Attachment

For

The Manual of PV System Management

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Contract on the PV Electrification in Mar Island

CONTRACT ON THE PV ELECTRIFICATION IN MAR ISLAND

This contract is passed between MATFORCE "Compagnie d'Applications Mécaniques" which headquarters is located at 10 avenue Feidherbe-Dakar represented by his Managing Director Mr. Mamadou SOW acting on the behalf and for the above-mentioned company hereunder referred as the "operator" and subscriber
Mr._____living in_____ (hereafter referred as "USER"). The two parties made the following agreement.

Preamble

This agreement is made in the idea of the execution of cooperation Pilot Project between MEH and JICA within the framework of Study for the PV Rural Electrification Plan. To cope with the new procedures of rural electrification subsequent to the reform on electricity sub-sector, the state has decided to entrust ASER through Project ownership delegation with the management of the Project.

The objective of this project is the implementation of PV system for the electrification of Mar Islands in the sub-prefecture in Fimela, Department of Fatick. This project consists in the installation of PV systems. The PV system for the contract consists of two parts.

1) The first part

The first part is as follows;
"One 55W Solarex PV panel (SX55)", "One Battery charge/discharge regulator Uhlman SLR1010", "One 100 Ah battery M14-SOL", "One battery box CPM-14" and "Cables and Fixtures" (hereafter referred as "MAIN PART")

2) The second part

There are three types of the second part. One type of the second part is selected by "USER".

The second part is as follows; (Please put a mark on the selected variety)

- Variety 1:
  "Five – 8 [W] fluorescent lamp DC", "One DC/DC Voltage dropper", "One radio socket", "Five switches" and "Junction box and cables and fixtures"
- Variety 2:
  "Three – 8 [W] fluorescent lamp DC", "One DC/DC Voltage dropper", "One radio socket", "One TV socket", "Three switches", and "Junction box and cables and fixtures"
- Variety 3:
  "Two – 8 [W] fluorescent lamp DC", "Four –LED lamp", "One DC/DC Voltage dropper", "One radio socket", "One TV socket", "Six switches", and "Junction box and cables and fixtures"
  (hereafter referred as "INTERNAL PART")

Chapter I: General Clauses

Article 1- Object of the Contract

The object of this contract is to define the necessary conditions for the implementation and management of the Rural Electrification Pilot Project in Mar Island and define the obligations and responsibilities of the concerned parties.

Article 2- Description of the concerned Partners

The owner of this project is MEH that entrusts its execution to ASER.

ASER, the executing agency of rural electrification is owner of the project and by the same way of the installed PV equipment and makes the Pilot Project Operator carry out management of the Project.

The Pilot Project Operator is entrusted by ASER, the mission to ensure proper management of the Project equipment.

The USER is the direct beneficiary of the electricity services offered.

Article 3- Validity

The present contract shall take effect for 5 years from the date of signature. The contract condition will be reconsidered between "USER" and "PILOT PROJECT OPERATOR" when the contract is terminated. "USER" also will be able to withdraw from the contract in this time.

Article 4- Settlement of Contentions

In case of contention between the two parties, the latter will try their best to reach amicable mutual understanding. If they fail to reach a compromise, the contention will be submitted to the judgment of ASER. If the contention still remains after submission to ASER, the two parties will submit to the competent Law court of Senegal.

Article 5- Penalty: Transfer of the PV System

If the "USER" does not pay the "Monthly Payment" within 30 days from the date of the invoice issued the "PILOT PROJECT OPERATOR" shall send a first notification to "USER" requesting payment of due amount within one week. If the latter still does not pay the "PILOT PROJECT OPERATOR" shall suspend the electric supply and give a last notification for payment within a fortnight. If at the end of that deadline "USER" still does not pay the "OPERATOR OF THE PILOT PROJECT" will remove the whole of the "PV System" from the "USER" at any time with its all accessories without any other notification and will keep at his disposition the removed system without prejudice to appeals given to him by legal clauses.

If the "USER" makes alternations or modifications that may cause damages to the PV system without approval of the "OPERATOR", the latter shall remove the PV system at any time from the "USER" as mentioned on article 13.

Chapter II: Obligations and Responsibilities of each party

(1) PILOT PROJECT OPERATOR OBLIGATION

Article 6– Maintenance & Repairs

The "PILOT PROJECT OPERATOR" under the contract with "ASER" shall be responsible for the maintenance and repair of the "MAIN PART" and the "INTERNAL PART". The "PILOT PROJECT OPERATOR" will carry out ordinary maintenance every month.

In case of minor repair, fixing or replacement is made within three (3) days from the date of notification. In case of major repair, fixing or replacement is made within seven (7) days from the date of notification. All of the necessary cost for maintenance and repair include replaced components is covered from the regular monthly payment.

Article 7– Replacement of PV system components

The "PILOT PROJECT OPERATOR" replaces components of the PV system based on the estimated lifetime of each component. Replacing components and estimated lifetime of components are as follows;

Replacing Components	Estimated Lifetime
Battery	4 years
Regulator	10 years
PV module	20 years
Ballast	10 years

All of the necessary cost for replacement is covered from the collected fees.

Article 8- Fee collection

The PILOT PROJECT OPERATOR is responsible for fee collection. The collected fees will be deposited in the bank account opened for that purpose.

The 25th of each month the User will receive an invoice which must be paid at the latest the 5th after consumption period. Fees must be paid to the operator employee who will give a receipt. Users will be informed of his visit 2 or 3 days before.

(2) OBLIGATIONS AND RESPONSIBILITIES TO BE TAKEN BY USER

Article 10– Initial Payment

So that to be provided electricity service using installed PV systems, User have to pay total Amount of FCFA 45,000 the Initial Payment for each PV system.
The initial Payment is not refundable.

Article 11– Monthly Payment

11-1 Amount of the Monthly Payment

The "USER" shall pay FCFA 3,700 as "Monthly Payment". The timing of the payment is depending on the payment schedule that the "USER" selected. (Please put a mark on the selected payment schedule). ASER and PILOT PROJECT OPERATOR have the possibility to revise the amount of the monthly payment every year. Meanwhile any modification must be submitted to a written notification and with ASER approval.

User chooses his own payment schedule and will put a cross in the corresponding box

- Monthly payment
  User will pay FCFA 3700 on December 30, 2000. The same amount will be paid all months from this date
- Quarterly payment
- User will paid FCFA 11,100 for December 30, 2000. The same amount will be paid all three months from this date.
- Semi-annually payment
  User will pay FCFA 22,200 on December 30, 2000, and will pay the same amount in every half year from this date.

11-2 Payment Method:

The "monthly payment " will be collected by the "Pilot Project Operator". "User" should pay his monthly payment as a schedule above

Article 12– Notification of the repairing demand

The "USER" must notify the "PILOT PROJECT OPERATOR" of malfunction and/or breakdown of the PV system. "PILOT PROJECT OPERATOR" fixes the PV system based on the notification. If the "PILOT PROJECT OPERATOR" does not fix the system beyond the schedule period, "USER" will inform ASER.

Article 13– Exclusion

Any repairing and replacement of the components of PV system in the case of following reasons, necessary cost is charged "USER".

- An important handling mistake
- A case of theft
- An accident, an omission or an abnormal use
- A displacement of the PV system without approval of the "PILOT PROJECT OPERATOR"
- Any modification, accessories assembling or dismantling of the PV system

If the "USER" makes alternations or modifications that may cause damages to the PV system without approval of the "PILOT PROJECT OPERATOR", the latter shall remove the PV system at any time from the "USER" who won't be able to ask for any compensation or indemnity.

Article 14– Cancellation of the contract

The User can cancel the contract when the operator does not respect his obligations as stipulated in the contract or when the latter does not provide the services as stated in above article 6 and 7.

In that case, that cancellation can be done through a letter (with acknowledgment of receipt) after having submitted a written notice without any success.

Article 15– Case of force majeure

The operator is not responsible for delays or damages springing from the execution of this contract in force majeure.

Force majeure means any event that the operator cannot control, any unexpected event that prevents the fulfillment of the obligations of the operator

Article16– Insurance

The operator will subscribe insurance for professional risks relating to the execution of this project.

Article 17– Accessibility

The operator can have access at any time and without restriction to the User's house to work on the PV system.

This contract was made into four copies and signed by both parties

Date, ...

The PILOT PROJECT OPERATOR

The USER

Attachment-2
Contract between the project operator and local operator

CONTRAT BETWEEN THE OPERATOR OF THE PV RURAL ELECTRIFICATION PILOT PROJECT IN MAR ISLAND AND THE EXTERNAL TECHNICIAN

The following agreement is made between MATFORCE « Compagnie d'Applications Mécaniques », operator of the PV rural electrification pilot project in Mar island and Mr. KAMA, solar energy technician:

Article 1 :

Mr. Joseph KAMA is the external technician of the PV rural electrification pilot project in the villages of Mar Lothie, Mar Soulou and Mar Fafako and is in that sense the part-time technical representative of the operator, MATFORCE « Compagnie d'Applications Mécaniques" in those villages.

Article 2 :

The external technician will have to visit Mar island every fortnight. Every visit, the external technician will have to undertake the following tasks:

- Constant inspection of users so that to avoid their modifying the initial installation or using appliances that are not authorised by the project;
- Provision of permanent and continuous training on proper system maintenance to the local technician;
- Maintenance and preventive and periodical maintenance of the 95 systems installed in Mar island, with the assistance of the local technician;
- Removal of system from users who don't pay monthly electricity fees;
- Submit to MATFORCE a report on the operation of the project, the main constraints and prospects, etc…

Article 3 :

The external technician will have to use his own equipment for the execution of these tasks.

Article 4 :

The external technician will have to take charge of necessary onsite transportation costs.
ARTICLE 5 :

MATFORCE will pay a total monthly amount of 80 000 CFAF (eighty thousand cfa francs) to the external technician for the assignments mention in the article 2.

Article 6 :

The term of this contract is 4 month, to be renewed.

However, in case the external technician does not respect the clauses stipulated in article 2 MATFORCE will have the right to terminate the contract at any moment.

DAKAR, January 05, 2001

The external technician
KAMA

MATFORCE
Mamadou SOW
General Manager

Attachement-3
Contract between the project operator and local technician

CONTRACT BETWEEN THE OPERATOR OF THE PV RURAL ELECTRIFICATION PILOT PROJECT AND THE LOCAL TECHNICIAN

The following agreement is made between MATFORCE « Compagnie d'Applications Mécaniques », operator of the PV rural electrification pilot project in Mar island and Mr. Pape Adama Faye solar energy technician:

Article 1 :

Mr. Pape Adama Faye is the local technician of the PV rural electrification pilot project in the villages of Mar Lothie, Mar Soulou and Mar Fafako and is in that sense the permanent technical representative of the operator, MATFORCE « Compagnie d'Applications Mécaniques" in those villages.

Article 2 :

Assignments of the local technician:

- Constant inspection of users so that to avoid their modifying the initial installation or using appliances that are not authorised by the project;
- Provision of constant and continuous training of users in the idea of a proper usage and maintenance of the system;
- Maintenance and preventive and periodical maintenance of the 95 systems installed in Mar island, with the assistance of the external technician;
- Prompt diagnosis and servicing in case of system trouble;
- Removal of system from users who don't pay monthly electricity fees;
- Management of the stock of spare parts at the local level;
- Remittance of monthly invoices to each individual user;
- Assist the account dispatched by MATFORCE in the collection of monthly fees;

- Permanent contact with local populations so that to promote the sales of the equipment sold by MATFORCE ;
- Submit to MATFORCE a report on the operation of the project, on specific constraints and prospects, etc...

Article 3 :

The tools provided to the local technician will remain the property of ASER and will be handed over to the operator in case of cancellation of the contract between the local technician and the operator. Those tools include :

- 1 ampere meter pliers,
- 1 digital multimeter,
- 1 analogical multimeter,
- 1 side cutters,
- 1 crimping pliers,
- 1 pliers,
- 1 compass,
- 1 hammer,
- 1 stripping pliers,
- 1 metal brush,
- 4 screw drivers
- 1 thermometer.
- Additional protection glasses and gloves against acid will be provided to the local technician by the operator.

Article 4 :

The operator will provide the local technician with an appropriate transportation means (horse cart, bicycle or motorbike) for him to be more preferment in his job.

Article 5 :

For the execution of the assignments stipulated in article 2 MATFORCE shall pay a monthly salary amounting at 40 000 CFAF (forty thousands cfa) to the local technician.

Article 6 :

The term of the contract is 2 years renewable.

However, in case the local technician does not respect the clauses stipulated in article 2 MATFORCE will have the right to terminate the contract at any moment.

MAR LOTHIE, January 05, 2001
The local technician
Pape Adama Faye

MATFORCE
Mamadou SOW
General Manager

Attachment-4
Technical Specifications of SHS

TECHNICAL SPECIFICATIONS FOR PV SYSTEM PROCUREMENT AND DATA LOGGER

1. Objective

The technical specification described in this document were prepared for the pilot project initiated in relation with the Photovoltaic Rural Electrification Plan in Senegal funded by JICA. The objective is the supply and installation and maintenance of lighting photovoltaic equipments.

2. Location of the Project

The project site is located in the region of Fatick, the Department of Fimela, villages of Mar Lothie, Mar Soulou and Mar Fafaco.

3. Technical Specifications of Components

3.1 LOT 1:Supply and Installation of PV System

(1) General Descriptions

The photovoltaic systems are designed to provide lighting of the three villages. Three types of equipment shall be installed.

1) Type 1:

a) One module of minimum 55Wp

b) One Battery of minimum 100Ah

c) One Charge Controller of 10A

d) Four Fluorescent lamps of 8W

e) One radio outlet

2) Type 2:

a) One module of minimum 55Wp

b) One Battery of about 100Ah

c) One Charge Controller of 10A

d) Three Fluorescent lamps of 8W

e) One TV outlet

f) One radio outlet

3) Type 3:

a) One module of minimum 55Wp

b) One Battery of minimum 100Ah

c) One Charge Controller of 10A

d) Two Fluorescent lamps of 8W

e) Four LED lamps of 0.7W

f) One TV outlet

g) One radio outlet

3.2 Photovoltaic Modules

1) The module should be made of mono-crystalline or poly-crystalline siliceous cells

2) The peak power shall be minimum 55Wp

3) Peak power must not be inferior to 90% of the nominal peak power.

4) The maximum output power at 60°C of cells junction temperature shall be higher than 85% of the nominal power

5) The voltage at the Maximum Power Point of the module at 60°C of cells junction temperature shall be higher than 16V

6) The module must be fitted with waterproof cases of IP54 standard at the connection points. The cases shall be fitted with oakum-press allowing the cables to pass through. The polarity of the terminals must be clearly indicated inside the cases.

7) Each module must be fitted with by-pass diode.

8) Each photovoltaic module must have a plate of notification at least the following prescriptions:
   a) name, trademark or symbol of maker
   b) number or reference of the model
   c) peak power, short-circuit current (A), open circuit voltage (V) for STC conditions
   d) Serial number
   e) manufacturing country
9) The proposed modules shall be tested by an authorized laboratory conforming to the EUR 101 and 502 (501) specifications published in the EUR 7078 and EUR 9414 reports or conforming to the corresponding IEC specifications. A ISPRA certification (or equivalent) showing that the tests are successfully achieved shall be attached to the document.
10) Incomprehensible things of these prescriptions, refer to the IEC1215, IEC1277, IEC1194, IEC904 standards

3.3 Support Structure

The material of the support for the module should last 10 years without any serious erosion. The following material is acceptable:

1) stainless steel
2) reinforced steel
3) anodized aluminum

A protection system against robbery must be taken into account either in the design of the type of fixation of the support (using bolts or anti-theft nuts) or in the design of the support itself.

3.4 Storage Batteries

The lead-acid monoblock batteries shall follow to characteristics shown below.

1) Nominal voltage: 12V

2) Nominal capacity: minimum 100Ah
3) A Lead-antimony flat or tubular plate and stationary liquid electrolyte batteries well adapted to PV systems
4) The thickness of each plate must be more than 2 mm
5) Self-discharge rate at 25°C must not exceed 6% of the nominal capacity in one month.
6) Tub of a battery must be thick and resistant enough to be transported and forwarded without any damage.
7) The level of the electrolyte of the battery must be easily verifiable by the user: marking of minimum and maximum on translucent tubs
8) The density of the electrolyte must not exceed 1.25 kg/l at 20°C
9) Gel electrolyte batteries are excluded.
10) The volume of electrolyte must be higher than 1.15 liters per 100Ah nominal capacity and per cell.
11) Each battery must have a notice plate of at least following information:
    a) name, monogram or symbol of maker
    b) number or reference of the model
    c) capacity (Ah) indicating the discharge system
    d) manufacturing date
12) The battery must have a permanent indication of polarity on each terminal.
13) Protection cover for the battery lead connections shall be delivered with the batteries.
14) The battery shall be dry-charged and delivered with necessary electrolyte. The volume of electrolyte must be more than 1.15 liters per 100Ah of the nominal capacity C20 and per cell.
15) The lead-calcium alloy as well as car batteries are excluded.
16) The batteries shall be put in a tub fitted with a lock and must have airing holes and endure erosion, acid spray and chocks. This tub shall be designed so as to allow easy access to the battery lead connections and control of electrolyte level and good cooling system.

17) Incomprehensible things of these prescriptions, refer to the IEC896, IEC1056 and NFC58510 standards.

3.5 Charge Controller

The function of the charge controller is to protect the batteries against surcharge and excessive discharge. The characteristics of the charge controllers shall be the following:

1) Voltage: 12V
2) Module current: 8A minimum, 10A maximum
3) Operation current: 8A minimum, 10A maximum
4) The charge controller must have Pulse Wave Modulation
5) The disconnection and reconnection voltages of the PV module and the loads of the charge controller must be fixed depending on the actual environment conditions and type of battery. The reference values for 20°C and 1.24 kg/L electrolyte density are the following:
   a) high voltage of disconnection =13.8v
   b) low voltage of disconnection =11.4v
   c) reconnection voltage = 12.6v
6) The charge controller must be fitted with a temperature compensation of high voltage of disconnection; the correcting factor to be applied is –4 or –5 mV/°C per battery cell (that is –24 or –30 mV/°C for a one piece 12V battery).
7) Self-consumption of the charge controller must not exceed 10mA whatever the operation condition.
8) The charge controller must be protected against the following accidents:
   a) inversion of the polarities when connecting battery or module to the charge controller
   b) short-circuits during operation: for this type of protection a fuse or equivalent must be used, which the user can easily replace without opening the case of the charge controller
   c) over voltage in the module input or in the load output (thunderbolt)

d) any use without battery, PV modules being connected to the charge controller.

9) The charge controller must be protected against current input 25% higher than the short-circuit current of the PV module and a load output current 25% higher than the maximal nominal current of the PV system (all appliances operating). for a period specified by the supplier. The charge controller must protect the module against nighttime discharge of the battery.

10) The charge controller must not create interferences with the radio waves whatever the operation conditions

11) The case of a charge controller must have the following characteristics:

a) minimum IP54 protection

b) fitted with a wall fixation system

12) The printed circuit of the charge controller shall be attached mechanically to the case immovably with clips or screws.

13) The charge controller must have a LED lamp showing the battery state of charge or an equivalent indication system providing users the following minimum information:

a) ready for use, charge level is sufficient

b) disconnected, very low battery charge

14) The charge controller shall be fitted with a warning system indicating that battery discharged completely, if possible

15) Each charge controller must have a plate indicating at least following information:

a) name, monogram or symbol of maker

b) number or reference of the model

c) nominal voltage (V)

d) nominal module input and usage output current (A)

16) The charge controller must be marked a permanent indication of polarity on each electric connection terminal.

17) The terminals must be out of the reach of users.

3.6 Lamps

Lamps are defined as the set including the bulb, the inverter and the case holding both components. Two types of lamp have been proposed:

1) Fluorescent lamps with electronic ballast and straight tube
2) LED lamp

(1) Fluorescent Lamp with Ballast Inverter

The fluorescent lamps must have the following characteristics:

1) nominal voltage: 12V
2) nominal power: 8W
3) frequency of the ballast: minimum 16kHz
4) The ballast must ensure normal operation of the lamp at voltage between -15% and +25% of the normal voltage.
5) The luminous efficiency of the ballast-lamp set must be minimum 40 lumens per watt.
6) The efficiency of the ballast must be minimum 80%.
7) The characteristics of the ballast current must satisfy the following conditions:
   a) The shape of the wave must be symmetrical.
   b) The peak factor must not exceed 1.7 times of the nominal operation current of the lamp at voltage between 11V to 12.5V.
8) The ballast must be properly isolated
9) The ballast must be protected against destruction in the case of;
   a) removal of the tube from its support while the lamp is under work or if the switch is turn on while there is no tube
   b) the ignition of the lamp doesn't work
   c) the polarities of the supplying voltage is inversed
   d) the terminals of the ballast are short-circuited

10) The ballast must not create interferences on radio waves whatever the conditions of usage

11) The lamp must be fitted with a wall fixation system

12) The electric connection point of the ballast;

   a) must allow a strong connection of the supply cable without causing any damage

   b) must have a size sufficient enough to allow connection of cable

   c) must have a permanent marking indicating of polarity of each input cable, which will be up to 2.5 mm^2

13) Since each system will provide one entrance lamp, the lamp should have a protection system against water infiltration.

14) If the lamp is fitted with a protection cover, this cover must be;

   a) insect proof

   b) easy to remove when the users need to change the bulb

15) The external lamps must follow IP 54 protection standard. An alternative solution to use the type of internal lamps with a protection system satisfying to the same tightness requirements is possible.

16) For each lamp, it must be possible to change separately the tube and the converter using spare parts without replacing the whole lamp set.

(2) LED Lamp

LED lamp shall have the following characteristics:

1)	Type	:	LED lamp
2)	Nominal voltage	:	12V
3)	Nominal power	:	0.7W
4)	Nominal current	:	60mA
5)	Luminous efficiency	:	22 lumen/W
6)	Working temperture	:	+10 degC to +50 degC
7)	Outlet	:	E27

For incomprehensible things of these prescriptions, refer to IEC458, IEC921, IEC924 and IEC925 standards relative to the characteristics and performances of transistorized ballasts.

3.7 TV Outlet

1) The TV outlets are designed for 12V appliances (radio, television, etc).
2) The television outlets shall be fitted with one indicator making the difference with standard 220V outlets. There must be a IP 32 protection standard at minimum and a permanent marking indicating + and – polarity.

3.8 Radio Outlet

1) The radio outlet shall be connected to a DC/DC converter to adapt 6 and 9v voltage.
2) The DC/DC converter must meet the following technical standards:
   a) Nominal input voltage : 12V
   b) Nominal output voltage : 6V or 9V
   c) Nominal current : 2A
3) The supplied voltage must correspond to the output voltage of the charge controller.
4) The converter must be a type of electronic conversion.
5) The case of the converter must have a IP 32 minimum protection standard
6) The case of the converter must be fitted with a wall fixation or hanging system
7) The switch of the converter must be clearly indicated to avoid confusion

3.9 Cables

(1) Wiring of the PV Module

1) The cable used between module to charge controller and between charge controller to battery connection must be adapted to external usage, following to the IEC60811 international standards.

2) H07 RNF type or equivalent standards

3) The section of the cable shall be 4 mm^2.

4) Maximum length: 10 m/system

(2) Connection Accessories

The fixations of the module connection cables shall be made following to "Legrand" components as below (or equivalent characteristics):

1) Legrand strings, Clipsotube type ref 319 03 or 06 or equivalent for the cables collected in the tubes,

2) For apparent cables the following fixation mode shall be used:

- with fasteners ref 31955 for masonry support and Colson polyamide UV resistant clamp fastener or equivalent.

(3) Internal Wiring of Buildings

1) Cables

The cables to be used for internal wiring should be available in the Senegalese market:

a) A03 VVF 2.5 types of wires or equivalent

b) 2.5 mm^2 section

c) Total inclusive lengths: 80 m/system

2) Switches

a) Switches shall be available in the Senegalese domestic market.

b) The following characteristics shall be respected:

- The level of protection shall be IP 43 for interior switches, and IP 55 for outside the buildings.
- Bipolar switches.
- ON/OFF position of the switch shall be identified clearly and shall correspond to the following directions:

+ ON: turning on, the switch moving from up to down
+ OFF: turning off, the switch moving from down to up.

3) Connection Boxes

The protection shall be IP 55.

Sufficient number of clips shall be prepared for wiring, that allows to carry out the installation following to the installation specifications of this book.

3.10 Technical Specifications of Installation

The complete installation of the systems shall be made carefully. The visual aesthetic of all installations must be respected:

1) Verticality of wires and of components fixed on the walls (outlets, switches, charge controller, clips, etc.).
2) Balance and arrangement of clips (every 25 cm)
3) Recovery of walls after making holes

(1) PV Module

1) Installation of PV Module

a) The supports of the PV modules shall be static.
b) The inclination of the modules in comparison with the horizontal position must be 15° with a margin of + or – 5°
c) The modules must be oriented towards the true South with a margin of + or – 10°
d) At each site, the place where the modules are installed must be chosen so that there shall not be any shade on them between 90 minutes after sunrise and 90 minutes before sunset.

2) Fixation of PV modules

a) In case of installation on a roof, a minimal distance of 0.1m must be left between the back of the modules and the roof. The module support must be

fixed to the body of the frame or of the building, but not to the roof itself. A mounting system can be planned if necessary.

b) In case of wall mounting, the module support must be fixed at minimum 2 points. This system must pierce the wall (bolts and tightening plate).

c) In case of ground mounting, the module support must be installed in a space out of the passages. The modules and wires must be set out of the children's reach. The buried wires must set into a conduit(PVC or PE pipe).

d) The feet of the module support must be bolted or embedded in concrete on the ground. The minimal dimension of these reinforced concrete shall be 300mm x 300mm x 300mm.

e) A unique reinforced concrete stone slab with a section of 250mm x 250mm chained in the length is another acceptable option.

f) Whatever the case, the concrete shall be weighed at minimum 350kg. The lowest level of the module from the ground shall be at least 1m.

g) The components used for the module fixation to the support (nuts, washers, bolts) must be stainless materials.

h) The combination of the various materials (including bolts) on one same system is accepted provided that the technical arrangements preventing the forming of an electrochemical pile among these materials are clearly defined.

3) Wiring of the Module

a) All connection wires for the module shall be H07RNF flexible type.

b) The wires between the modules shall be systematically collected in the protection pipes set up under the modules, which are resistant to bad weather.

c) The wire between the module and the building shall be mechanically protected by pipe or a tube made for that purpose and buried (if the module is fixed on the ground).

d) The acceptable voltage drops shall be;

- module-charge controller connection : maximum 2%
- charge controller- battery connection : maximum 1%

- charge controller- lamp connection (the farthest lamp), under all lamps lit :5%.

(2) Charge Controller

The charge controller shall be set under shelter at 1.5 m from the ground, on a place as close as possible to the battery.

(3) Battery

1) The battery shall be set in a well- ventilated room where people do not spend the day (office, bedrooms, etc.) and shall be out of children's reach.
2) The wires for battery connections shall be;
   - either terminal covered with appropriate material
   - or covered in appropriate battery lead connections.
3) Soldering shall be strictly forbidden.
4) The battery lead connections shall be protected by stoppers filled with silicone, which shall protect them against conversion by users.
5) Preliminary charge shall be done following to the procedure as shown in attached sheet.

(4) Interior Wiring of Buildings

1) The wires shall be installed on surface of the walls or the structures of the frames of the roof.
2) The wires clips shall be put every 25 cm. Cables shall be set perfectly horizontally or vertically. At the points where the directions have to change, the curve shall exceed 6 times its exterior diameter.
3) The distance between components like switches, outlets, connection boxes, a charge controller and the closest clips leading cables to those components shall be equal to 5cm.
4) All connections shall be made with connection barrettes inside the appliances. Every terminal shall be hidden.

5) The connections or shunts by splices are forbidden. All connections shall be set in connection boxes or in electric appliances.

6) The end of cable in appliances shall be done through a pressing terminal whose size shall be adapted to the sections of the cables.

7) The cable goes to components located outside building like switches, outlets and lamps, shall be made in water proof. The entrance of the cable shall be made from lower horizontal level.

8) In order to make repairing easier, the cable color shall be standardized for all installations, with a standard color code for the positive and the negative poles.

(5) Switches

Switches shall be installed for each lamp. For double doors, the switch shall be set at the left of the entrance, at 20 cm from the door when the door is flapped against the wall.

(6) Lamps

Lamp bodies shall be set on the walls and their position must be at 1.80 m in comparison with the vertical from the ground except for case of contrary specifications,. Therefore, all fluorescent lamp bodies installed in the same building shall be set at the same height generally except for case of contrary specifications.

(7) Connection Boxes

Connection boxes shall be solidly fixed to the walls. They shall be high enough to be out-of- reach of users.

(8) Outlets

Outlets shall be installed at 25 cm from the ground and shall be fitted with a "disabuser" which allows making the difference from 220V standard outlets.

4. LOT2: DATALOGGER

(1) Objective

LOT2 aims at the supply of 3 sets of datalogger as well as accessories indispensable to the data collection of 3 PV systems planned in LOT1.

(2) Measurement Objects

The following measurements shall be done:

1) Irradiation: 0-2,000 W/m²
2) Ambient temperature: 0-50°c
3) PV module voltage: 0-25V
4) PV module electricity: 0- 10 A
5) Battery voltage: 0-25 V
6) Electricity consumption: 0- 10 A

(3) *Technical Specification of Datalogger*

The datalogger shall have the following characteristics

1) Number of analogical input: 6 to 8
2) Margin of input voltage: + or – 2,500m/V
3) Margin of common mode: + or – 5 V
4) Resolution: 0.33 μ V
5) Vivid memory protected by one internal lithium dry battery
6) Protection against transient
7) Rechargeable battery
8) Data shall be collected directly on the field by computer or telecommunication
9) Fitted with RS232 interface for a direct connection by notebook computer
10) Support software for the development of programs, data collection and analysis.
11) These data shall be collected as ASCII files and be transferred in Excel or Access software.
12) The datalogger shall be delivered with protection boxes.

(4) Accessories and Sensors

Each unit shall be delivered with compatible accessories and sensors. These accessories and sensors shall have the following characteristics:

1) 2 pieces of shunt for electricity measurement: 10 A/60mV
2) 2 pieces of voltage divider for voltage measurement
a) Input voltage: 25 V
b) Output voltage: 2,500mv
3) One temperature sensor for the measurement of ambient temperature.
4) the installation of a pyranometer for the measure of the irradiation

5. Pre-charging of the Batteries

The pre-charging of batteries must be done according to the following procedure.

(1) Preparation of Battery

1) Measure the electrolyte density
2) Fill the batteries up to the low level marking
3) At least two hours wait after filling up electrolyte
4) Adjust the electrolyte at its nominal level, if necessary
5) Measure battery voltage
6) Measure density of electrolyte
7) Measure temperature of electrolyte
8) I f the temperature of the electrolyte is higher than 55°C or if its density drops down to 1.20 kg/l, postpone pre-charging until the following day.

(2) Charging

The charging source shall not be connected to charge control apparatus to avoid early stop of charging. The battery should be connected directly to the module or to a generator.

The battery shall be charged as follows:

1) Constant current should be used in the first stage till the gassing, if possible
2) After this stage, the value of the current will be reduced to nearly 2.5A
3) In case the above procedure cannot be respected, the battery will be charged during 24 hours
4) Measure voltage, and electrolyte density every 30 minutes after gassing starts
5) It is considered that the battery is full charged;

a) During constant current charging, when voltage and electrolyte density do not show any variations higher than the accuracy of the measuring instrument for duration of two hours and considering the variations of temperature of the electrolyte;

b) During constant voltage charging, when the recorded current and electrolyte density don't show any variations higher than the accuracy of the measuring instrument for duration of 2 hours, considering the electrolyte temperature variations, except for when maker provides a specifics.

6) The measured peaks shall be recorded in an appropriate form. The gap between the measured peaks should not exceed 0,005V for the voltage and 0,01kg/l for the density by each cell.
7) At the end of the charging process, the level of electrolyte must be adjusted at the maximum mark of each cell.

Attachment-5
Plan Sommaire

EXAMPLE OF PV SYSTEM LAY OUT IN A HOUSEHOLD

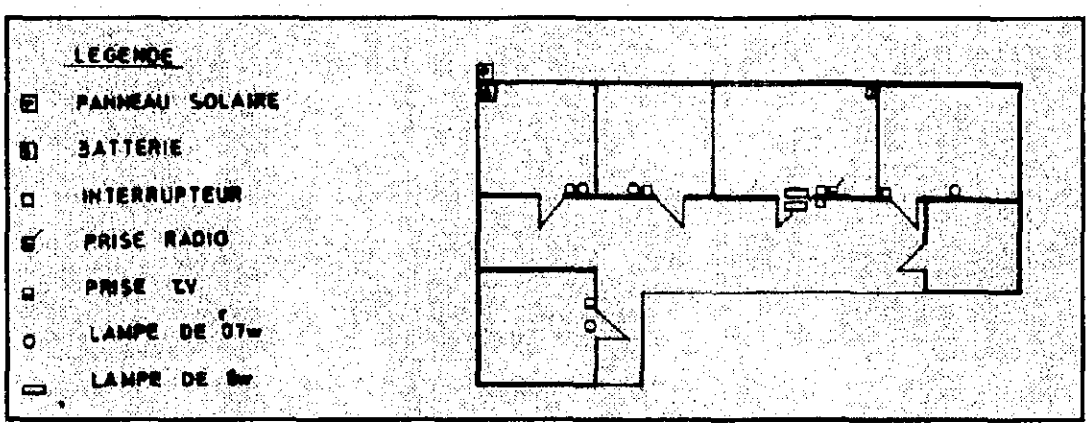

Figure 5-1 One PV system in a household

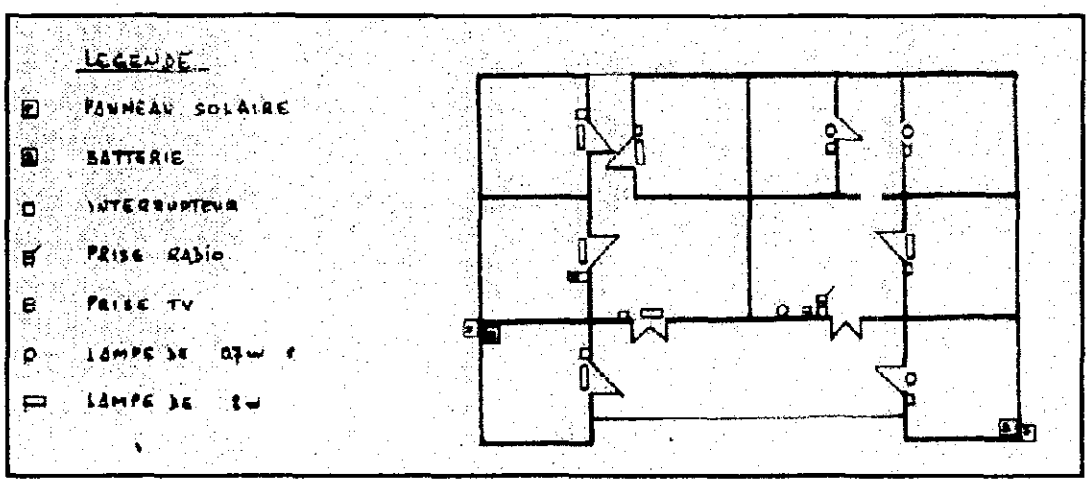

Figure 5-2 Two PV systems in a household

Attachment-6
Acceptance Check List for installation

Form A: Free Writing

ACCEPTNCE CHECK LIST

Date			**TIME**	:	:		
Mar Lothie		**Mar Soulou**		**Mar Fafaco**			
OPTION 1		**OPTION 2**		**OPTION 3**			
Customer							
ITEM		***observations***					
1	PV						
2	Support structure						
3	BAT						
4	C/C						
5	LAMPS						
6	SOCKET						
7	SWITCH						
8	CABLE						
		LENGTH OF CABLE	PV - C/C: max 5m				
			C/C - BAT: max 2m				
			C/C - Load: max 20m				
9	REMARKS						

Form B: Check Sheet Type

ACCEPTANCE CHECK LIST

Date			**TIME**	: to :			
Mar Lothie		**Mar Soulou**		**Mar Fafaco**			
Customer							
Tester's signature			**Supplier's signature**				

	ITEM	POINT	SPECIFICATIONS	r.
1	PV	Inclination	15° ±5°	
		Azimuth	0° ±10°	
		Shadow	no shadow within azimuth ±60° to 120°	
			no shadow over 20° of elevation	
2	Support structure	Installation type	ROOF / WALL / GROUND	
		POINT	**SPECIFICATIONS**	r
		Module height	Out of child's reach	
		Material of fitting device (bolts, nuts, washers)	Stainless or galvanic corrosion proof	
		? if roof mount — Distance between PV module and the roof	Minimum 0.1 m	
		? if ground mount — Ground anchor	300mm x 300mm x 300mm	
		? if ground mount — Lowest point	Minimum 1 m above G.L.	
3	BAT	Location	Well - ventilated	
			Out of child's reach	
		Terminal connection	Cover with appropriate terminal cap	
		Electrolyte level	Between upper and lower indication	
		Electrolyte density: 1.24 kg/l ± 0.01		
		+Cell 1 / Cell2 / Cell3 / Cell4 / Cell5 / Cell6-		
4	C/C	Location	1.5m from ground as close as possible to the battery	
5	LAMPS	Height from the G.L.	At the same height in the same building	
6	SOCKET	Height from the G.L.	25 cm from the ground	
7	SWITCH	Location of switch	Left on the entrance	
8	CABLE	Cable protection when piercing the wall	pipe	
		Layout of cable	Outward on the walls	
		Pegging interval	25cm	
		Distance of first peg from objects	5cm	
		Connection method of wire - wire	Pressing clips	
		Branching method	Connection box	
		End of cable	Pressing clips	
		Polarity distinction	Colored	
		Verticality/ horizontality of wiring		
		Voltage drop	PV - C/C: max 2%	
			C/C - BAT: max 1%	
			C/C - Load: max 5%	
9	User's Guide	Location	Next to the regulator	
		Form	Picture	
		Guideline contents	Technical, security	

Attachment-7
Example of System Working Condition (Interim Data Collection)

INTERIM DATA COLLECTION

1. Installation of Isolation Amplifier

Because of fluctuation with the signal from shunt resistances for current measurement, accurate data couldn't be obtained at the time the datalogger was installed. It became obvious through the test in CERER that the data would be obtained well with isolating the signal from the shunt resistance (Through the kindness of the local expert, the study team was able to test how the datalogger work with putting an isolation amplifier into the system). An isolation amplifier was prepared in Japan and brought to the site. In order to cut the noise, the isolation amplifier was installed into the datalogger system. Although it is said that isolating all signals to the datalogger is preferable to be absolutely sure for accurate data acquisition, it was not necessary to isolate the signal of voltage this time.

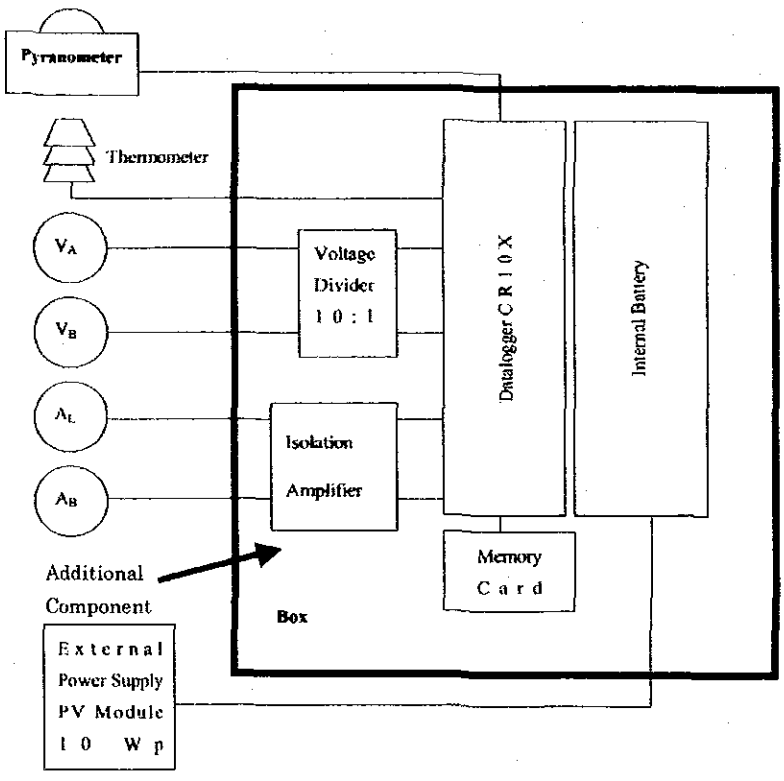

Figure 7.1 Block Diagram of Datalogger System

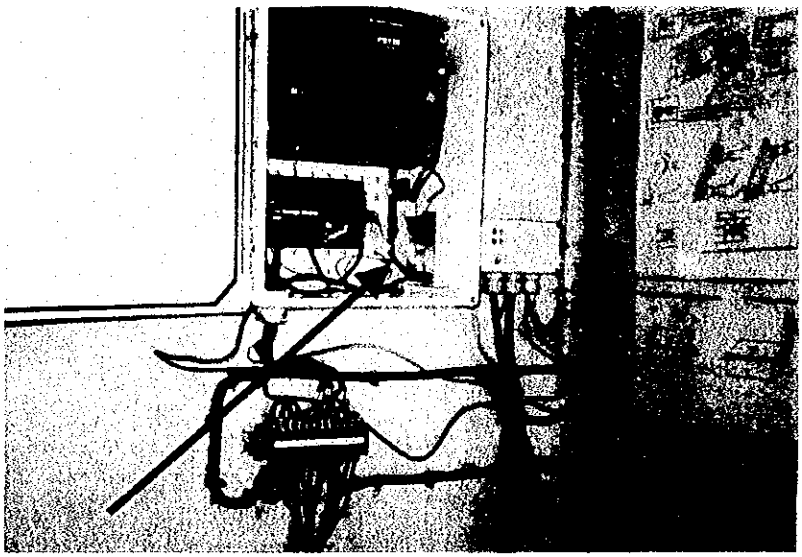

Figure 7.2 Isolation Amplifier Apearatus

2. Data Collection

Thorough the kindness to the local expert, a set of isolation amplifier had been borrowed and installed at one site in Mar Fafaco. Here is shown the data acquired at the site over 3 months since the installation.

(1) Computation of Generation and Consumption

Figure 7.1 shows the point of capturing basic data. The data shown in Table 7.1 was calculated with those basic data.

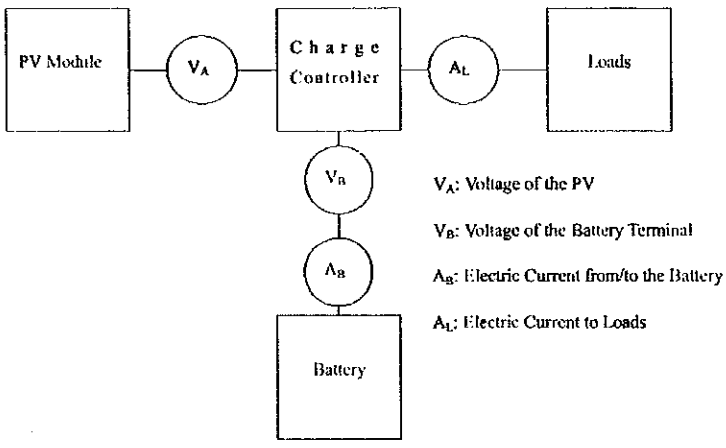

Figure 7.3 Data Capturing Point

Watt-hours are calculated by multiplying the current and voltage and cumulating the result. VB was applied on calculating watt-hours based on the assumption that there is no voltage drop between the capturing points. Current from PV is calculated with AL and AB (See figure 7.4). When sign of AB is positive, the current goes to the battery (charge). When it is negative, the current comes from battery (discharge).

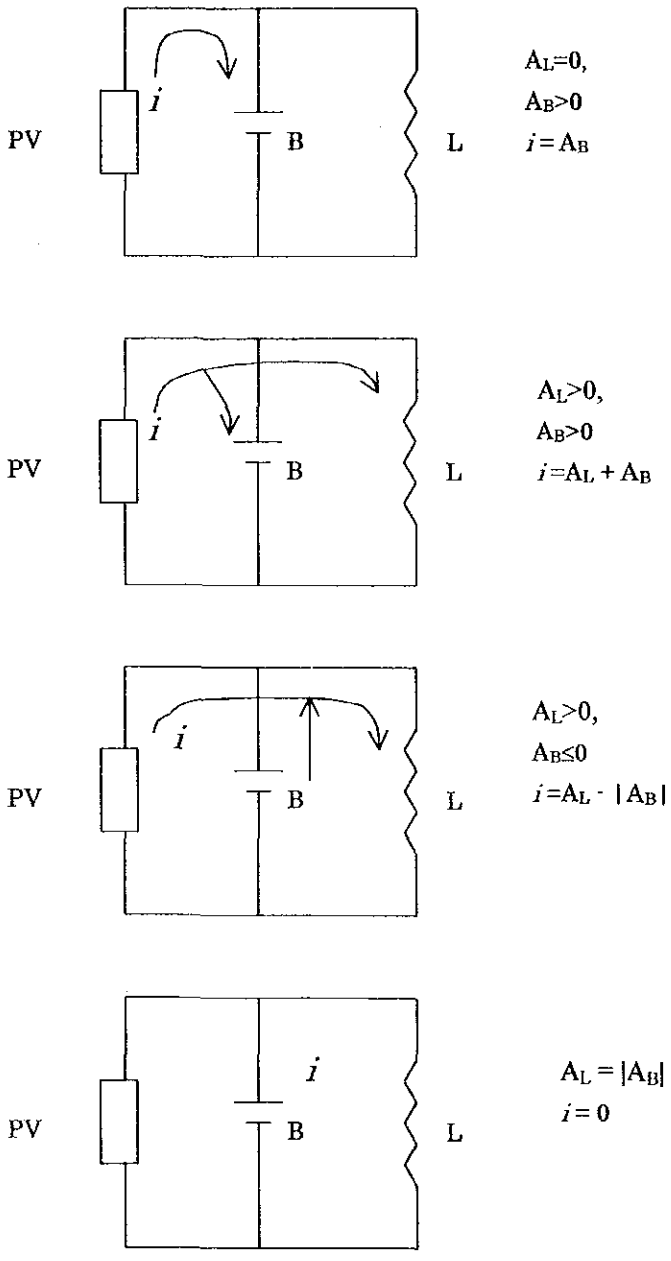

Figure 7.4 Determination of PV Current

Table 7.1 shows cumulative power generation and consumption by users. Since the system was put into service since November 28, 2000, here the value in November 2000 was omitted. The values in March are cumulative from 1st to 12th of the month.

Table 7.1-1 Generation and Consumption [kWh] in Term

	Irradiation [kWh/m²/term]	PV Generation [kWh/term]	Battery Charge [kWh/term]	Battery Discharge [kWh/term]	Consumption [kWh/term]
Dec-00	176.84	2.583	2.574	1.426	1.255
Jan-01	195.77	2.249	2.219	1.606	1.489
Feb-01	154.23	2.222	2.195	1.489	1.414
Mar-01 (1st–12th)	83.15	1.269	1.240	0.956	0.942
Total	609.99	8.32	8.23	5.48	5.10

Table7.1-2 Generation and Consumption [Ah] in Term

	Irradiation [kWh/m²/term]	PV Generation [Ah/term]	Battery Charge [Ah/term]	Battery Discharge [Ah/term]	Consumption [Ah/term]
Dec-00	176.84	185.88	185.70	114.43	100.79
Jan-01	195.77	162.37	160.66	129.03	119.57
Feb-01	154.23	161.73	160.20	119.45	113.38
Mar-01 (1st–12th)	83.15	92.37	90.64	76.82	75.58
Total	609.99	602.35	597.20	439.73	409.31

(2) Verification of Generation

The expected energy output of the system is given by the equation below.

$$E_O = P_M\left(\frac{R_A}{G_S}\right)K$$

Where,

E_O: Expected Energy Output [Wh/day]
P_M: Nominal Power of PV Module [Wp]
R_A: Irradiation [kWh/m²/day]
G_S: Irradiance at Standard Testing Condition [1000 W/m²]

K: System Loss Factor
The power output of the system was estimated about 180 Wh/day (what about 5.4 kWh/month) with the assumption below.

P_M: 55 [Wp], RA:5 [kWh/m^2/day], K: 0.65

Table 7.2 Actual Consumption and Expected Energy Output

	Irradiation [kWh/m^2/term]	(A) Actual Consumption [kWh/term]	(B) Expected Energy Output [kWh/term]	(A)/(B)
Dec-00	176.84	1.255	6.32	0.198
Jan-01	195.77	1.489	7.00	0.213
Feb-01	154.23	1.414	5.51	0.256
Mar-01 (1st–12th)	83.15	0.942	2.97	0.317

Expected energy output calculated with actual irradiation and estimated system loss factor is shown in Table 7.2. Actual consumption is 20 to 30 % of the expected energy output. Because of this small consumption of energy by users, the battery did not run so much as to be charged with the maximum performance of the PV module. The reason of this small consumption is considered that the user does not use loads other than lamps.

Table 7.3 Actual Daily Average Irradiation and Power Generation of the PV module

	Irradiation [kWh/m^2/day]	PV Generation [Wh/day]
Dec-00	5.705	83.31
Jan-01	6.315	72.54
Feb-01	5.508	79.36
Mar-01 (1st–12th)	6.929	105.75

Table 7.3 shows actual irradiation and power generation of the PV module in average of each month. This table shows that the PV module didn't work in its full performance while the irradiation was higher than expected.

(3) Monitoring of Battery Charge and Discharge

Table 7.4 Battery Circuit Efficiency

	(A) PV Generation [kWh/term]	(B) Battery Charge [kWh/term]	(C) Battery Discharge [kWh/term]	(C)/(B) Battery Circuit Energy Storing Efficiency	(C)/(A) Battery Circuit Correction Factor
Dec-00	2.583	2.574	1.426	0.554	0.552
Jan-01	2.249	2.219	1.606	0.724	0.714
Feb-01	2.222	2.195	1.489	0.678	0.670
Mar-01 (1st–12th)	1.269	1.240	0.956	0.771	0.754

There are two factors for Monitoring of Battery Charge and Discharge. Each factor is defined as follows.

$$\eta \equiv \frac{E_{BO}}{E_{BI}}$$

$$K_B \equiv \frac{E_{BO}}{E_A}$$

Monitoring these factor allows to assess the efficiency of battery charge and discharge. When the factor decreases significantly, the battery may be going to die. However, it has to be totally determined with other parameters like battery terminal voltage, electrolyte density after equalization charge, rapid decrease of electrolyte level (high amount of water filled), if the battery has had used up.

(4) Consumption by Users

Figure 7.5 shows daily irradiation and daily cumulative energy generated by the PV module, charged to the battery, discharged from the battery and daily cumulative energy consumed by users since the first operation. For the day missing data observed because of maintenance of datalogger, the cumulative data was omitted. For the first few days, generated power by PV module and charged energy to the battery decreased day by day, despite of small energy discharge of the battery and energy consumption by the user. This is to compensate a shortage of initial charge of the battery.

After the battery was charged sufficiently, PV energy generation moved along with the fluctuation of energy consumption.

In order to see the energy consumption tendency of the user, monthly average of consumption at each sampling time (every 20 minutes) is shown in Fig 7.6. The peak current of consumption increased every month up from November to March. Moreover, the time range of consuming energy got broader and broader as time passes.

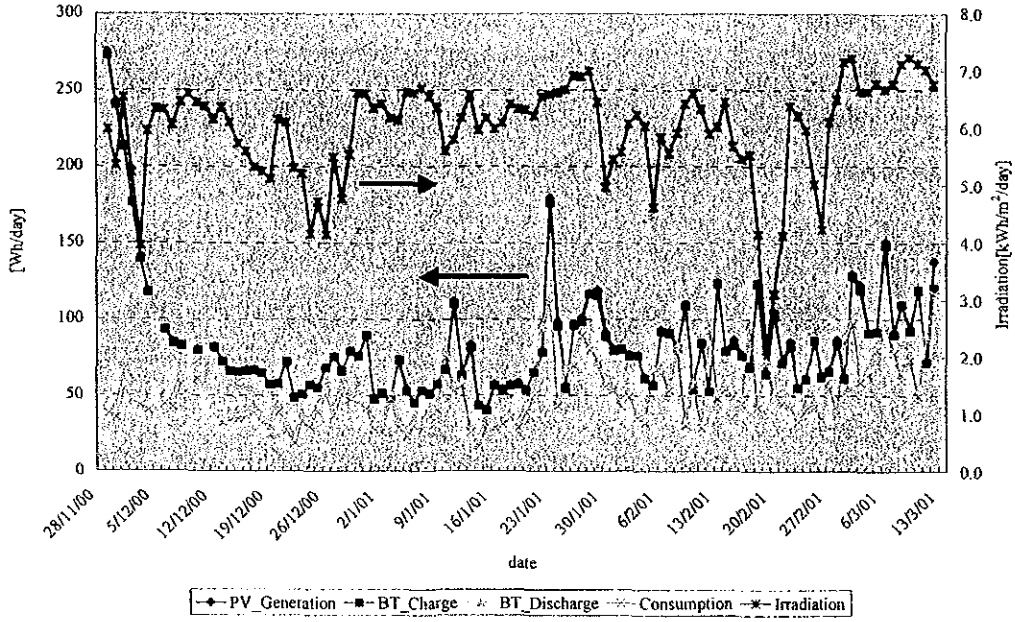

Figure 7.5 Daily Trend of Energy and Irradiation

The loads of the user are two 8W of fluorescent lamps and four 0.7W of LED lamps (Option-3). In addition, there are two outlets for TV and radio. One fluorescent lamp can be assumed to consume about 0.7 – 0.9 Amps, taking into consideration of the efficiency of its ballast inverter. As for a LED lamp, it would be 0.06 Amps. Considering over this current consumption of each lamp, the user seems to have used only one fluorescent lamp for 3 hours from around 7 to 10 pm in the evening on November and December in average. Since January, the user seems to have started using 2 fluorescent lamps in the same time slot of the day. The reason why the current in January and February is around 1.2 Amps, which does not correspond to the total value of 2 fluorescent lamps consumption, is considered that there were both days 2 lamps were used and days only one lamp was used. The user seems to have started using 2 fluorescent lamps in the peak time range.

All through the period the data gathered, the user seems to have used one LED lamp all through the night.

There can be seen another peak in the early morning on November and March. This phenomenon may be because of religious reason. About this reason, further socio-economic survey is expected.

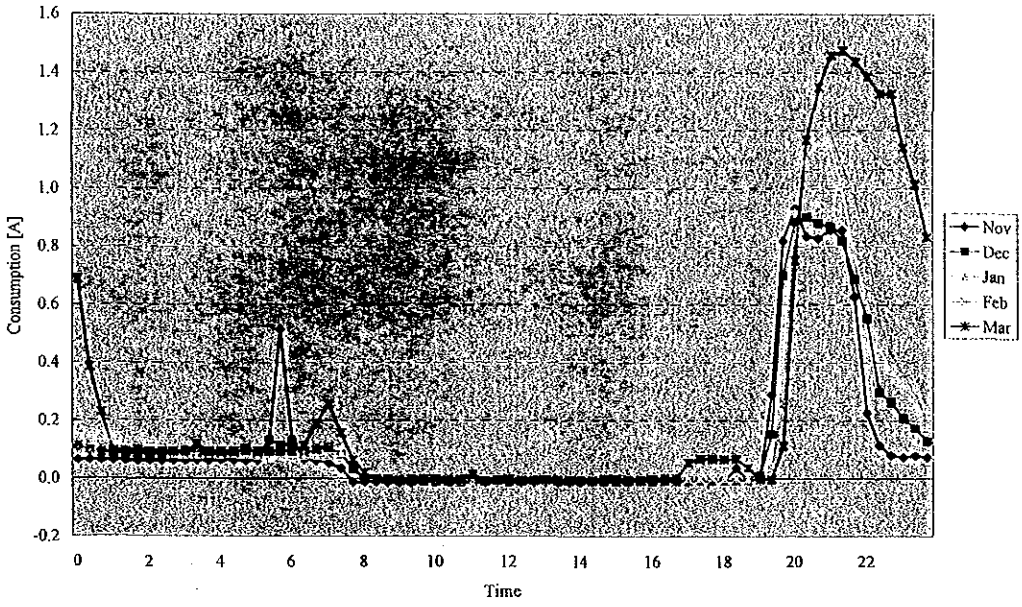

Figure 7.6 Monthly Average of Every 20 Minutes Trend of Consumption

(5) Battery Condition

The trend of current flow into/from the battery is shown in Fig. 7.7 and the battery voltage trend is in Fig 7.8. These trends are monthly average of each sampling time (every 20 minutes). The battery discharge current went higher and the discharging time spread out wider; consequently, the user got familiar with the system as mentioned above. However, the current charged to the battery stopped around noon even in March when the user started using more energy. This means the battery was charged fully by around noon.
The threshold voltage of the charge controller is shown in table 7.5.

Table 7.5 Threshold Voltage of the Controller

	SOC	Voltage (Reference)
Load Disconnection	<30 [%]	11.1 [V]
Load Reconnection	>50 [%]	12.6 [V]
Final Voltage of Charge Normal		13.7 [V]
Cycle		14.4 [V]
Equalization		14.7 [V]
Temperature Compensation		-4 mV/K/cell

Source: SLR1010 Installation and Operation Instruction Manual,Uhlmann Solarelectronic GmbH

All through this monitoring period, the battery voltage has never fallen down lower than the load disconnection voltage. The lowest battery voltage observed was 12.33 [V] in fact.

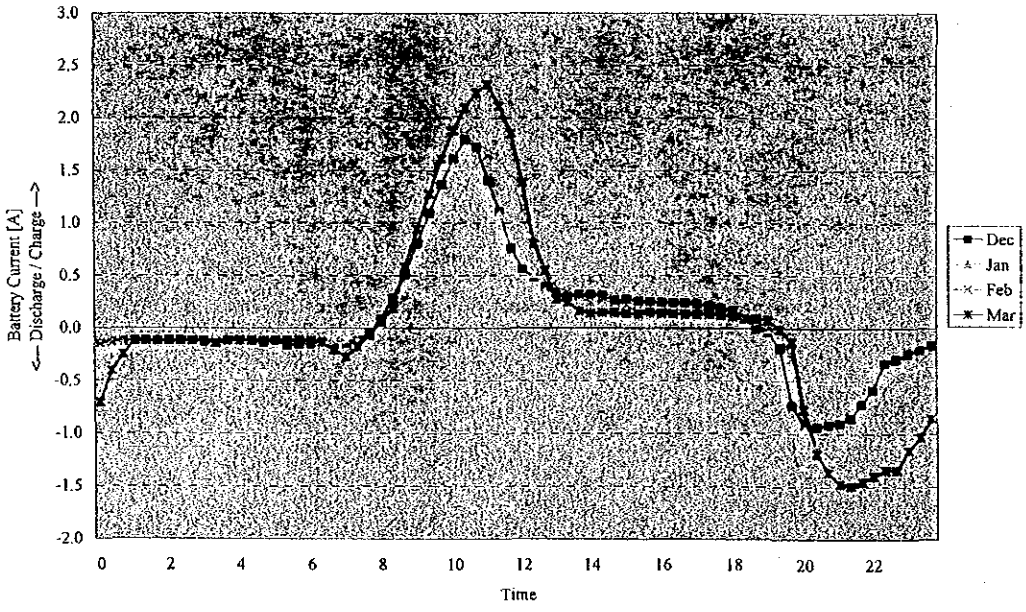

Figure 7.7 Monthly Average of Every 20 Minutes Trend of Charge/Discharge of the Battery

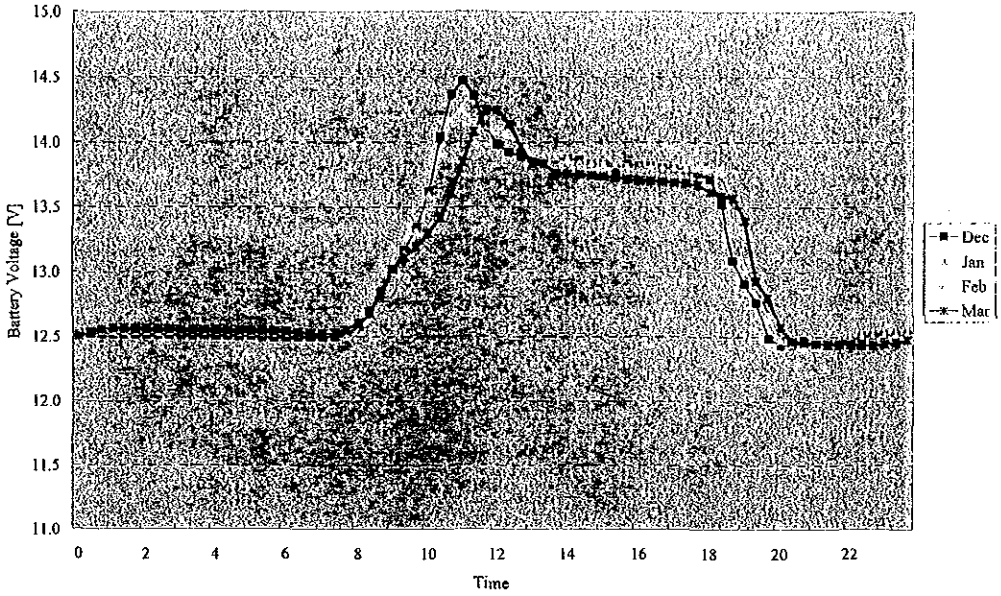

Figure 7.8 Monthly Average of Hourly Trend of the Battery Voltage

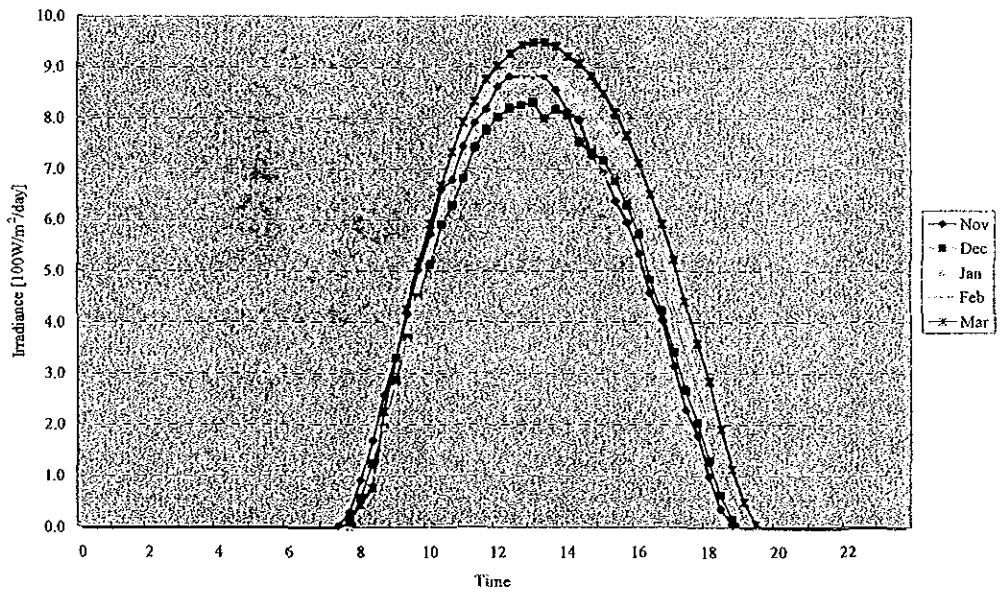

Figure 7.9 Monthly Average of Every 20 Minutes Trend of Irradiance

(6) Conclusion

Despite of sufficient irradiation, the power generation of the PV module was less than expected because the battery was not used full compared to its capacity. The user does not

seem to have started using loads other than lamps so far. However, the user started using lamps longer hours as they got familiar with the system. The charge controller won't start regulating power until the user starts using another loads like TV and radio. It is expected the user will start learning how the system behaves after the charge controller begin regulating power when further consumption is added.