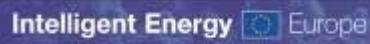


EIE-06-256 REEPRO



Promotion of the Efficient Use of Renewable Energies in Developing Countries

**Report on Visiting Possible Pilot Community and
Project Community, Koh Thom district, Kandal Province
on August 13, 2008**

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1 Background

The visiting place is located in Prek Chrey village, Prek Chrey commune, Koh Thom district, Kandal Province. Prek Chrey Commune is the green area in the green outlined district of Koh Thom.



Figure 1: Location of Prek Chrey commune highlighted in green outline

Prek Chrey commune is based in Koh Thom district, Kandal Province at the border to Vietnam. The population is about 12,500 which are mainly Vietnamese (84%): the Khmer are only about 2000 inhabitants (16%).

Officially, all inhabitants of Prek Chrey are Cambodian, and the use of written Vietnamese in public affairs is not allowed.

The original Khmer population in Prek Chrey Commune has become in the past a small minority among a growing Vietnamese majority, a situation that could develop to a major source of conflicts in the middle or long term. Now already, this situation between both communities is the reason for tensions which are nourished and at the same time embanked by the Vietnam friendly policy of the government and the local authorities.

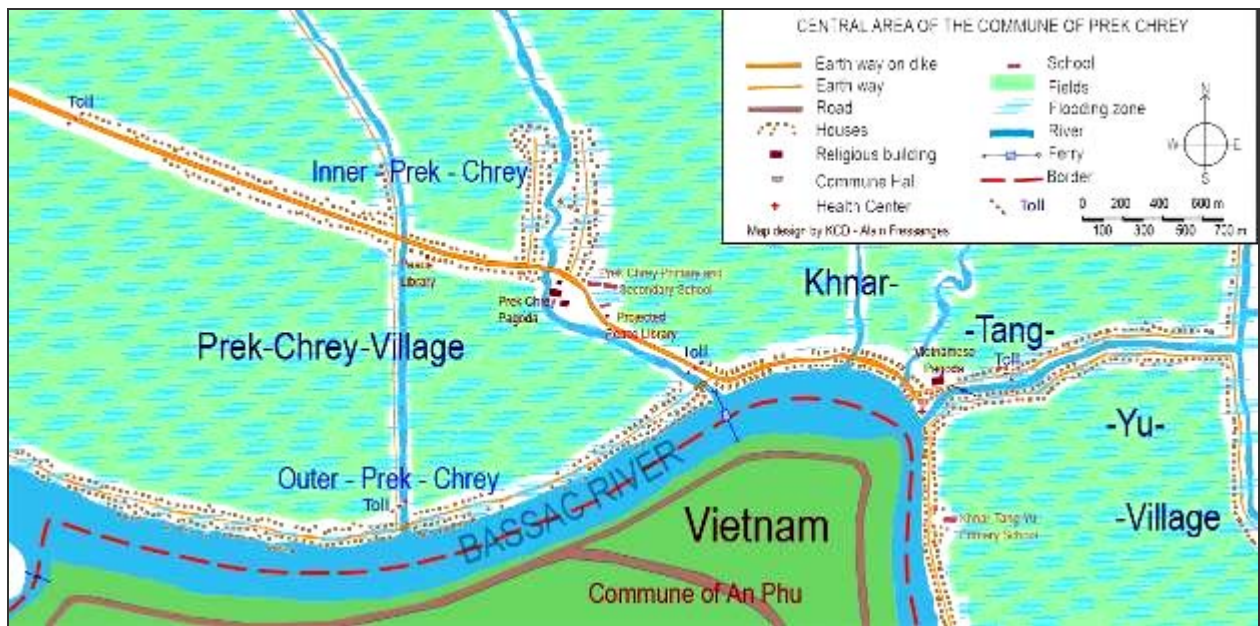


Figure 2: Social map of Prek Chrey village

2 Purpose of the visit

Mr. Kim Heng and Mr. Rithy from COMPED; Mr. Norith and Mr. Phok from ITC and Mr. Alin visited Prek Chrey village to look for the pilot community and project community for the REEPRO project. We have visited three areas:



Figure 3: Battery Charging Station in Prek Chrey

Relevant data on the battery charging station were collected for the feasibility study of using Solar PV for charging the batteries. The health centre is located about 1 Km from the charging station. The study was done by ITC for the capacity needed.



Figure 4: Prek Chrey Health centre

The library is used for students coming for reading and it is planned to install computers for students to have more advanced knowledge with computer.



Figure 5: Library of a primary school in Prek Chrey

3 Potential and Suggestion of COMPED after Visiting

- COMPED would suggest to have the battery charging station for Project Community. Mr. Alain will propose to GTZ for a loan for the owner to run his business as
 - it has been charging large amount of batteries every day (60 batteries);
 - It can reduce unfriendly toxic particles in the air
 - It is independent from oil price increase
- COMPED would suggest selecting the Primary School Prek Chrey as a Pilot Community and Mr. Alin will look for funds for installing computers and PV system in cooperation with REEPRO.

4 Annex: result of project design and calculation by ITC

4.1 PV charging battery

In khnar Taing Yu Village, there is a charging battery station which uses small generator of capacity of 5.5KW. This small Genset is operates almost everyday for charging battery with 10 hours a day. This station is located Kandal Province along the Bassac River nearby Cambodia-Vietnam border. The road is in good condition from Phnom Penh to Check point and about 3km by board from the check point. The centre is in the remote area there is no electricity grid for providing the consumption of the population who live in that area. In the center, they use small generator for light or charging battery which very difficult to keep the medical in cool condition.

4.1.1 Input data

- **Village name:** khnar Taing Yu Village, Prek Chhrey Commune, Koh Thom District, Kandal Province
- **Population:** N/A
- **Location:** Along Bassac River, 3km from check point.
- **Occupation:** Owner
- **Services:** Charging battery
- **Husbandry:** no
- **Income range:** N/A
- **Income Sources:** small business
- **Favorability:** Good solar insolation
- **Difficulty:** surrounded by big trees
- **Facing Problems:** (1) lack of electricity supply, (2) high price of electricity by using charging battery, (3) inefficient uses of gas for cooling, (4) absence of the income generation activities
- **Energy resources and consumption:**
Use for charge the batteries, television and ventilation.

Solar radiation in Kandal

The solar radiation in Kandal area is 4.3KWh/day/m².



Figure 6: Battery Charging Station

4.1.2 First general discussion of different possibilities

Here are short concepts of possible options, in case of charging battery station electrification:
Hybrid system – PV + Diesel Genset: The electricity will be produced by the combination of PV and diesel genset. The diesel genset can be set to run permanently during the evening time or when there is not enough energy from the PV or during peak load for instance. The scheme may vary depending on the nature of load, solar resource and desire of consumers.

4.1.3 Detailed design of the selected solution

4.1.3.1 Charging Energy

The charging batteries for this station are listed below:

Battery	Number	Voltage (V)	Energy (Wh)
70Ah	5	12	4200
50Ah	15	12	9000
40Ah	10	12	4800
20Ah	6	6	720
Total	36		18720

4.1.3.2 System Components

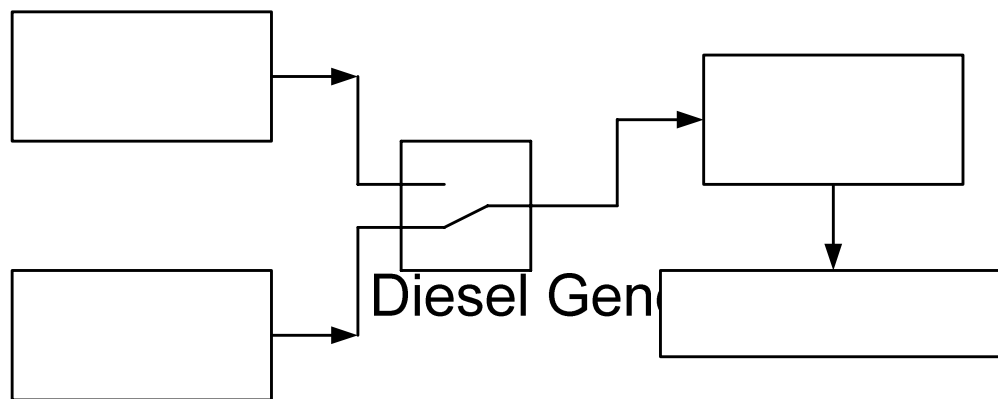


Figure 7: Layout of the PV system

4.1.3.3 Systems sizing

- **PV Generator (P_{PV}) :**

$$P_{PV} = \frac{W}{\eta_{system} \times LDSR}$$

Where P_{PV} : Peak Power of PV generator (W)
 W : Daily energy consumption (Wh)
 $LDSR$: Least Daily Solar Radiation = 4.3 KWh/day.m²
 η_{system} : System efficiency = 75%

Hence

$$P_{PV} = \frac{18720}{0.7 \times 4.3} = 6219.26 \text{ Wp}$$

By using Sharp Module of different capacity with nominal voltage of 12 V, the number of modules are needed and connected in parallel shown in table below:

Module capacity (Wp)	Nb of module	Voltage (V)	Total Capacity
195	32	12	6240
185	34	12	6290
175	36	12	6300
170	37	12	6290

- **Charge controller :**

$$C = \frac{P_{PV}}{U}$$

Where P_{PV} : Peak Power of PV generator (W)
 C : Capacity of the charge controller (A)
 U : System voltage (V)

Hence, the capacity of charge controllers is list in the table below

PV module	Charge controller (A) @12V	Charge controller (A) @ 24V	Charge controller (A) @ 48V	Charge controller (A) @ 180V
module 195	520	260	130	34.66667
module 185	524.1667	262.0833	131.0417	34.94444
module 175	525	262.5	131.25	35
module 170	524.1667	262.0833	131.0417	34.94444

From the above result, the owner can select any configuration which is cheaper for the investment cost.

4.1.3.4 Cost calculation of the selected solution

The information on the system cost is not available.

4.1.3.5 Financing options

...

4.1.3.6 Gant chart for project implementation...

4.2 PV for Health centre

4.2.1 PV Case Study – Kandal

Health Centre (in Khmer, Mondul Sokhakupheab) is located Kandal Province along the Bassac River nearby Cambodia-Vietnam border. The road is in good condition from Phnom Penh to Check point and about 3km by board from the check point. The centre is in the remote area there is no electricity grid for providing the consumption of the population who live in that area. In the center, they use small generator for light or charging battery which very difficult to keep the medical in cool condition.

4.2.2 Input data

- **Village name:** khnar Taing Yu Village, Prek Chhrey Commune, Koh Thom District, Kandal Province
- **Population:** N/A
- **Location:** Along Bassac River, 3km from check point.
- **Occupation:** nurse, wet nurse
- **Health Services:** vaccination, provide health care to population, pregnant

- **Husbandry:** no
- **Income range:** N/A
- **Income Sources:** support from government.
- **Favorability:** Good solar insolation
- **Difficulty:** surrounded by big trees
- **Facing Problems:** (1) lack of electricity supply, (2) high price of electricity by using charging battery, (3) inefficient uses of gas for cooling, (4) absence of the income generation activities
- **Energy resources and consumption:**
 - **Cooling:** the medical that keep in refrigerator (Electrolux) uses gas for cooling in 24hours per day. Due to the difficulties in transportation
 - **Lighting and ventilation:** all electricity consumption is provided by Diesel Gen-set. Monthly consumption varies from -- KWh to -- KWh. The diesel price is 0.7 USD/L and is expected to increase to 0.75 USD/L.

Solar radiation in Kandal

The solar radiation in Kandal area is 4.3KWh/day/m².



Figure 8: Health Centre

4.2.3 First general discussion of different possibilities

Here are short concepts of possible options, in case of Health Centre electrification: **Individual Solar systems:** This health center will be equipped with one solar home system. Electricity consumption will be independent from other energy resources.

4.2.4 Detailed design of the selected solution

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4.2.4.1 Energy consumption

The electricity consumption for this health center is listed below:

Load	Number	Power (W)	Total Power	Hours (h)	Energy (Wh)
Lamp 1	1	20	20	5	100
Lamp 2	2	20	40	12	480
Lamp 3	1	20	20	12	240
Lamp 4	1	20	20	4	80
Lamp 5	1	20	20	6	120
Lamp 6	1	20	20	6	120
Electrolux	1	120	120	24	2880
Fan	2	34	68	6	408
Total			328		4428

4.2.4.2 System Components

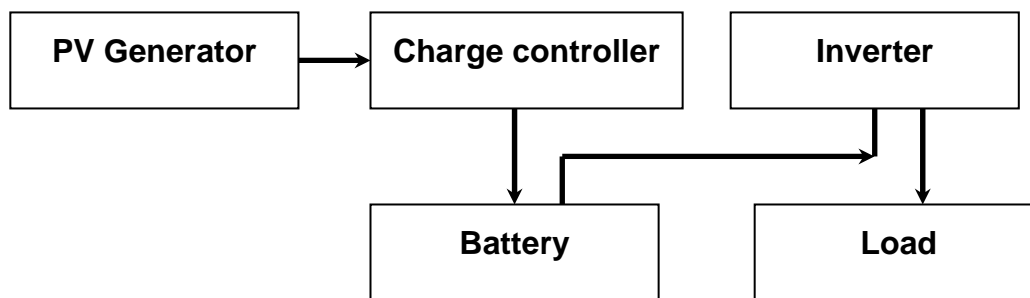


Figure 9: Layout of the PV system

4.2.4.3 Systems sizing

- **PV Generator (P_{PV}) :**

$$P_{PV} = \frac{W}{\eta_{system} \times LDSR}$$

Where P_{PV} : Peak Power of PV generator (W)
 W : Daily energy consumption (Wh)
 $LDSR$: Least Daily Solar Radiation = 4.3 KWh/day.m²
 η_{system} : System efficiency = 75%

Hence

$$P_{PV} = \frac{4428}{0.75 \times 4.3} = 1373.023 \text{ Wp}$$

By using Sharp Module with the capacity of 195 Wp each and nominal voltage of 24 V, 8 modules are needed and connected in parallel.

- **Charge controller :**

$$C = \frac{P_{PV}}{U}$$

Where P_{PV} : Peak Power of PV generator (W)
 C : Capacity of the charge controller (A)
 U : System voltage (V)

Hence

$$C = \frac{195 \times 8}{24} = 65 \text{ A}$$

- **Inverter :**

$$P_{Inverter} = P_{load} \times 1.3$$

Where $P_{inverter}$: Nominal power of the inverter (W)
 P_{load} : Total load power (A)
 1.3 : Allow 30% additional power or during starting

Hence

$$P_{Inverter} = 328 \times 1.3 = 426.4 \text{ W}$$

- **Battery :**

$$Ah = \frac{W \times N_d}{DOD_{max} \times U}$$

Where Ah : Battery capacity (Ah)
 W : Daily energy consumption (Wh)
 DOD_{max} : Maximum Depth of Discharge of the battery, usually 50%
 N_d : Number of autonomy day, usually 3 days for tropical region
 U : System voltage (V)

Hence

$$Ah = \frac{4428 \times 3}{0.5 \times 24} = 1107 \text{ Ah}$$

Using battery with capacity of 200 Ah with nominal voltage 24 V, 6 batteries are connected in parallel.

4.3 PV for Prek Chhrey School

4.3.1 PV Case Study – primary/secondary school

Prek Chhrey primary/secondary school is located in Kandal Province along the Bassac River nearby Cambodia-Vietnam border. The road is in good condition from Phnom Penh to Check

point and about 3km by board from the check point. The centre is in the remote area, there is no electricity grid for providing the consumption of the population who live in that area. In school, there is no electricity for lighting or using they use small generator for light or charging battery which very difficult to keep the medical in cool condition.

4.3.2 Input data

- **Village name:** khnar Taing Yu Village, Prek Chhrey Commune, Koh Thom District, Kandal Province
- **Population:** N/A
- **Location:** Along Bassac River, 3km from check point.
- **Occupation:** nurse, wet nurse
- **Services:** Education
- **Husbandry:** no
- **Income range:** N/A
- **Income Sources:** support from government.
- **Favorability:** Good solar insolation
- **Difficulty:** surrounded by big trees
- **Facing Problems:** (1) lack of electricity supply, (2) high price of electricity by using charging battery, (3) absence of the income generation activities
- **Energy resources and consumption:**
 - **Cooling:** the medical that keep in refrigerator (Electrolux) uses gas for cooling in 24hours per day. Due to the difficulties in transportation
 - **Lighting:** Candle, the diesel price is 0.7 USD/L and is expected to increase to 0.75 USD/L.

Solar radiation in Kandal

The solar radiation in Kandal area is 4.3KWh/day/m².



Figure 10: Prek Chhrey primary/secondary school

4.3.3 First general discussion of different possibilities

Here are short concepts of possible options, in case of Prek Chhrey primary/secondary school electrification: **Hybrid system – PV + Diesel Genset:** The electricity will be produced by the combination of PV and diesel genset. The diesel genset can be set to run permanently during the evening time or when there is not enough energy from the PV or during peak load for instance. The scheme may vary depending on the nature of load, solar resource and desire of consumers.

4.3.3.1 Detailed design of the selected solution

4.3.3.2 Energy consumption

The electricity consumption for this school is listed below:

Load	Number	Power (W)	Total Power	Hours (h)	Energy (Wh)
Lamp 1	3	20	60	4	240
Lamp 2	3	20	60	6	360
Lamp 3	1	20	20	3	60
Lamp 4	3	20	60	4	240
Notebook	10	60	600	6	3600
Total			800		4500

4.3.3.3 System Components

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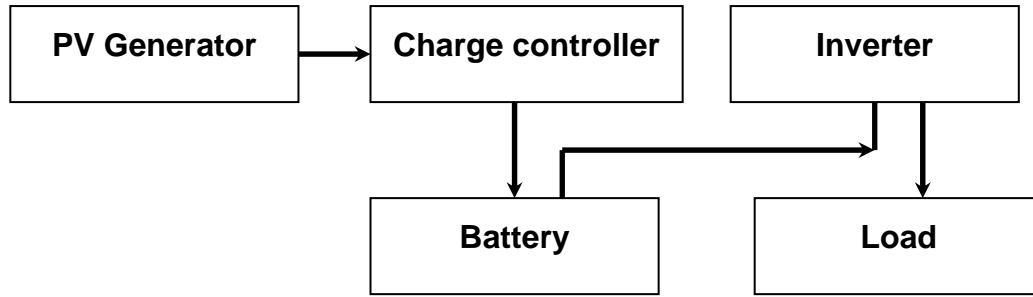


Figure 11: Layout of the PV system

4.3.3.4 Systems sizing

- **PV Generator (P_{PV}) :**

$$P_{PV} = \frac{W}{\eta_{system} \times LDSR}$$

Where P_{PV} : Peak Power of PV generator (W)
 W : Daily energy consumption (Wh)
 $LDSR$: Least Daily Solar Radiation = 4.3 KWh/day.m²
 η_{system} : System efficiency = 75%

Hence

$$P_{PV} = \frac{4500}{0.75 \times 4.3} = 1395.35 \text{ Wp}$$

By using Sharp Module with the capacity of 175 Wp each and nominal voltage of 24V, 8 modules are needed and connected in parallel.

- **Charge controller :**

$$C = \frac{P_{PV}}{U}$$

Where P_{PV} : Peak Power of PV generator (W)
 C : Capacity of the charge controller (A)
 U : System voltage (V)

Hence

$$C = \frac{175 \times 8}{24} = 58.33 \text{ A}$$

- **Inverter :**

$$P_{Inverter} = P_{load} \times 1.3$$

Where $P_{inverter}$: Nominal power of the inverter (W)
 P_{load} : Total load power (A)
 1.3 : Allow 30% additional power or during starting

Hence

$$P_{Inverter} = 800 \times 1.3 = 1040 \text{ W}$$

- **Battery :**

$$Ah = \frac{W \times N_d}{DOD_{max} \times U}$$

Where Ah : Battery capacity (Ah)
 W : Daily energy consumption (Wh)
 DOD_{max} : Maximum Depth of Discharge of the battery, usually 50%
 N_d : Number of autonomy day, usually 3 days for tropical region
 U : System voltage (V)

Hence

$$Ah = \frac{4500 \times 3}{0.5 \times 24} = 1125 \text{ Ah}$$

Therefore, the battery with capacity of 1200 Ah with nominal voltage 24 is used.