.com
6	SUNDAYA INDONESIA	Evergreen, USA	Jl Pondok Randu No 38 Jakarta Barat	Maurice Adema	info@sundaya.com
7	SUNEAST PERDANA	Kyocera, Japan	Menara DEA Lt 10 Kawasan Mega Kuningan Jl Mega Kuningan Barat Kav 4,3 No 1 Jakarta 12960	Didi Rasyidi	suneastperdana@indo.net.id
8	GUNA ELEKTRO	Shell	Jl Rawa Gelam II No 8 Kawasan Industri Pulo Gadung Jakarta Timur 13930	Ir Sarwono T. SE.MBA/Iskan dar Gani	iskandargani@gae.co.id
9	WIKA INTRADE	Kyocera, Japan	Jl DI Panjaitan Kav 3-4 Jakarta 13340	R. Moh. Budi Prasetyo/Gelora Yala	bpras@coenergy-wi.com
10	PT KANDIYASA ENERGI UTAMA		Jl Wijaya I No 75 Kebayoran Baru Jaksel 12170	Ir Henry Yuliarso/Ir Roeslan Sadhana	kanergi@cbn.net.id
11	PT GLOBAL POWER SYSTEM	Sunseap	Jl Puri Kencana Blok M8 no 2H Perkantoran Puri Niaga III Jakarta 11510	Drisman Damanik	globalps@indosat.net.id
12	PT BANGUN BASKARA MANDIRI	BP Solar	Jl. Sunan Sedayu No 2 Jakarta Timur 13220	Witono	bangbaskara@cbn.net.id

IV. Technical solutions marketed

Anticipating the growth of application of solar energy, especially Solar Home System (SHS), the Government of Indonesia, supported by the World Bank, established the PV Component Test laboratory accredited by ISO 17025.

This effort creates the National Standard for the SHS component such as Battery Storage, Battery Charge Controller (BCR), small fluorescent lamp and general requirements of SHS.

There are 4 National Standards (SNI) on the Component of the SHS, namely:

1. SNI no 04 – 6391 – 2000, Battery Charge Regulator (BCR) - Test Procedure and electric requirements.
2. SNI no 04 – 6392 – 2000, Battery for PV System, General Requirement and test methods.
3. SNI no 04 – 6393 – 2000, System fluorescent lamps for the SHS, Requirement and Test Performance.
4. SNI no 04 – 6394 – 2000, the procedures for the classification of SHS, General Requirements.

The Agency for The Application and Assessment of Technology (BPPT) is also working on the standard of PV-Diesel Hybrid systems, as well as the centralized Photovoltaic system. These standards are expected to be finalized by the end of 2009.

IV.1. Solar Home System (SHS)

As stated earlier, the common solar home system in Indonesia consists of a 50 Wp photovoltaic module, a lead acid battery with the capacity of 70 Ah, a 12 Volt, 10 Amps battery charge controller, three fluorescent lamps (6 Watts) and one DC outlet socket for low power consuming appliance. The other components include: the battery box, switches, interconnecting wires and PV module support structure.

The daily energy output of this system is about 130 Wh, on the average irradiation of 4.5 kWh/m²day.



Source : PT LEN Industry

Figure 3. Diagram of Solar Home System



Source: BPPT

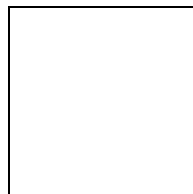
Figure 4. Typical SHS installed

IV.2. Hybrid System

Most of hybrid systems installed in Indonesia are the combination of the photovoltaic system and the diesel generator. The Hybrid PV-Diesel System has been implemented by the government to some remote areas since 1996.

Under French Protocol, 4 units have been installed in South Sulawesi and East Kalimantan. Moreover 14 units of Hybrid systems, sponsored by AUSAID, were installed in South-East Sulawesi and South Sulawesi. Then the latest hybrid system, which is under supervision of BPPT, was installed in 2003 in village of Ponelo, a small island in the Province of Gorontalo, North Sulawesi. Those systems are a part of a demonstration plant of the government program on PV-Diesel Hybrid system for rural electrification.

These implementation programs aimed to provide a 24-hour-a-day electricity supply for rural areas of Indonesia. Ranging of power is 8 kWp to 25.6 kWp photovoltaic array, and the storage battery is from 86.4 kWh to 480 kWh battery bank. The capacity ranges of diesel generators used are from 25 kW to 125 kW, and they are equipped with inverter from 20 to 90 kW capacity. The inverter is acting as solar regulator, control system and distribution network for hundreds of houses.



Source: Optimal Power Solution.

Figure 5. Block diagram of Hybrid System

IV.3. Photovoltaic Pumping System (PVP)

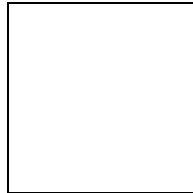
Inadequate supply of drinking water in remote area is a real problem, especially in the eastern part of Indonesia. There is no access to grid power, and the people have to rely on hand pumps and diesel-driven pumps, many of which are out of service due to technical defects or a lack of fuel.

The GTZ program was implemented in 1993 up to 1995. The program has implemented 16 units of Photovoltaic pumps (PVP) in the Province of East Nusa Tenggara. The electricity produced by the array of PV module was connected to submersible pump to lift the water from underground. Basically the PVP system runs automatically as soon as the sun comes up. However, a management plan needs to be established in order to look after the system and all the supporting facilities to distribute the drinking water to the villagers.

Management operation was established on those PVP systems to maintain sustainability of the system.

There are some mining companies facilitating surrounding communities with PVP for the drinking water. The scheme was established through the community development program.

The PVP that have been installed in the last five years in Indonesia represent almost 40 units, in the range of 1.2 kWp to 3kWp, mainly for drinking water supply.

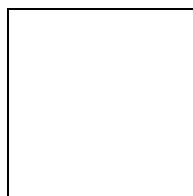


Source: [10]page 60.

Figure 6. Photovoltaic pumping systems

IV.4. PV Refrigerator system for Vaccine storage in rural clinic

The Ministry of Health (M.O.H) and several local Governments are implementing the photovoltaic for vaccine fridge in remote areas, especially areas which do not have access to the electricity. The PV vaccine fridge is one of the important facilities in the Community Health Centre in the remote village to store vaccine and medicine. The facility is mostly free of charge for the community and the maintenance of the system is looked after by the doctor who is in charge of the health centre.

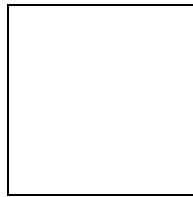


Source [10] page 61.

Figure 7. PV systems for Vaccine storage

IV.5. PV system for Lighthouse navigation aid

25 units of PV systems for navigation aid have been installed throughout the country. The power of each system is 3.2 kWp in the form of hybrid systems. Electricity produced by this system is for powering the lighthouse and the navigation aid tower. Additional systems were installed in lighthouse complex: 18 units of AC PV systems for employees who look after the lighthouse. These systems were installed in the year 2005 under the program of The Ministry of Transportation.



Source: BPPT 2005

Figure 8.PV Lighthouse navigation aid

IV.6. PV Grid-connected system

To encourage the use of photovoltaic systems in urban area, the government of Indonesia through the Minister of Energy and Mineral resources, Minister Research and Technology and Minister of Environment launched the program photovoltaic system in urban area, in August 2003. The first priority of the program was dedicated to the government and state enterprises buildings. This is to show that electricity from PV can reduce the use of conventional electricity, and simultaneously reduce the electricity bill.

The eventual aim of the program was to persuade the people who lived in the urban area to use the photovoltaic systems to reduce the use of electricity from PLN (electricity state company); however this program was not successful since the regulation and the tariff of electricity from photovoltaic system did not exist.

At the moment, PV grid connected system is still in the research and demonstration stage, and currently the total capacity installed is about 112 kWp distributed on several buildings:

Building of the Ministry of Energy and Mineral resources: 90 kWp

Building of The BPPT: 10.5 kWp

Building of The German International School: 11.2 kWp.

Building of The Ministry of Education: 1 kWp.



Source BPPT

Figure 8.The PV grid connected on the BPPT building.

V. Breakdown of the cost prices and selling prices for materials

V.1. *Solar Home System*

Photovoltaic Modules

50 Wp PV modules can be purchased in the range of price Rp 2.8 million to Rp 3.2 million. Most PV modules are imported. There is one company who produced PV module locally, but only doing laminating and framing. This company is called PT LEN Industry, and is established in Bandung.

Battery Charge Regulator

The price of BCR varies from Rp 250 000 to Rp 400 000. The BCR are mostly locally made. There are also imported BCR used by suppliers.

DC Lamps

The 6-Watt fluorescent lamps using electronics ballast/inverter are made locally. The price of the electronic ballast is in the range of Rp 70 000 to Rp 120 000.

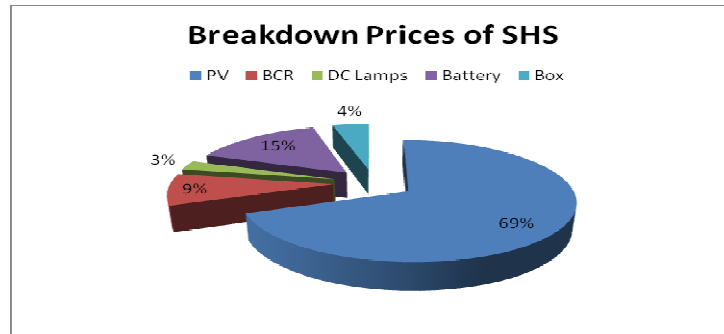
Battery

The 70 Ah lead acid SLI batteries or modified automotive batteries are commonly used in the SHS. The price of these batteries varies from Rp 500 000 to Rp 700.000 .Quite often some suppliers offer the Valve-regulated lead acid batteries (VRLA) for the price of Rp 1.2 million.

Battery box

The battery box/battery enclosure is made of injection-molded plastic or combination plastic with metal, the enclosure contains the battery, charge controller, charge indicator, and switches. The electronic elements are isolated from the battery, and the battery enclosure has ventilations to disperse gases and channels to divert any acid overflows. There is no exposed wiring and the battery can be checked and filled easily. The battery box price is Rp 100 000 to Rp 200 000.

Figure 9 displays the breakdown in prices for these SHS.



Source: Association of Photovoltaic System Suppliers (APSURYA)

Figure 9. Breakdown prices of SHS.

V.2. Hybrid System

Photovoltaic Modules

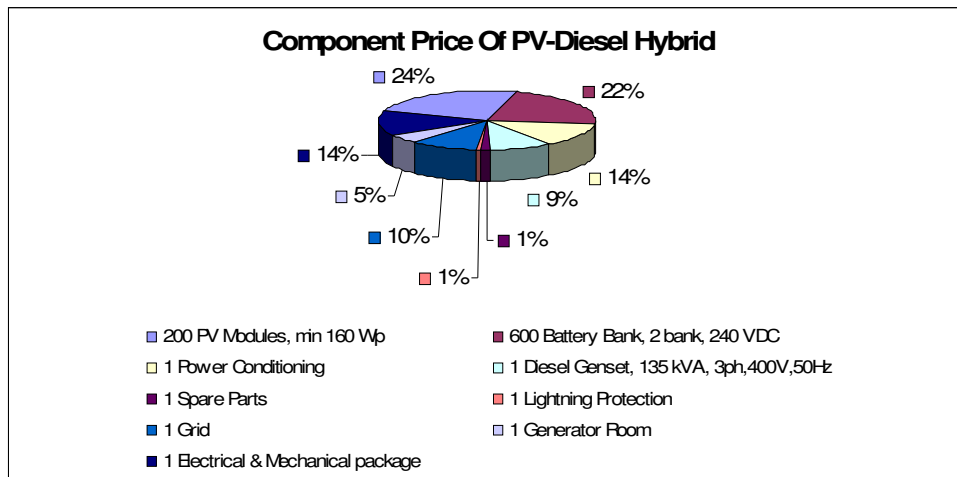
The Price of photovoltaic array in the hybrid PV-Diesel system is approximately Rp 70 million/kWp including the array mounting.

Hybrid Power Conditioning

There are several international companies offering the hybrid power conditioning. The price is around Rp 15 million/kWp.

Battery

The battery used in the hybrid PV-Diesel is the tubular lead-acid battery with the price of Rp 5 million/kWh. Unfortunately, this kind of battery is not produced locally.



Source: Association of Photovoltaic System Suppliers (APSURYA)

Figure 10. Component Price of PV-Diesel Hybrid System.

V.3. Diesel generator

The largest Diesel Generator usually used is 135 KVA, 3 phases, with the voltage system of 400V, 50Hz, completed with the electronic governor, and over speed control. The price of diesel generator is around 901,264,500 Rp (almost 100,000 USD). This price includes fuel tank (2*2000L), pipe, flow meter, interconnection cable, panel, and 4 000 liters of starting fuel, spare of engine oil and oil filter, and grounding system.

V.4. Grid

The low voltage grid with 70 mm² cable, 7 meters pole height with length of 3 km maximum is used, completed with distribution board, 2 feeders plus metering cost about Rp 450 million, per km.

VI. Identification of the barriers and constraints

The electricity needs in Indonesia is still very high. The rate of electrification is only 56 %. It means, almost 18 million households are not electrified yet, especially those who lived in the rural and isolated areas.

Currently, most of the Indonesian PV market is coming from the Government, with the aim to speed up the rate of electrification. The distribution of 50 Wp SHS, which is run by the Government, is free of charge. This condition makes it difficult to have a sustainable system. To anticipate this, a management institution on the site and sales distribution of spare parts needs to be established in the location where SHS are installed.

The scheme of implementation of SHS among Government agency is not identical. This also could create a problem if there are close locations, which are installed with different agency.

As mentioned earlier, there are less than 20 suppliers involved in the business of PV system, and only few are dealing with commercial retail market and offering after sales services.

VI.1. Quality problems pertaining to the national or imported material offer

Most of major component of photovoltaic systems are still imported, especially for bigger system such as the hybrid system, stand alone centralized and pumping system. For small systems like SHS, only PV modules are imported and the other components such as battery storage, battery charge regulator (BCR), DC Lamps, are produced locally.

So far, PT LEN Industry is the only company in the country which is producing local PV modules. The cells and some other materials for lamination are still imported.

In general, there are no technical quality problems for PV systems and component whether they are domestically made or imported. This is because all PV components supplied by the suppliers have to follow the available Indonesian Standard.

There is also a case that supplier is offering the Solar Home System which does not comply with the available SNI. For instance, they import BCR from International market which in fact did not pass the Indonesian Standard. Since they recognize that their BCR were not complying, the suppliers have to modify their product to comply with the requirement standard.

The standard of Solar Home System (SHS) for the governmental project, as mentioned earlier, is 50 Wp PV module, 12 Volt, 10 Amps charge regulator (BCR), 70AH lead acid battery, 3 (three) DC fluorescent lamps and installations kit. Quite often suppliers are trying to offer the SHS with the 8 to 10 Wp PV module completed with LED lamps. Since these systems are not accredited, these SHS are not complying with the SNI.

Most of the suppliers are located in Jakarta, the capital city of the Republic of Indonesia, but there are also some suppliers in the capital city of Provinces and Districts.

VI.2. Distribution or maintenance difficulties

The distribution of the system is carried out by the suppliers, even to the very remote areas. The suppliers are working together with their partner in the Provincial region to execute the projects.

Since the deployment schemes of SHS from the government are free, it is difficult to handle the maintenance of the systems. There is a lack of management in the area: who will look after the systems. Therefore, some of the suppliers are encouraging the villager to establish an operation management. This operation management will be used by the suppliers as a contact institution to send some spare parts, and monitor sustainability of the systems.

In the case of Hybrid and Stand Alone Centralized Systems, there is a limitation of the supply of the power conditioning equipment. Very few International companies producing the power conditioning conform to Indonesian hybrid concept.

Indeed, most of the power conditioning produced is aimed to use the diesel generator as a back-up system only. Whereas the Indonesian Hybrid concept is to reduce the use of diesel oil, the diesel generator runs during the peak load only.

VI.3. Appropriateness of the professional qualifications

Professional qualifications are required for the suppliers supplying the Solar Home System and component as well as installing all the PV systems. Qualifications of personnel include performing feasibility study and designing the systems to meet the requirement of the clients.

Even though most suppliers are performing training and installation, they are not really developing their distribution network in the locations. In this condition, lack of spare parts is often a problem.

Some suppliers, who are considered as more advanced, export their products such as BCR, DC lamps to the international market.

VI.4. Financial and fiscal constraints

Since most projects are coming from the government, the schedules of the projects are depending on the government agenda. Sometimes the projects are delayed up to the end of the fiscal years.

The incentives for the solar energy suppliers from the government are limited to the import tax of the PV module.

There is no credit facility to purchase SHS for low-income people in the villages. The Banks or the financing institutions consider SHS as non-productive goods. It is advisable that a substantial fund is deposited in the bank, which can be used as collateral for microfinance scheme to provide PV systems for villagers.

VII. Technical and material skills available locally

Technical skills for the PV systems are quite available in the country. However, in area of implementation, which is mostly in the rural areas, there will be a slight problem to find skilled people. Therefore, training of local people is compulsory by the suppliers who install PV systems in the area.

The manufacturing companies who produced the photovoltaic system and component in Indonesia are limited to the Solar Home Systems and component while for hybrid systems the components are still imported.

VII.1. Test laboratories, university laboratories

The available test laboratory for the Solar Home System and component is provided in the Energy Technology Centre (B2TE) BPPT. This laboratory is equipped with the ISO 17025. The B2TE test laboratory was developed in cooperation with TUEV Rheinland and Fraunhofer ISE Germany. This laboratory was certified by the National Certification body of Indonesia (BSN) in the year of 2000. The personnel involved in the PV and component test laboratory consists of 5 qualified engineers and 4 technicians.

Apart from B2TE, another division under BPPT who works on solar energy activities, is the Energy Conversion and Conservation Centre (PTKKE). This division works in the field of Photovoltaic systems. 6 scientist works in the research of PV grid connected and PV Hybrid systems.

Other institutes who work in the field of solar energy are the Ministry of Mine and Energy, Indonesia National Science Institute (LIPI) and Institute of Technology Bandung (ITB). LIPI and ITB are doing research, stressing on the material of photovoltaic cell materials such as poly, mono and amorphous silicon technology. The ITB is also working on the test of small inverter for DC lamps in the SHS.

VII.2. Certification or standardisation bodies

The institution responsible for the implementation of standardization and certification is the National Standardization Agency (BSN). BSN is supported by KAN (National Accreditation Committee) in conducting activities related to accreditation and certification in Indonesia. The main task of KAN is to award accreditation to certification bodies (such as those related to quality system, products, personnel, training, environment management system, and forest conservation management system), test/calibration laboratory as well as inspection and accreditation of standardization of other fields in accordance with the requirement, and to give advices to the Head of BSN in setting up accreditation and certification systems.

The B2TE test laboratory is one of the test laboratories of SHS component to meet the requirement of SNI no 04 – 6391 – 2000, Battery Charge Regulator (BCR), SNI no 04 – 6392 – 2000, Battery for PV System, SNI no 04 – 6393 – 2000, System fluorescent lamps for the SHS and SNI no 04 – 6394 – 2000, the procedures for the classification of SHS. The B2TE certificate of products (PV module, BCR, Battery and small inverter for dc lamps) is awarded to the suppliers who have the products that meet the requirement with SNI.

VII.3. Manufacturers and installers, operators

The manufacturer and installer companies are member of the Association of Photovoltaic system suppliers (APSURYA). The operator usually comes from local people who are trained by the supplier.

As stated earlier, the majority of PV modules are not produced locally, except of PT LEN Industry, which is working on PV module framing and laminating with limited capacity. Most of the PV modules are imported from international market such as BP Solar, Shell Solar, Solar world, Sharp, SET and unknown Chinese products.

The small components of SHS such as DC lamps, Battery Charge Regulator, and Storage battery are produced locally. They are covering the demand of SHS in Indonesia, but now, there is an international competitor for the SHS components which is China. The Chinese products for the SHS components are relatively very cheap.

Because most of the projects are turn-key, it is obligatory for the PV suppliers to carry out the installation of the PV Systems. They do bidding in the government projects to install photovoltaic systems such as SHS, PV central system, PV-Diesel Hybrid System and communication system in all over Indonesia, usually in remote and isolated areas.

VII.4. Training institutions

Training in the PV systems, so far, is dedicated to SHS. This is because SHS is the largest deployment in the country. They are mostly implemented in the rural areas, where the users are very simple people.

There are many institutions performing training to those interested in the SHS and other PV systems. These institutions include BPPT, Ministry Mines and Energy, Universities and some foreign NGOs which are financed by multilateral donor.

B2TE laboratory, which tests for qualifying SHS components, is also executing regular training of photovoltaic system and component. Usually the request comes from the local government who has PV implementation program in their area. The training agenda of B2TE lab is performed twice a year.

In the case of government project, there is usually a package including training for the local technicians. Therefore, the supplier who wins the tender is obliged to run a training session to the local people. The trained local people will act as operator candidates, where the SHS are installed.

VIII. Conclusion

Indonesian energy sector is still heavily dependent on non-renewable energies such as fossil fuels, coal and natural gas as sources of energy. These non-renewable energies are limited and gradually depleting. Moreover, these non renewable energies are contributing to the emission of greenhouse gas.

Meanwhile the installed capacity of photovoltaic systems in Indonesia up to 2008 is about 20 MWp, with a target of 800 MWp for 2025.

The rural electrification program using photovoltaic system is still continuing, in the fiscal year 2009 approximately 5 MWp PV systems will be installed. These systems consist of SHS, Hybrid system and PV centralized stand-alone system.

Most of these installations are government funded, and only one financial institution, namely BRI KUPEDES PLTS has the credit facility for the SHS; however the scheme is still not dedicated to the low income people. They are still practicing a normal banking system, which requires collateral.

Concerning the local availability for manufacturing PV system component, Indonesia is limited to the Balance of System such as BCR, DC lamps, and small batteries. Only one company is laminating and framing PV modules locally, while solar cell kits are still imported.

For proper system maintenance, training activities have to be implemented more often to more people, particularly to those who are dealing with PV systems in the villages. The chain of spare parts supply has to be established from the manufacturer to the customer in the village.

On the certification and standardisation side, the test laboratory requires to be expanded, not only the facility to test SHS but also to allow for testing of bigger components such as power conditioning and inverter.

The implementation of various policies and programs on the renewable energy by the government of Indonesia increased the awareness of the importance of renewable energy in a sustainable energy system. However the strategy of national policy on the application of solar energy, especially for rural electrification programs, needs to become clearer and more intensive.

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