CHAPTER 5 PV BATTERIES AND ENVIRONMENTAL COSIDERATIONS

5.1 Recycling of Used Batteries

(1) Car Batteries

Lead acid batteries are widely adopted for SHS, they are same as car batteries on its material, that is to say SHS battery recycling is the lead recycling for secondary use of the refined lead in a battery manufacture industry. Since constant supply of certain amount of used batteries is necessary to keep the refining industry economical, it is better to establish recycling system combining with car batteries. It is almost impossible to establish SHS battery recycling system separating from car used batteries, because of their quantity is too small. Therefore, in this paragraph we describe current status of car batteries in Senegal. Since there is no authority to control used batteries in Senegal no one can tell the actual situation of the problems, but we can estimate how many batteries would have been exposed from the statistics of car industries.

The car batteries used in Senegal are lead acid liquid type batteries and thy last for only two years due to harsh condition of the roads and high temperature environment. According to "The Motor Industry of Great Britain",the registered total amount of car in Senegal as end of 1997 is 116,500, including passenger use of 91,000 and 25,500 of commercial use resulting 60 persons per a car. Based on these statistics, estimated 58,250 of used batteries have been disposed each year.

(2) Current Status of Litter Treatment in Senegal

There is no litter treatment plant in Senegal. All of litters have been dumped without any treatment. It is creating big problems because of the limited space to be dumped and creation of heavy stress to the environment and habitants near the dumping area. In Dakar litters are mainly collected by private sectors and government pay according to weight of the collected amount of litters. People dispose their litters with out separation by its nature. Eventually, all kinds of litters are dumped into a place as it is, but all of valuable litters like metals are picking up by the people before dumping and even at the dumping area.

(3) Current Status of Used Battery Disposal in Senegal

There is no used battery collecting system nor lead refining plant under operation 1980 the lead refining company of SATE in Senegal started lead refining process of used batteries and exported 40 tons of lead to Tunisia by 1987, but they closed their operation due to price fall down of the lead in the international market. BENEX Co. in Senegal exported untreated lead electrodes to Europe 300 tons to 1000 tons but they ended in 1990 as well. Generally, people are disposing or reusing for other purposes of their used batteries by their own responsibility. Limited amount of used batteries are re-melted and converted to fishing net sinkers.

(4) The institutions in Charge of Waste Regulation

The institution in charge of the regulation of the polluting wastes in Senegal is the Division of Nature protection. With the technical assistance of the French Cooperation the Division of Nature Protection, Ministry of Environment and Nature Protection initiated the identification of the special wastes. However the used batteries was not taken into account in that program. Therefore, there is no regulation as regards the recycling of used batteries in Senegal.

(5) Some Example of Industrial Countries

1) Japanese Lead Recycle Program

In 1994 the Minister of Health and Welfare requested the Minister of International Trade and Industry to take necessary measures for used batteries recycling to related industries based on the 'Law of disposal treatment and cleaning' established in 1994. The minister requested battery industries that 'the manufacturers should be involved positively to collect used batteries through their selling network without charge and reuse of recycled lead'. According to the request, The Industrial Society of Storage Battery has been taking realistic action focused on purchasing of recycled lead at appropriate price and reuses them. The action named 'Lead recycle program'. As a result of their action 94% or 28,000,000 of car batteries was recycled as of 1996. The flow of used batteries shown in Figure.5.1. The five major battery makers agreed to buy the recycled lead to offset their products emission even the recycled lead market price goes up much higher than virgin lead. The virgin lead refiners also agreed to support this program to treat used batteries. According to a field survey the construction cost of used battery treatment plant processing 1000 tons per month, nearly equal to Senegal's used batteries emission needs approximately to US$ 8 billions. The programmed price of recycled lead for the battery maker is approximately US$ 750 per ton as of 1999.

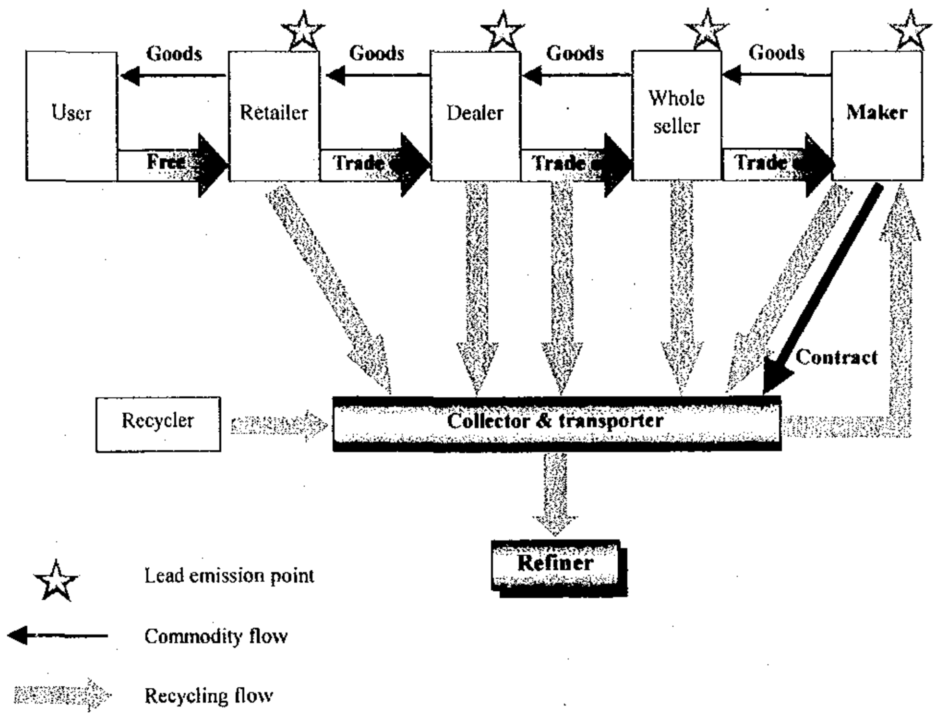


Figure 5.1 Recycling of Lead in Japan

2) Outline of World Regulation

Japan, EC, USA have been established the recycling system controlled by regulation and law.

German system is instructive for Senegal because it contains the responsibility of importers, i) no recycle no sell ii) end user responsible to return and local authority accept with no charge iii) importers are responsible as well as maker to support recycling system financially corresponding to their market share.

Table 5.1 World Recycling Status

Contents	Japan	USA	EC
Law an regulations	• Resources recycle law • Guideline • Waste cleaning law	• Federal law of battery (PL104－142) • States law	• EC mandate-battery
Purpose of law	Effective use of resources	Environmental protection	Environmental protection
Actions	• Display marking • Easy removal • Collection promotion	• Display marking • Easy removal • Collection promotion	• Display marking • Easy removal • Collection promotion

(6) Used Battery Processing

The popular used battery processing methods in the world are Engitec-CX method、 and RSR reverberant furnace. Figure 5.2 shows flow of RSR method.

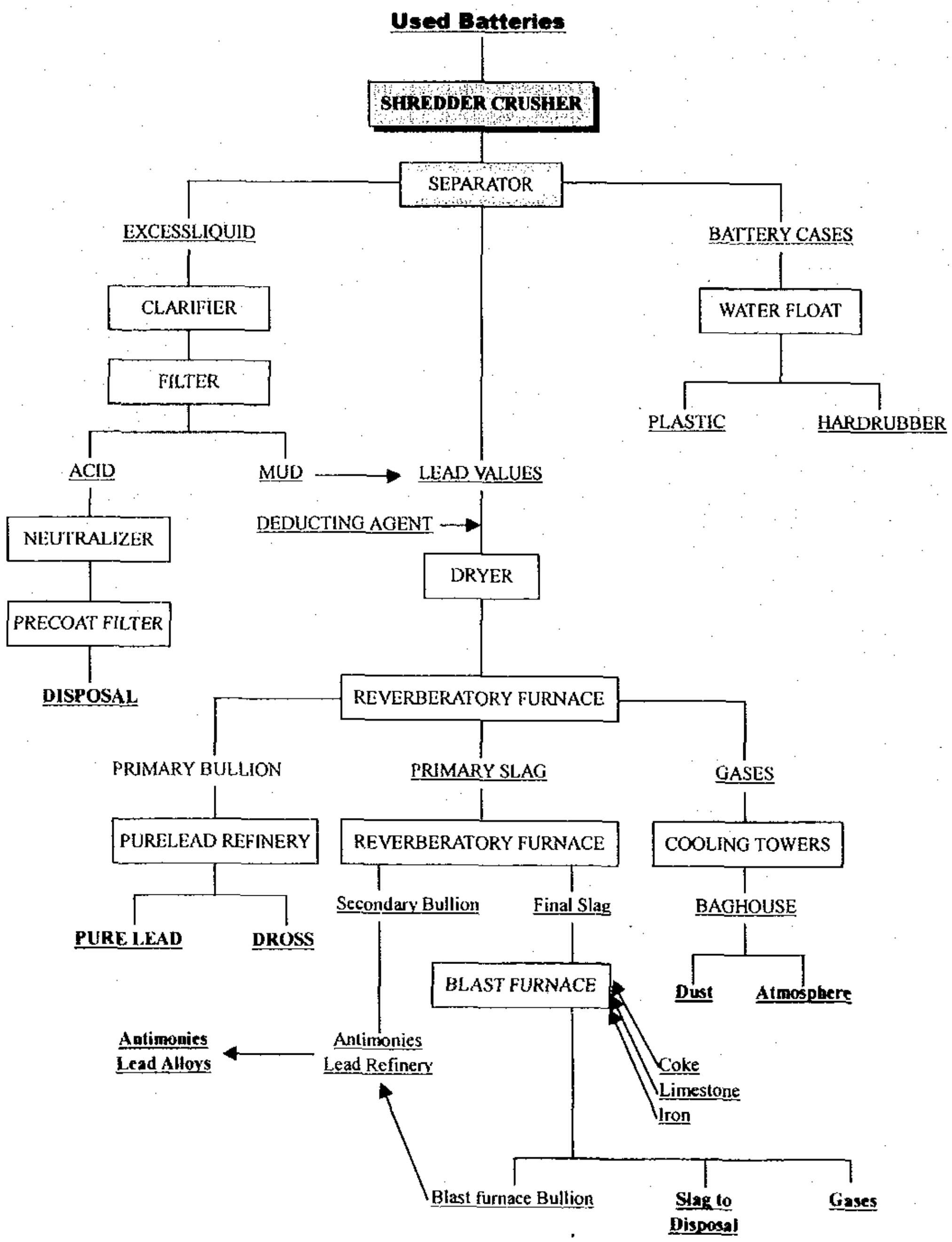


Figure 5.2 RSR Reverberant Furnace Method

(7) Future Target in Senegal

Senegal has experience in used battery refining producing lead ingot for export and has its possible user of two active battery manufacturers. Only problem is price of recycled ingot. The lead price is fairly stable in international market but it is unstable locally reflecting money exchange rate. The lead recycle industry had been profitable when the virgin ingot price is higher than recycled one but current situation is not competitive against virgin lead. Considering above it is necessary to establish proper legal and financial support system for the recycling system viable. Although, it is not practical to establish costly battery recycling plant when it not commercially viable and they have much urgent necessity to build incinerators for city litters treatment. Since the batteries recycling is not only problem of Senegal but it is international problems, it is better to solve the problems internationally cooperating with neighboring countries for its operation. For practical temporally solution the government can set up a regulation to impose a duty of 'take buck used batteries policy' to importers or its original manufacturers.

1) Related Industry in Senegal

Local battery assembly plant

SAAA (African Company of Car Batteries)

The company has their plant in Sodida, their production capacity is 48,000 batteries per year and the actual production is estimated about 7,200 per year or so.

FULMEN

The company has their plant in Rufisque their capacity is estimated as same as the AAA.

2) Proposal of Legal Control and Recycling System

It seems necessary to have joint committee of the government and related industries to organize a recycle action body to tackle burst amount of financial and complicated coordination problems.

The items to be proposed are below.

a) Impose a duty to battery makers take back of recycled lead corresponding to their production.

b) Battery importers including battery mounted cars importers must be responsible as well as battery maker to support recycling system financially or take back recycled lead ingot corresponding to their market share.

c) Battery maker and importer have to cover necessary collection cost of used batteries.

d) End user responsible to return their used batteries to trade with new one at the market, or retune to the authorized collector, or deposit necessary charge for collection.

e) Establish recycling roots including reverse flow of existing marketing flow or creating new job opportunities.

f) Support the recycling institutes using money created above measures.

(8) Temporary Used Battery Treatment Measure for the JICA Project

1) Fishing Net Sinker

Since there is no battery recycling system in Senegal except to fishing net sinker makers, we have to bring them to the sinker maker, or re-export to original manufacturing countries who can make recycling.

2) Acid Treatment and Dry Battery Store

Other way the used batteries must be stored in safety storage area. Batteries can be stored out door for certain period of time safely because they are designed tough enough to resist to vibration, high temperature and mechanical shock as a component of a car. The problems is the liquid, which contains sulfuric acid, it is better to be neutralized by comical method. Most possible way is neutralization by alkaline salt like baking powder adding the powder through the water filling holes or after draining of the acid to a plastic container. Field technicians can do this procedure. Then after the acid treatment people able to use them for the weight or ballast materials for structures like buildings or fences wall stuffs, which people utilizing some time.

5.2 Contribution to Environment Protection

This project contributes to the environment by effect of CO_2 emission reduction, which will be caused by current fuel lighting used by un-electrified people in Senegal, but it is rather small compared to other emission source does. In other hand when we consider SHS as alternative energy source to diesel or conventional grid power electrification, their CO_2 will be one eighteenth (1/18). On top of that global diffusion of PV for two billion of un-electrified population reduce the cost of PV and create enormous application for industrialized countries. Consequently PV diffusion contributes greatly to environment protection.

(1) Conventional Oil Thermal Power Distribution VS PV

Referring to the JPEA (Japanese Photovoltaic Engineering Association) evaluation formula the CO_2 emission reduction effect of PV systems will be given as below,

CO_2 emission by PV power generation (g/kWh) =

CO_2 emission on PV system production/accumulated power production by PV system in 20 years (PV panels life time is 20 years)

The result is 20g/kWh.

In the same manner the oil thermal power plant emission is 200g/kWh. According to above manner CO_2 reduction effect of PV is 180kg /kWp year against oil thermal power plant or saving 243 litter per year of crude oil.

The energy pay back period of PV power generation systems including balance of systems is 3 to 4 years, another 16 to 17 years of PV life time produce power without any energy resource except sunshine.

The above values are variable depends on the sunshine irradiance of the site where the system installed and rate of system utilization, but some of Japanese field tests shows reduction effect of 1/4 CO_2 emission against conventional grid power at average home with grid-connected system.

CO_2 emission by PV system	Approx. 20g/kWh
CO_2 emission by oil thermal	Approx. 200g/kWh
CO_2 reduction effect / 1kWh of PV installation	Approx. 180g/kWh

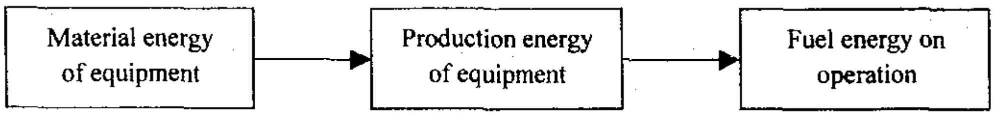
(Jpea at <http://www.jpea.gr.jp/3/3-5.htm>)

(2) Diesel option VS PV

In addition to CO_2 diesel power generator emit NOx and SOx while PV emit nothing during the operation, but in case of population density area without grid, diesel option is will be much economical against PV especially with local industries. In this paragraph a comparative study of CO_2 emission will be made on PV VS diesel.

Methodology

To estimate diesel CO_2 emission, the necessary energy for a diesel power system was divided into three categories. They are basic material energy, production energy and fuel energy



Preconditions

In this case the CO_2 emission equivalent units and diesel production energy consumptions are based on Japanese industry scale.

Crude steel:	520g-C/kg
Machinery production:	127g-C/kg
Petroleum products:	855g-C/kg (exploration to combustion)

CO_2 emission of a diesel power generator

On equipment preconditions

Size diesel of generator:	5 Kw
Wight:	100kg
Efficiency power generation:	20%

Fuel consumption/1kWh: 0.43kg / kWh

Table 5.2 CO_2 emission of a Diesel Power Generator

	Conversion	g-C
Material energy	100kg × 520g-C/kg	52,000
Production energy	100kg × 127g-C/kg	12,700
Fuel energy	2,220kWh/year × 20years × 0.43kg/kWh × 855g-C/kg	16,323,660
Total CO_2 emission		16,388,360
CO2 emission/kWh	16,388,360g-C ÷ 2,222kWh/year ÷ 20years	369g-C/kWh

As shown above 369g/kWh CO_2 emission of diesel power generation is 18.45 times larger than PV power generation of 20g/kWh.

CHAPTER 6 PILOT PROJECT

6.1 Objective of the Pilot Project

Rural electrification with photovoltaic system only started in the 1980' in Senegal through the assistants of foreign donors such as France, Italy and Spain. The most typical PV project was the Senegal - German Project started in 1987.

According to the past PV electrification projects, it is considered that the technical specification of SHS was almost established. The main constraints of the PV diffusion is not in the technical aspect, but in the operation and management, and financial aspect.

In consideration of the problems confirmed through the past electrification projects, the Pilot Project aimed to confirm the feasibility of project which was proposed in the Master Plan in Chapter 3.

The Pilot Project was designed with following conditions, based on the "concession system" and "privatization of the eclectic industry" advocated by the Government of Senegal.

- Private company (Operator) is installed in the operation and management system
- Limited area (1 to 2 village) would be selected for target area. Then the Pilot Project supply the service to certain number of users.

6.2 Site Selection

(1) Three Candidate Sites

At the preliminary stage of the present JICA Study, the Senegalese Government presented three candidate sites for implementation of Pilot Project. These three sites are located in Fatick, Thies and in Kaolack Regions respectively. The location map of these three sites are shown in Figure 6.1.

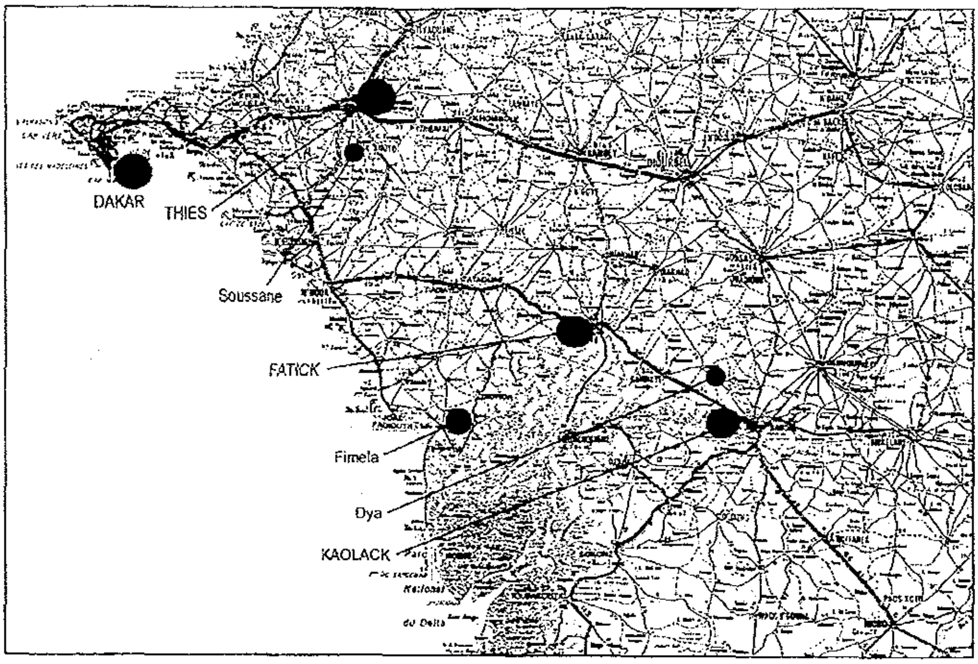


Figure 6.1 Location Map of Three Candidate Sites

These sites consisting of one central village and a relatively smaller village were selected so that the correlation between the size of the village (population and surface area) and the functions for operation and maintenance would be confirmed through the implementation of the pilot project.

The overall outline of these villages is shown in the Table 6.1 below:

Table 6.1 Outline of Candidate Sites

Fatick			
Sous Prefet	**Fimela**		
Communauté Rurale	**Fimela**		
Village	**Mar Lothie**	**Mar Soulou**	**Mar Fafako**
Population	1,550 (1999)	886 (1999)	2,172 (1999)
Number of Concessions*	197	39	186
Distance from Grid	3 km	5 km	6 km
Economic Activity	Agriculture, Livestock, Fishery, Remittance	Agriculture, Livestock, Fishery, Remittance	Agriculture, Livestock, Fishery, Remittance
No. of Existing SHS			11

Thies		
Sous Prefet	**Ngoekokh**	**Fissel**
Communauté Rurale	**Malicounda**	**Ndiaganiao**
Village	**Mbouleme**	**Soussane**
Population		
Number of Concessions*	53	12
Distance from Grid		
Economic Activity	Agriculture, Livestock, Fishery	Agriculture, Livestock
No. of Existing SHS		
Kaolack		
Sous Prefet	**Sabassor**	
Communauté Rurale	**Dya**	
Village	**Dya**	**Ngothie**
Population	785	1,550
Number of Concessions*	67	34
Distance from Grid	7 km	N.A.
Economic Activity	Agriculture, Livestock	Agriculture, Livestock
No. of Existing SHS	SHS 1 and stand alone generator 1	

* Concession is defined as a collectivity of households in which same family is sharing the spaces. Usually, there is an elder chief of the family (chief of concession) and his sons are having independent households within one concession.

Source: FAO (1999), Recensement National de l'Agriculture et Système Permanent de Statistiques Agricole, and others

(2) Socio-economic Situation of Three Candidate Villages

At the initial stage of the first field survey, brief socio-economic survey was conducted in order to appraise the present socio-economic situations of these three candidate sites so that the most appropriate selection of Pilot Project site would be realized. The outcome of this survey is under processing.

(3) Selected Project Site

In selecting the Pilot Project Site, the following criteria were applied.

a) Future grid extension plan; the area where there is no grid extension plan within ten years,

b) Household income and expenditure level; the households' capacity to pay for initial and operation & management costs.

Based on the criteria above, Mar Lothie and Mar Soulou in Fatick Region were selected firstly and Mar Fafako was added afterwards. The main reasons are such that the selected three villages are located on the island, as shown below on Fig. 7.2. They would be reached only by an engine boat in 30 minutes from the town of N'Dangane, which is connected to the power grid network of SENELEC. And it is expected that cash income can be secured as a whole, because fishery activities are rather popular, and there appears to be villagers engaged in navigation, spending most of the year overseas. Then, further socio-economic survey was implemented for the villages that were selected as a project site. At the same time, public consultations were held in the pilot site in order to explain JICA project, SHS system's function and its use to village people as well as to have a dialogue with the villagers.

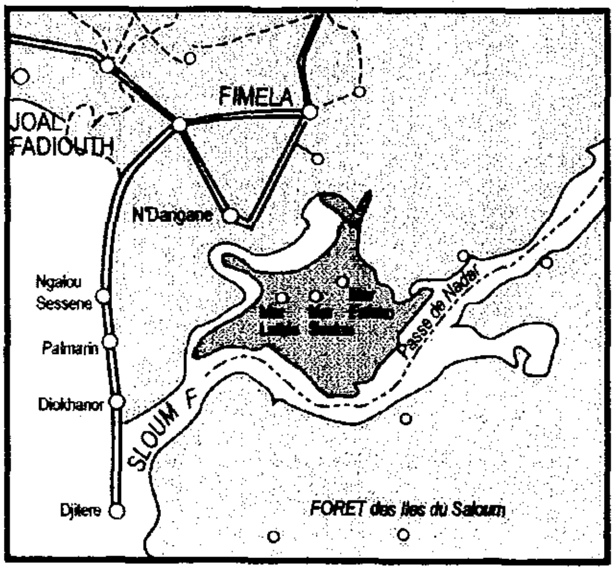


Figure 6.2 Pilot Project Site Map

6.3 Project Design and Implementation Schedule

(1) Pilot Project

The Pilot Project roughly divided into two stages, one was preparation stage and the other was implementation stage. The schedule of the Pilot Project is as follows;

Period	Contents
Phase 1 Field Survey (Jan. to March 2000)	Site selection, Design of the Project (Project purpose, activities, etc), Design of SHS and options, Recruitment of the participants,
Phase 2 Field Survey (June to July 2000)	Preparation of the selection criteria for Operator, Tender of the SHS, Drawing up the operation system
Phase 3 Field Survey (Sept. to Oct. 2000)	Final selection of the participants, Establishment of the VUA, Installation of the SHS (from Nov. 2000)
Phase 4 Field Survey (Nov. to Dec. 2000)	Making a contract between Operator and user, Start the project activities such as fee collection, maintenance and management), Hold the 1st Seminar (Explanation of the project for the participants, Establish the maintenance and management system)
Phase 5 Field Survey (June 2001)	Mid term evaluation of the Pilot Project, Hold the 2nd Seminar (Extraction of the constraints and study the countermeasures)
Phase 6 Field Survey (Oct. 2001)	Final evaluation of the Pilot Project, Hold the 3rd Seminar (Future subjects, lesson learned)

Pilot Project was designed through the field survey in Mar Island and problem analysis by the participants from MMEH, NGOs, local consultants in rural electrification sector, and members of the JICA study team. The project design was summarized on the Project Design Matrix (PDM) shown in Table 6.2.

Project purpose and output of the Pilot Project is as follows;

[Project Purpose]

Operation and management system for SHS is established in Mar Island.

[Output]

1. SHS units are installed to the households which want to be electrified with the SHS system.
2. User utilizes the SHS manuals.
3. Electricity fee are collected from users in schedule.

4 Maintenance and repair of SHS are well carried out.
   4-1 Operator carries out the regular maintenance of SHS.
   4-2 Operator maintain the broken SHS.
5 SHS works in line with a specification.

(2) Fee for Service

The regular payment of the users for the pre-condition of "Fee for Services" is computed on the following assumptions. These assumptions are to be verified in the operation stage.

• No. of system unit			150 Units
• Unit price of the system			450,000 FCFA (The initial cost is fully financed by JICA.)
• Initial payment of the subscriber			45,000 FCFA (The initial payment is equal to 10% of the above amount.)
• Estimated O & M cost			
Manager		0.1 M/M	500,000 FCFA/month
Accountant		0.2 M/M	200,000 FCFA/month
PV Engineer		0.3 M/M	200,000 FCFA/month
Local Technician		1.0 M/M	50,000 FCFA/month
Fee collection & book keeping		0.2 M/M	200,000 FCFA/month
Total	Monthly expense		240,000 FCFA/month
	Annual expense		2,880,000 FCFA/year
• Renewal period			
PV Panel			20 years
Charge Controller			10 years
Battery			4 years

The regular payment has been calculated on such a condition that the number of system units to be installed be initially estimated at 150. In this calculation, renewal cost (the system price after 20 years be assumed to be gradually reduced to 50% of the current price.), and expenses for the daily operation & maintenance cost, are taken into account. Finally, 100 units of the system was purchased, 95 of which were installed at the site. The remaining 5 units are regarded as spare parts and are planned to be used in a adequate manner for the operation and maintenance purpose.

This pilot project is all financially supported by JICA. From the outset, the major focus is placed on the build-up of the sound and responsive management structure, for the global diffusion of the rural electrification. Therefore, the tariff for "Fee for Services" has been set up to cover minimum operation and maintenance cost and renewal cost during the operation period of 20 years, without consideration of any profits. In addition to that, the final installed units of the PV system was decreased from 150 to 100. Eventually, the operation of the pilot project has been forced to be managed under financially constrained condition from the beginning. Under such circumstances, the O & M cost has been recognized to be critical to the sustainability of the pilot project, considering the future renewal cost. From the diffusion of the global PV rural electrification as well, the grasp of the real recurrent O & M cost was recognized to be the most important factor and vital to the sound management, not limited to the pilot project, among JICA and MMEH/ASER of PPMC at the selection of the Pilot Project Operator.

(3) Operation and Management System

1) Organization structure of the Pilot Project

The Pilot Project is implemented by the three organizations such as Pilot Project Management Committee (PPMC), the Operator, and Village Users Association (VUA). PPMC consists of MMEH, ASER and JICA Study Team.

The respective role of the stakeholder for the Pilot Project is shown below.

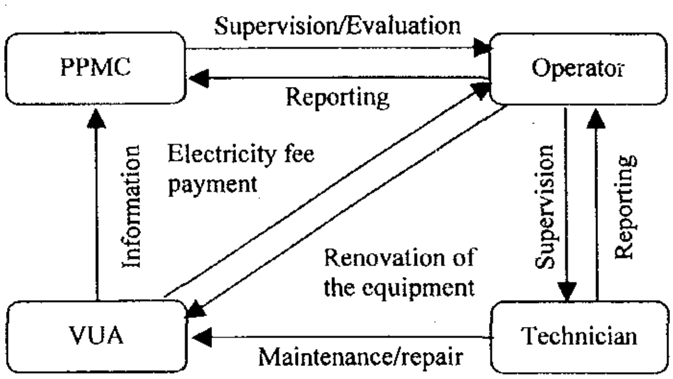
1. Pilot Project Management Committee (consisted of MEMI, ASER, JICA Study Team)
   1) To supervise the activities of both operator and VMO.
   2) To collect and analyze the data from Data Loggers installed in Mar Island.
2. Operator
   1) To maintain the installed SHS system at least once a month. Maintenance is conducted based on the maintenance manual prepared by PPMC.
   2) To monitor the appropriateness of SHS system utilization of each user when maintenance is conducted.
   3) To instruct and rectify the inappropriate usage of SHS system, if any.
   4) To collect the electricity fee from the users.
   5) To repair the SHS system, if necessary.
   6) To divide the collected charges into the fund for battery replacement and fund for the other activities by operator such as transportation fee, salary for technicians, etc. These funds are deposited in the bank accounts which managed by the operator.

7) To replace the batteries when life of the batteries are terminated (Necessary cost for the replacement is paid from the deposited fund for battery replacement).
8) To recall the SHS system from the users who don't pay the charges more than limited period provided by the PPMC regulations. (Necessary cost for recalling and uncollected electricity fee are collected from the initial payment of user)

Remarks: The roles from 1) to 3) are filled by the technicians employed by the operator. *This technicianstays in the project site during the project period. The roles* 4) to 6) are filled by the head office of the operator, and role 7) and 8) are filled by experts who dispatch to the Mar Island from the head office of the operator.

3. Village User's Association (VUA)
   1) To instruct and rectify the users who don't pay the charges.
   2) To monitor and enlighten the users through the monthly meeting.
4. User
   1) To attend the meeting held by PPMC.
   2) To clean the SHS system in line with the user's manual.
   3) To pay the electricity fee as scheduled.
   4) To cooperate the surveys conducted by PPMC.

The relationship between each organization is as follows;



6.4 Technical Specification of the SHS

The specification of SHS which was introduced by the Pilot Project was drawn up as follows;

1) Out put: DC12V
2) Autonomous operation capacity: Continuous 3 rainy days with listed loads.

3) PV panel : power max. 55W single crystal (SX55, Solarex,USA)

4) Battery : Solar Grade 12V 110AH/ C10, 120AH C/20, 145/AH C/100 (Type:M14sol, Accus National, Morocco)

5) Charge regulator : 10A (AtonlCinside SLR1010, Uhlman Solareleelecronic Gmbh, Germany)

6) Voltage converter : 3/6/7.5/12V (Uhlman Solareleelecronic Gmbh, Germany)

7) Fluorescent lamp : 8W (Thi-Lite,U.S.A) and 11W (SolsumESL,Steca, Germany)

8) LED lamp : 0.7W (SolsumESL,Steca, Germany)

LOAD	TYPE 1	TYPE 2	TYPE 3
F/L LAMP, 8W (supplied as a kit)	5	3	2
LED LAMP, 0.7W (supplied as a kit)	none	none	4
Socket for TV (DC. B/W)	none	1	1
Socket for Radio	1	1	1

Remarks: TYPE 1; lighting oriented system,
TYPE 2; TV oriented system
TYPE 3; TV and light oriented system

6.5 Contract Condition of the Pilot Project

Following service model was adopted in the Pilot Project.

Major Conditions of "Fee for Service" in Pilot Project on Mar Islands

Payment Method

1.	Initial payment	10,000 FCFA at registration 35,000 FCFA before installation
2.	Regular payment	Fee for service shall be paid as follows; Monthly 3,700 FCFA every month (Definite month should be proposed by users in cases of bi-monthly and semi-annually)

The regular payment will be reviewed every two years.

Service period

The service period is 20 years, however the renewal of the contract be made every 5 years.

Guarantee Clause

Any equipment and materials shall be fixed or replaced by the Pilot Project Operator when the system doesn't work, as far as the end-users follow the instruction of the Pilot Project Operator. The reason and causes will be

investigated with cooperation of the end-users of the system in problem jointly by the technician trained and the experts nominated by the Pilot Project Operator. The battery, charge controller, module, etc. shall be taken care of by the Pilot Project Operator. However, consumable materials such as bulb shall be bought by the users themselves.

Maintenance Supporting System

The fixing and replacement shall be made within 3 days in minor case and 1 week in major case after malfunctioning of the equipment.

Collection Method

Bill collection will be made by the person to be nominated by the Pilot Project Operator.

Cash Management of Collected Fee

The fee to be collected, in the form of initial payment and regular payment, will be deposited and secured in the reliable bank. Bank A/C will be opened for current expenses for administrative activities and for equipment replacement/renewal purposes. These funds shall be properly managed by the Pilot Project Operator.

Removal of the System

The system shall be removed in case that the regular payment is not paid

6.6 Evaluation

(1) Technical Evaluation

SHS systems installed in Mar Island were evaluated on static condition and dynamic condition. The both of conditions are attached below as the "periodical maintenance report" and for the dynamic condition "logging data analysis" was made taking advantage of the data-loggers.

1) Periodical maintenance

The periodical maintenance had been held on June and August 2001. All of the systems are working normally as designed, and they had been under good care of the local technician, except for below mentioned items. The most important indicator of batteries voltage has shown normal on all of systems through the testing period of a year.

2) Dynamic condition

To check actual functions of SHS, load patterns and meteorological data, three data-loggers have been installed in the households separately and the data were analyzed. The result shows normal action of the systems through worst weather condition of rainy season in June to August. The batteries had been recovering its normal capacity on the days following night power consumed. As the attached graphs show the batteries voltages show fully charged voltage of 13.7 V by 1:00 p.m. of following days and never falling down to 11.1 V of over charged.

3) *Troubles and actions taken*

There were two major troubles as follows:

a) Unusually short life of fluorescent tubes (14% of fluorescent tubes have been broken done showing local black spotting).

b) Charge regulator troubles

a) Unusually short life of fluorescent tubes

- Cause of break down

This phenomenon may originate from spreading of radiation material coated on the anode of fluorescent tubes, which occurred over heating of the electrode when it started to work. In this case the trouble was generated for poor quality of ballast inverter. It is clearly identified by the test result of CERER.

- Measures taken

JICA study team and the supplier discussed on the matter and agreed that, all of troubled lamps should be replaced in charge free based on the agreement of purchasing. For the replacement "the integrated lamp"(the ballast combined with a "U" F/L light in a solid shape: "SOLSEM", the product of Steca, Germany) shall be used. The integrated lamps have been widely accepted with good experience for SHS around the world. As of 12th October 2001 immediate necessity replacement of 57 sets (14% of all installation) were replaced.

Additional 50 sets of "the integrated lamps" are stored in the local technician's hand for future replacement.

- Reason for replacement

Initially installed fluorescent lights "Thin-lite" have advantage of low cost to replace because of the tubes are easy to separate from the ballast inverters when "the integrated lamps" are not, but those, for general use tubes are designed to apply stable grid AC current to energize. In other hand the integrated lamp are designed to apply DC of SHS, so that matching of tube and ballast is perfect. Expected life of integrated lamp of 6000 Hrs (manufacture's data) with high performance will compensate higher initial cost. Availability also covered by the operator stock of 50 units in the village.

b) Charge regulator troubles

3 pieces of charge regulator's indicator lamp were not worked and was replaced. They were presumed that improper soldering of indictor lamps. 5 pieces them are erroneously acted. The erroneous action may occur when temperature compensation unit were not connected properly at the installation work. Since the action may not generate serious situation immediately, field technician reconnected tightly after cleaning the terminals and put them under careful observation. He shall replace them when the same error happened again.

3) Conclusion

Considering the generally good aspect of the periodical maintenance record and the logging -data analysis result, it seems that all systems are working as designed under the good care of the local technician. It is recommended to make periodical maintenance once a year from now on.

(2) Project Evaluation

Evaluation of the Pilot Project was conducted using PCM method. The Pilot Project was evaluated from the viewpoint of 5 evaluation criteria (efficiency, effectiveness, impact, relevance, sustainability).

The evaluation was conducted based on the Project Design Matrix (hereafter referred to as "PDM") which was prepared on December 2000. Necessary data and information for the evaluation were collected through the questionnaire survey and field survey. The questionnaire surveys were conducted three times. First questionnaire survey aimed to collect base line data of users was conducted on December 2000, and second questionnaire survey aimed to collect data for mid-term evaluation was conducted on June 2001. Then third survey aimed to collect data for final evaluation was conducted on October 2001. The results of these surveys were shown on ANNEX B. In addition, field surveys aimed to discuss with village people were also conducted. The targeted peoples of the field surveys were not only individual users, but also the representatives of the public facilities installed SHS. The survey results for public facilities were also shown on ANNEX C.

The Pilot Project was evaluated form the viewpoint of the "five evaluation criteria" which consisted "efficiency", "effectiveness", "impact", "relevance" and "sustainability". The outline of five evaluation criteria and PDM was described on ANNEX D.

The result of evaluation is mentioned as below. The more detail of the evaluation is shown on Table 6.2.

a) Efficiency

In assessing the efficiency, achievement level of the outputs in comparison to the efficient use of financial, human and material resources are examined.

As of October 2001, almost all of the outputs were realized. There were several problems recognized during the mid-term evaluation (June 2001). The necessary measures for these problems were drawn up through the discussion among the PPMC, the Operator and users. The JICA study team confirmed that the Pilot Project was well operated without any major problems on October 2001.

However, MMEH/ASER pointed out following items about the timing and quantity of input.

Concerning the duration of stay and dispatched frequency of JICA Study Team, MMEH recommended assigning at least one JICA expert for whole period of the Pilot Project. The JICA Study team also pointed out the importance and necessity of assistance by Japanese side during the initial stage of the implementation.

The timing of the project also needs more consideration. So far, any comprehensive rural electrification plan has not been drawn up yet in Senegal. Therefore, expected role for SHS by Senegal side has not been defined yet. In addition, ASER who is one of the main counter part agencies of the Project, also didn't established when the Project started. The efficiency of the input might be reduced in these situations.

Besides of above problems, difference correspondence of VUA is one of the subject should be concerned. The new fee collection system which required more participation of VUA has been adopted since June 2001. However, VUA in Mar Lothie was less cooperative to assist the new system than VUA in Mar Fafaco. It is considered that some kind of education activities for VUA's capacity building would has been included in the project activities.

(2) Effectiveness

Effectiveness concerns the extent to which the project purpose has been achieved, or is expected to be achieved, in relation to the outputs produced by the project.
The project purpose, establishing operation and management system of SHS, is almost realized as of October 2001. Many of SHS units well worked and maintained. However, there are still some subjects should be solved in the operation and maintenance system, such as revision and cutback of the operation cost and capacity building of the VUA.

c) Impact

Impact is intended and unintended, direct and indirect, positive and negative changes as a result of the project.

The major impacts reported by users were;

- Learning condition for children was improved
- Streets got less darkness during night time because the entrance light of the houses along the streets.
- Petrol consumption was saved
- Working condition in night time was improved

Based on the experience of the Pilot Project, ASER prioritized Mar Island for a model area of decentralized rural electrification, and is preparing new project which consists of improving utilization of existing generator, introducing SHS for individuals and public light in Mar Island. Any negative impacts in socio-economic and environmental sector wasn't reported.

It is concluded that Mar Island is going to get great deal of positive impact from the Pilot Project.

d) Relevance

Relevance is to question whether the outputs, project purpose and overall goals are still in keeping with the priority needs and concerned at the time of evaluation.

Rural electrification by SHS is in line with the basic policy of the Government of Senegal. Although any actual electrification strategy and/or program using SHS hasn't been drawn up, ASER / MMEH allots SHS for important role for realizing the Rural Electrification.

Considering the needs of village people, SHS satisfied almost all of users. However, it seems that user's demand to power is increasing as time passed. Therefore, there is some possibility to change the degree of user's satisfaction in near future.

e) Sustainability

Sustainability of the development project is to question whether the project benefits are likely to continue after the JICA project has come to an end.

MMEH is a responsible ministry for electrification, and ASER is an implementing agency for rural electrification. Both organizations have important roles for rural electrification in the Government of Senegal.

MMEH /ASER has strong intention to continue the project activities after the termination of the Pilot Project. In fact, ASER has a plan to establish the new project which covers all activities of the Pilot Project.

People in Mar Island also eager to continue the project activities, too. The users are satisfied with SHS, and want to use it continuously. In addition, there are about two hundred subscribers on the waiting list.

Although both MMEH and ASER couldn't prepare the budgets for continuing the future activities, they will take necessary procedures before January 2002 when the Pilot Project is handed over.

On the other hand, operation cost of the project activities such as maintenance and replacement cost of the equipmentare covered by the collected electricity fee. The assumption adopted for drowning the financial plan of the Pilot Project such as price projection of PV equipment should be monitored continuously, and it's results should be reflects the financial plan.

(2) Factors behind the Achievement of the Project Goal: Participation and Motivation

The pilot project belongs to the Senegalese side, while JICA's contribution to the pilot project is to provide a financial support by procurement and installation of the PV system. To promote 'participatory approach', the JICA study team encouraged the Senegal side to take initiatives on all the activities except the bidding related process during the pilot project implementation. At the pilot sites, the JICA study team made effort to involve villagers in the project implementation from the early stage; the team requested village representatives to select a local technician among the villagers by themselves for assisting the supplier/operator in the installation of PV equipment. Through a number of public hearings and seminars, the JICA study team attempted to exchange information and opinions with MMEH, ASER and the representatives of village communities in order to reflect different kind of ideas in the project implementation. At more individual levels, the team members made close contacts with the counterpart personnel and managed to build good personal relationships with them.

Throughout the implementation period, the Pilot Project Management Committee (PPMC), consists of MMEH, ASER and JICA study team, paid frequent visits to the project sites and gave relevant advise to the supplier/operator, the local technician and villagers. This contributed to motivate the village users and led to their active participation in the pilot project. In particular, at the initial stage of the implementation, the JICA study team conducted extensive works: socio-economic survey, public hearing on project service details, payment methods and PV installation schedule at each project site. Furthermore, the effort of the project personnel, such as the JICA PV installation expert, the supplier/operator, and the local technician, for the installation of PV equipment during Ramadan season, was deeply appreciated by the village users. Through these works, the reliable relationship was established among the personnel concerned in the site.

Along with the efforts of project members, some technical contributions, such as the proper installation of PV equipment and the satisfaction of users' expectation on PV electrification, have equally become a crucial part in achieving the project goal in the pilot project.

(3) Conclusion

It is concluded that the Pilot Project was almost succeeded, although there were several inappropriate points in "Efficiency".

MMEH and ASER place the Mar Island as a priority area for rural electrification, and villagers in Mar Island also eager for continuing and expanding the project activities.

However, some subjects should be solved still remain, such as enhancement of the VUA's capability and establishment of more effective operation system. Recommendations and lessons learned are shown on following chapter.

6.7 Recommendations and Lessons Learned

(1) Recommendations

1) Ensuring the Budget Allocation for the Pilot Project

Both MMEH and ASER didn't draw up any budget for the future activities of Pilot Project on October 2001, although it was decided that both agencies would take responsible to continue the project activities in Mar Island.

The Government of Senegal doesn't need to allocate any operation and renovation cost of the Pilot Project, because these costs are covered by the electric fee. However, indispensable costs for periodical field survey and local consultant mentioned below should be prepared by the Government of Senegal.

It is desirable that both MMEH and ASER take immediate action to budget for these activities.

2) To Establish the Practical Working Sector for the Pilot Project

ASER planed to hire consultants for managing the rural electrification projects in their Rural Electrification Plan. The JICA Study Team took this role in the Pilot Project. AS of now, MMEH and ASER don't have enough number of staffs to manage each project by themselves. Therefore, the JICA Study Team recommended that MMEH and ASER should establish the practical working sector for the smooth operation of the Pilot Project, and feedback the results to the rural electrification plan in the future.

3) To Educate and Enhance VUA

We requested VUA to take a part of fee collection activities in the Pilot Project. In addition, VUA instructed users to keep the due date and payment system of the electric fee for ensuring the smooth fee collection.
These activities are indispensable to operate the Pilot Project effectively. However, the results depend on the user's quality. It is recommended that the PPMC should add education programs for VUA in the activities of the Pilot Project for strengthening the participation of users.

(2) Lessons Learned

1) System Capacity

User's additional demands, encountered on the users seminar and questionnaires are,

- Color TV
- Refrigerator
- Additional lamps (some families have more than 7 bed rooms)
- Cooling fan

The above users additional demands are not available by the single SHS unit that we installed, even they have wills to pay for the appliances. Local PV engineers say, based on their experience "people consider SHS as same power source with grid supplied electricity" for some extent of time.

A power unit designer starts his work from the estimation of users demanding capacity but it is impossible to design economical SHS to satisfy every body with specific one unit when people have different live styles. General definition of SHS is "the power unit consist of 40 –50 W PV panel with a car battery, supplying enough power to 2-3 lamps and black and white TV, for 3 or 4 Hrs per day". This capacity was determined from the availability of components in the market rather than power demand at villages.

For this project we selected a 55W PV module, because of 55w or 75W panel have been substituting 40W or 50W in the market because of the technology improvement. Fortunately, PV power systems can be expanded by module to module upon the request.

2) Problems and Solutions

- Prior to the user's signing on the contract of "fee for service", a seminar was held at the villages. The study team as "a mock operator" explained expected performance of the systems using a picture but it was not enough to have understanding of potential customers. It is recommended to make demonstration with actual systems installing in some public building.

- To get best satisfaction of users with a set of SHS, the project offered three different sets of appliances kits, the first "Lighting oriented kit", the second

"TV oriented kit" and finally "Eclectic TV and lighting kit". For large families the LED lamp, which works with extremely low power consumption of 0.7W is introduced. Thus 7 bed rooms able to light for all night long. The LED lamp has accepted for baby caring, but in other hand, some people clams for its dimness. Double mounting of LED lamps in a room should have been considered.

3) Procurement of SHS Components

Although most of all components for SHS are made in industrialized countries, common international standards are not yet established enough. Prior to open a bid many preparation works are necessary to get reliable components. Normally, suppliers have not enough stock of the components for big projects, particularly, batteries stock are limited for the reason of degradation by time. A purchaser needs to survey availability of necessary components, read time of supply to the project site, testing laboratories to check qualities based on required specifications. Bidders side also need to study availability with manufacturers or primary suppliers and read time for import. Consequently it takes more than 6 months. In this context, we need to accelerate establishment of pre-designed "standard SHS " and "standard specification for the SHS components" designing base on the sociological study. It is also recommended that the special instruments like data loggers need to be prepared separately by study team because it is not easy to purchase in developing country and it is only tool for research work.

4) Local Technician for Maintenance

The local technician has been working very effectively. He understood basic of SHS and diagnose on minor system troubles beside of his dairy maintenance work of battery checking and lamp replacement. He says it is very happy to have a job.

A local technician shall be the mediator between users and a project operator, so that he shall be forced to stand different position from village people when he lives in traditional village society. To keep a technician's professionalism and their position stable, it is recommendable to give them official license and give chances to refresh their performance.

Table 6.2 Project Design Matrix for Pilot Project (1/2)

Project title : Pilot Project for PV Rural Electrification in Mar Island
Project area : Mar Island
Target Group : People in Mar Island
Duration : From March 2000 to October 2001
Prepared by JICA Study Team on June 2001

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
【Overall Goal】 People in Mar Island realize the possibility to improve living condition through the electrification.	• Electrification plans for improvement of the living standard (not limited to lighting purpose) are proposed from people in Mar Island.	• Project proposal prepared by the people in Mar Island	
【Project Purpose】 Operation and management system for SHS is established in Mar Island.	• All of installed SHS units are worked well when the pilot project terminated. • The operation cost is recovered by collected electricity fee.	• Report of the PPMC • Result of "SHS working condition survey in Mar Island"	• Operator continues their activitiy. • Price of SHS is decleased 50% during next 20 years.
【Output】 1 SHS units are installed to the households which want to be electrified with the SHS. 2 User utilizes the SHS following manuals. 3 Electricity fee are collected from users in schedule. 4 Maintenance and repair of SHS are well carried out. 4-1 Operator carries out the regular maintenance of SHS. 4-2 Operator repairs the broken SHS. 5 SHS works in line with a specification.	1 All of installed SHS units are worked appropriately when these units are installed. 2-1 Any SHS units aren't modified without permission from the operator. 2-2 User cleans SHS up. 3-1 CFA 3.5 million was collected by the end of September 2001. 3-2 CFA ??? of surplus was secured by the end of September 2001. 4-1 Utilization conditions of SHS are confirmed every month. 4-2 Repair of the broken SHS is started within one week from the report. 5 SHS generates electricity as planned.	1 Construction record of contractor / Completion certificate 2-1 Report of monitoring survey 2-2 Report of monitoring survey 3 Record of bank account 4-1 Report of monitoring survey 4-2 Report of monitoring survey 5 Record of data logger	

Table 6.2 Project Design Matrix for Pilot Project (2/2)

Narrative Summary	Input	Important Assumption
[Activities] 1-1 Specification and capacity of SHS are designed. 1-2 Specification and capacity of SHS are explained to the people in Mar Island. 1-3 Initial payment is collected from subscriber. 1-4 SHS units are installed to each household. 2-1 Users manual for SHS unit is prepared. 2-2 Directions for using SHS are explained to users when it's installed. 2-3 User training are conducted regularly by the Operator. 3-1 Role of each stakeholder is defined. 3-2 VUA is established. 3-3 Operator is selected. 3-4 Schedule of electricity fee collection for each user is prepared. 3-5 Operator collects the electricity fee as scheduled. 3-6 Operator penalizes the person who doesn't pay an electricity fee. 3-7 VUA educates users to heighten their awareness of payment. 4-1 Operator conducts periodical maintenance of SHS. 4-2 Operator rectifies inappropriate usage of SHS. 4-3 Operator repairs the SHS based on the request from VUA. 4-4 PPMC supervises the maintenance and repair activities by the operator. 5-1 PPMC sets up the data logger. 5-2 PPMC collects the data from data logger, and analyzes it.	Japanese side Dispatch of consultants team 8 consultants 35.7MM C/P Training Provision of equipment - 100 units of SHS system Senegal side C/P Office of PPMC	• Spec. and capacity of SHS meets user's needs . • Trained member of VUA continues his work. • Income level of users doesn't become worse than present level. **[Precondition]** • Village people in Mar Island want electrification by SHS.

CHAPTER 7 POLICY AND INSTITUTIONAL RECOMMENDATIONS

This chapter consists of two (2) parts, 1) suggestion to the Senegalese government and 2) recommendations to ASER in principle, for promoting the public-private initiative rural electrification, not only limited to photovoltanic technology.

7.1 Suggestion to the Government for Promoting PV Rural Electrification

(1) Government Policy, Referring International Experiences

1) Overview of International Activities

International experience shows that government policy support is a key to promote renewable energy deployment at initial stage.

It is important role of the central government that preparation of policy instruments adoption, and legislative and regulatory environment must be as conducive as possible for the end users and renewable energy industries based on view point of a long term strategy.

With the privatization of SENELEC, it is predicted that the off grid independent electrification systems, including SHSs will carry an important role of rural electrifications instead of grid extension. The government will be required to establish a rural electrification plans identifying classification of electrification mode by area to area, specifying there are realistic limitations for grid extension. In the evaluation of rural electrification mode, PV systems should be viewed from a cross-sector perspective rather than solely from an energy perspective, because of PV technologies have wide rage of potential, which provides basic electric energy for a family use to public purposes in rural area. Therefore, the PV option helps total solution for rural infrastructures arrangement. In this context involvement of PV experts are important in those Ministries who involved in rural development activities like health, educational, agricultural, mining, telecommunication and environment etc.

Cost analysis should be made based on life-cycle costs approach, which includes sustainability and environmental issue with high added value compared to fossil fuel. In the life-cycle costs analysis, hidden subsidies to necessary fuels for grid power generation and small diesel generators, and environmental impacts should be taken in to account in order to provide fair bases for the comparison.

The central government need to have people understood that there are realistic limitations of grid extension and the PV optioned has unique added value offering to people not only least cost replacement of smoky kerosene lumps but, it is an attractive option which provides cultural tool and information source, it will be the foundation stone for the rural development toward bright future of Senegal.

Government can play an important role facilitating deployment of new technologies through the use of appropriate policy and realistic implementation manuals. To establish the policy and manuals it is essential to refer renewable and PV related international organizational activities, because Senegal need international financial assistance and the PV industry have to depend on imported products for the moment.

One of recent feature of international conferences on PV seems that their activities are concentrating to establish 'practical guide lines' and 'Standardizations' to deploy PV in developing countries reflecting worldwide lessen and learns from multilaterally and bilaterally financed large scale SHS projects including the World Bank, GEF etc. They have been preparing very useful documents, including suggestions to government roles.

The main international organizational activities have been held by the PV GAP (Photovoltaic Global Approval Program) and the IEA (International Energy Agency)/ PVPS (Photovoltaic Power System programme)-PV task 9, and as a regional conference in Tokyo 'The second work shop on facilitation of rural electrification in the APEC (Asia Pacific Economic Cooperation) region was held in 1997'. Among above conferences, IEA-task9 is preparing 'Recommended Practice Guide' and in the APEC-work shop importance of government roles had been discussed.

The object of IEA/PVPS-PV task 9 which have commenced in 1999 is to increase the overall rate of successful deployment of PV systems in developing countries through the cooperation and information exchange between developing countries and the international donors. Twelve countries participate in the work of Task 9, which is an international collaboration of experts appointed by national governments and also includes representatives of the World Bank and United Nation Development Program. Developing countries were also invited as participants of the conference. The PV GAP has been established in 1996 supported by the World Bank, aiming to setting up of SHS quality standards for PV dissemination programs in under developing countries. The founding members established the following mission as the goal of " PV GAP is a global PV industry-driven organization that strives to promote and maintain a set of quality standards and certification procedures for the performance of PV products and systems, to ensure high quality, reliability and durability". More over, they issued "Quality Management in Photovoltaics" and promoting training courses for under developing countries to get ISO-9000 authorization for local manufacturers. The goal of them is establishing a system of a quality seal for international quality assurance, which will be given for PV systems and components that were tested under PV GAP condition.

In this paragraph, some of useful information will be introduce referring above mentioned international activities for which are necessary to establish Senegal PV promotion manuals.

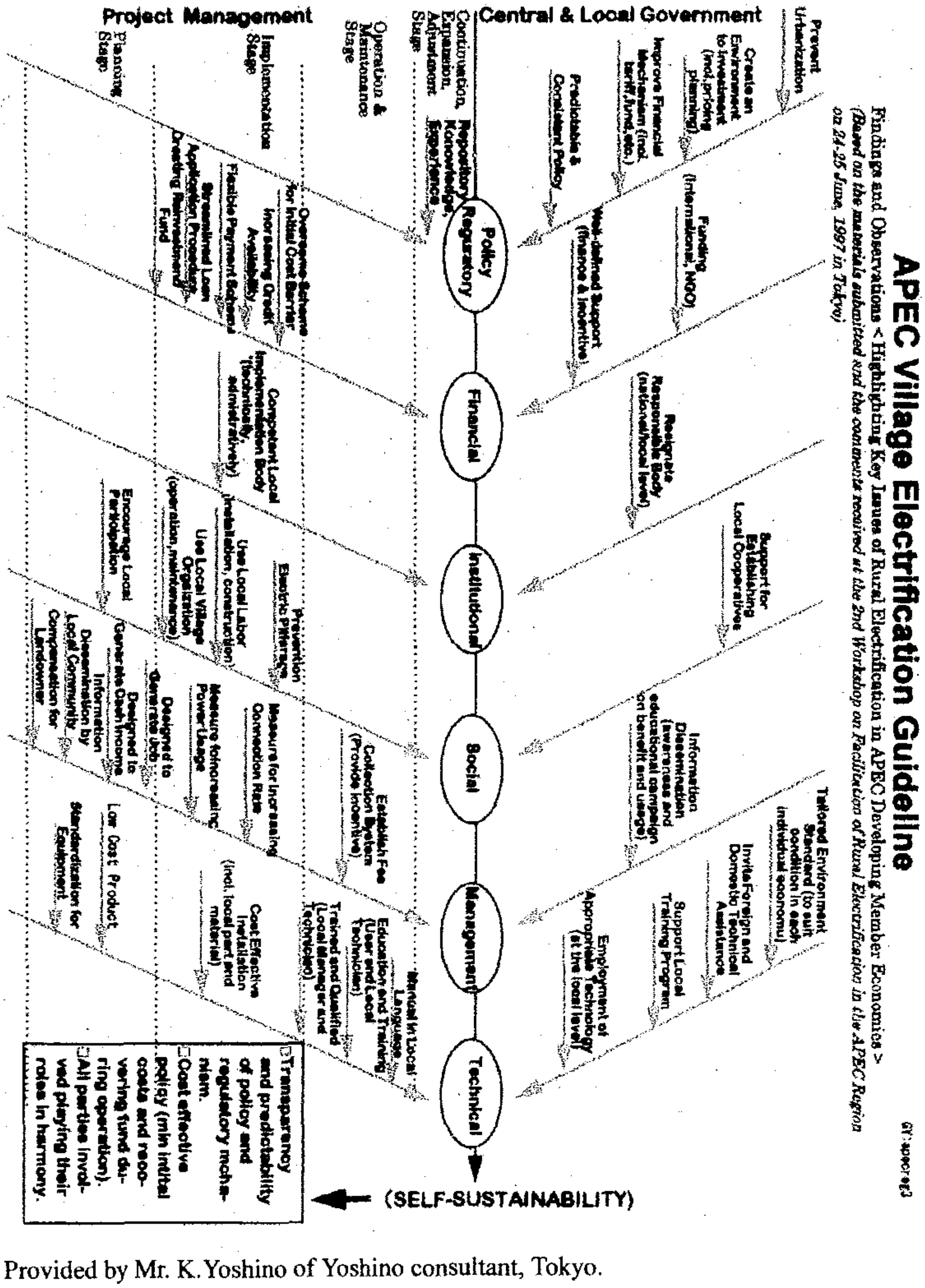
2) Role of National Government

Taking lessons and learned from worldwide experiences, Senegal PV promotion policy and implementation manuals can be summarized as follows.

- Establishment of predictable and consistent PV support policy in the framework of national electrification policy.
- Minimization of government subsidy on fossil fuels, give tax exemptions to PV to create level playing field on electric market and cross-subsidy from urban electrified era to rural un-electrified area.
- To keep in close contact with international PV related organizations.
- Creation of environment to have investment and financial mechanism to rear the new industry.
- Provision of initial subsidy for SHS to increase affordability and thus gain market size, which should eventually result in reduced system cost.

- Support domestic manufacturing incentives when they overcome quality issues.

The next page shows illustrative village electrification guideline, which compiled the fruit of 2nd workshop on facilitation of rural electrification in APEC (Asia Pacific Economic-cooperation Council) region in June 1997 in Tokyo.



Provided by Mr. K.Yoshino of Yoshino consultant, Tokyo.

3) Institutional Frame work in Senegal and target to be achieved

To ensure the government rural electrification policy successful, institutional framework is a key factor. The following Table 7.1 shows necessary Institutional Frame work and summary of role of institutions. Although, Republic of Senegal already has basic institutional framework for the rural electrifications, but once the electricity market is opened to the private sectors, it is important to review focused on PV dissemination purpose.

Table 7.1 Done and Undone Subject in Senegal for PV Promotion

Status of Senegal PV Promotion Institutes		
Entity	Items	**Present status in Senegal** Code No., Document No., Name of the institute **Symbols** ***1: Not exist, 2: Need to improve, 3: good***
*National Government	• Legislation on electricity by PV, 1) On autonomous generation, 2) On PV, 3) On concession, 4) On consumer products 5) On electric appliances • Policy on PV and RE Within the framework of rural energies • Promotion of fair competition for local suppliers (service, quality and price-not only price) • Financial support of pilot projects, awareness raising etc. • Publication of grid extension planning area • Regulation of private sector • Subsidy provision to rural dwellers	 2:ASER Procedures 2:ASER Procedures 2:ASER Procedures 1 2: National standard 2: QC committee 1 2: Rural Electrification Plan SN 2:Lavalin 1998 2:Regulatory committee of electrification sector 1
Provincial *District or Municipal	• Additional policy on PV and RE • Grid extension planning area • Marketing infrastructure, support job creation in this new business • Training programs	1 1 1 1

*Utility Distributor	• Provision of grid extension planning area • Organizing the supply, 1) Installation and fee for service 2) Lease fee collection • *Understanding,* 1) Different rules for off-grid 2) Realistic limitation of grid extension	2:SENELEC 1 2: arrête portant creation de la *Cellule* 2:CQPV, No.2104,1999, 0029 3:SENELEC
*Investors *Project Developers	• Investment of equity in a sound PV deployment business plan • Learn what off-grid electrification means • Learning about RE technologies • Check that the PV standards are adhered to on any project invested in	2:ASER procedures 2: E.S.P (Ecole Superieure Polytechnique) 2: E.S.P 2: ASER procedures
Financing institution *Bank *NGO, *Supplier with credit	• Provision of loans, subordinated loans or guarantees to commercial PV programs or projects • Provision of loans to end-user or PV-supply entities as on-lending	2: ASER 1
R&D organization	• Adjustment of PV systems to local conditions and applications, • Testing, systems on performance and durability	2: CERER/E.S.P 2: CERER
*Training institute or Educational system	• Training of installers, sales people, suppliers • Training of field technicians • Training of PV financers • Training of Government officials • Training of Utility sector • Awareness raising programs for customers	2: CNQP, CFPT, Infor Energie 2: CNQP, CFPT, Infor Energie 1 1 2:SENELEC 2: Centre de formation capede biche (SENELEC)
*Standards *Testing organizations	• Development of national standards • Adherences to international technical standards • Provision of Certificates of the PV systems and components and applications to interested parties (e.g. suppliers, operators, financiers)	2: I.S.N 2: I.S.N 2: CERER

It is essential to have quality bidders to open concession bidding. To clear the problem establishment of the institutional framework is the key.

It is important to have close discussions with potential operators, financers, found providers, specialist consultants NGOs etc. conducted by ASER to find out fundamentals to be arranged by the government for fair bidding conditionings.

The government implementation manual establishment work can be completed through,

- Based on fact of international lessens and learned
- *Rational use of existing institutes*
- Through practical discussions with actual potential players and supporters
- Giving confidence to joiners
- Under the government consistent and realistic PV supporting policy.

(2) Quality Management and Quality Assurance for Diffusion of PV

1) Quality System

The Republic of Senegal is a rich in experience of PV utilization. Their activities have been supported by GTZ and resulted establishment of national policy of PV diffusion for rural electrification, and to materialize the policy a state organization of ASER was founded for rural electrification promotion. There are many supporting people as well. They are The Senegal Quality Control Committee, R&D laboratory of CERER, training facilities, PV specialist consultants, system suppliers and NGOs. These valuable resources could be the great power to materialize the policy when they integrated into the quality system to complete a model system for rural electrification. Subjects to be covered by the quality system have to include project planning, procurement procedure, quality control of the components, operation, maintenance, waist disposal, recycling and so on. To establish quality system ISO-9000 series is the best practice because it is the international standard and there are many authorization institutes in the world.

For the SHS modules and balance of system components certification an effort to develop a single global standard is underway by the PV GAP (Photovoltaic Global Approval Program) The PV GAP has been established in 1996 supported by the World Bank, aiming to setting up of SHS quality standards for PV dissemination programs in under developing countries but it seems on its infancy. PV GAP is domiciled at the central office of the ECA in Geneva and works closely with IECQ (IEC's Quality Assessment System for Electronic Components). In May 1999 representatives of world PV industry, standard organizations, the World Bank and developing countries got together for the first PV GAP conference in Geneva by the invitation of PV GAP, UNDP and Swiss government. The aim of the conference was to develop a consensus on two proposed manuals, one for quality manufacturing processes based on ISO 9000 and the other for testing laboratories based on ISO/IEC Guide 25.

A goal of PV GAP is established by the founding members as follow, "PV GAP is a global PV industry-driven organization that strives to promote and maintain a set of quality standards and certification procedures for the performance of PV products and systems, to ensure high quality, reliability and durability" and may be symbolized to issue quality labels for the SHS and its components based on the single standardization system.

Maintenance of quality is a critical issue for large-scale deployment programs of SHS in under developing countries. Especially when the international financing, such as the World Bank or bilateral co-operations are implemented. Although, it seems that there are number of objects remained to be cleared to get international consensus on the PV GAP system completion.

To date, two comprehensive documents have been issued regarding to SHS international standards, one is the "Quality Standards for Solar Home Systems and Rural Health Power Supply" issued by GTZ February 2000 other is "Universal Technical Standard for Solar Home Systems", Themie B SUP 995-96, EC-DGXV II issued by University of Madrid (Spain), funded by European Commission in 1998. In preparing both of the documents all of well-known national and international institutions were contacted. They are contains very useful information and documentation obtained from the World Bank, World Health Organization (WHO), IEC, the European standards institution (CNELEC), the U.S. standardization office (IEEE) as well as a series of projects, firms and experts were compiled and evaluated. Under the circumstances it is very important to watch the international activities on the standardization activities.

Meanwhile, there is a sophisticated institute to handle the standards in Senegal named ISN (Institute of Senegal National Standard) and PV is taking a position of the CT13 "solar energy". To set up the Senegal PV national standards it is essential to have conformity with international standards. In case of local standards establishment for which has no international standard exist, INS can make the great contribution to the world SHS standardization society reporting their activities.

For the time being the issue of the Senegal quality label seems practical solution for the government controlled PV projects. ISN may request suppliers to submit certificates for their goods referring international standards and testing laboratories for INS evaluation activity.

Since the rural electrification practice have to have wide range of peoples and organizations from deferent fields, it is better to cover all of major participants and their activities have to be made based on the quality plan. These issues shall be discussed in other paragraph entitled Manual for government activities as well.

STRUCTURE OF ISO 9000

ISO 9001	ISO 9002	ISO 9003
*Designing *Growth		
*Production *Installation	*Production *Installation	
*Final inspection *Test	*Final inspection *Test	*Final inspection *Test
*Service attached	*Service attached	

ISO 9000 or 14000 for manufacturers
ISO Guide 25 for Testing Laboratories

2) Current PV Standardization Promotion Institutes in Senegal

The decision to submit PV activities into the quality policy is up to the project owner. In the case of Senegal this is the responsibility of MEH and ASER.

Let's point out the Senegal quality control committee that was created in 1998 by order of the Minister of Energy and that was in charge of the coordination of the quality plan for PV equipment.

The quality control committee of Senegal comprises:

- The director of Energy who is the president of that committee
- The Director of Industry, vice president
- The Director of CERER executive secretary-ship

Beside of these persons the following members are involved.

- One representative of the Division of Maintenance of MEH,
- One representative of the Senegalese standardization Institute
- One representative of the Department of Sciences from CAD University
- One representative of Ecole Superieur Polytechnique
- One representative of the Delegation to Scientific and Technical affairs (DAST/MESRS).
- One representative of the Division of Energy
- One representative of SENELEC
- One representative of CERER.

On the initiative of the GTZ project, the CT13 "solar energy" committee was created in 1998 inside the Senegalese Standardization Institute. That committee, composed of four groups has to prepare national standards for PV application and includes:

- Representatives of research centers

- Representatives of the Senegalese administration
- PV suppliers and installers

Work team No. 1 - PV modules: that team, under professor Mansour KANE director of CERER prepared three documents on PV modules. These documents are presently being revised and will very soon be submitted to public investigation process before being approved as national standards.

Work team No. 2 - power conditioning: this team, under professor Gustave SOW from ESP prepared a document relating to the specifications and testing conditions of SHS charge controllers. This document is as well under revision and will soon be submitted to public investigation before its approval.

Work team No. 3 - electrochemical storage: this team led by professor Mamadou ADJ from ESP issued to two documents. The first one is relating to the characteristics and testing conditions of lead-acid batteries.

The second one is about electrolyte and addition waters for lead-acid batteries. At the instance of the documents prepared by the two first teams, this document is under revision and will be submitted to public investigation for approval.

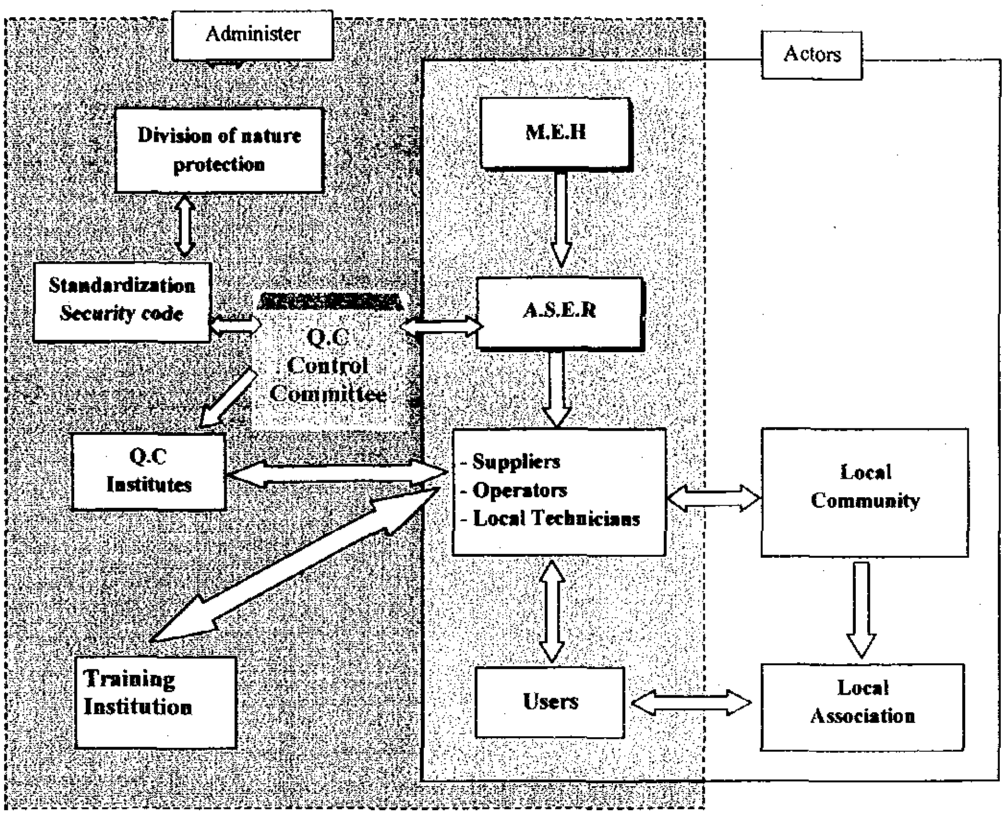
Work team No. 4 - PV systems: This team under Gregoire CISSOKO and so far has not prepared any document.

The objective of the CT13 - quality control laboratory is not only to prepare national standards and carry tests on PV components but also deliver quality label to the local PV suppliers. The laboratory after testing the components imported by a supplier, will submit the results to the Senegalese Standardization Institute for delivery of the national quality label. This procedure will help operators and users in their future selection of PV system.

3) Proposal of Total Quality Control Structure

Present work of the CT13 "solar energy" committee of ISN (Institute of Senegal National Standard) seems concentrating on technical matters, but it will be recommended to include administrative matters like organizations, documentations, safety, environmental protection etc. The organization chart of the quality control procedure could be shown on next page.

Total Quality Control Structure Proposal



4) The current PV Components Quality Control Procedure

A laboratory that has been fitted out by the solar energy Senegal - German project, presently carries quality control of PV components. This laboratory is mainly destined to the testing of SHS Components. Besides, endurance tests (life lasting tests) are carried in CERER, there is Quality complementarities agreement between the laboratory and the CT13 technical Committee of the Senegalese Standardization institute. The national standards, which are fixed by this committee, will be used as the basis of tests conducted by the laboratory of CERER.

The following test can be performed in that laboratory:

On Modules

Since there is no solar simulator, the only tests that can be carried on modules are performed using natural light. The performances of the modules tested are recorded in the memory of high-resolution digital oscilloscope. Their data are then transferred on of floppy disc and proceeded using a computer.

The measured intensity can be calibrated using mathematic models to make comparison with data reported by the maker.

However, the performances recorded in these conditions may not be accurate and consequently may be used to confirm the data provided by the maker but are not enough to qualify the modules.

The Authorized laboratories internationally normally qualify modules. (JRC, ISPRA, TUV-RHEINLAND, etc) and the certificates delivered by those institutes exempt from detailed test on modules at the national (local) level. Nevertheless, if the requisite equipment were available the laboratory of CERER would be in a position to conduct detailed testing.

Charge Controllers

The laboratories that can conduct testing of small size charge controllers are very few all throughout the world. Such tests are generally carried out by the research institutes of FRAUNHOFER INSTITUTE-FREEBURG, FLORIDA SOLAR ENERGY CENTER, etc.)

The testing procedure used by CERER was prepared in collaboration with FRAUNHOFER INSTITUTE-FREIDBURG and are carried in the same conditions.

In CERER the following tests are conducted on the charge controllers:

The pre-test that includes several stages: identification of the product, verification of the mechanical characteristics and the electrical characteristics.

The operation tests that allow:

- Verifying the regulation Thresholds

- Control of the maximum permissible current of the charge controllers.
- The detailed tests which aimed at verifying the electric performances, the protection capacities, as well as electromagnetic compatibility of the charge controllers.

These tests are carried using well-adapted high precision equipment and provide accurate results.

The tests can be carried on charge controllers which maximum current does not exceed 20 Amps, corresponding to the power of the equipment of the laboratory. No test relating to the life duration of charge controllers is carried.

Batteries

In Senegal the most used batteries for PV applications are the Lead/acid type. Consequently the tests carried in the laboratory of CERER mainly focus on lead/acid batteries.

Presently CERER carries the following types of battery test:

Pre-tests meant to verify the mechanical and electro-chemical characteristics of the batteries

Operation test in order to identify the nominal capacity of battery and therefore provide for its conditioning

Detailed tests that include the three tests below:

- Capacity tests
  The capacity tests make it possible to verify the nominal capacity of the battery. Five charge/discharge cycles being carried, the nominal capacity should be recovered during these five cycles.

- Gassing current
  The measurement of the gassing current is to identify characteristic of energy performance of the battery, the rate of losses within the battery.

- Charging speed
  One of the main characteristics of the batteries used for PV application is its capacity of adaptation to a charge depending on the sunshine duration in one specific site. These tests allow the verification of the charge speed of a battery after discharge. Besides it allow the confirmation of the rate of losses within the battery through the identification of the charge factors.

  In addition to the tests that are presently carried by CERER, two types of tests that were not carried before because of its high cost and duration could be introduced in the future. These are:

- Endurance tests
  Endurance tests define ability of battery to withstand operation under specified conditions for a minimum period of time.
- Charge retention tests
  Establish the capability of the battery to retain charge by means of test for the case where the battery may become electrically disconnected either normally or accidentally.

Fluorescent Lamps Fitted with Electronic Ballast

The usage of fluorescent lamps fitted with electronic ballast in PV applications allows optimizing of energy performances of the systems; this concludes that the lamp-ballast set respects certain standards. Manufacturers maker doesn't provide enough information to appreciate if these lamps meet the requested standards or not, consequently it is necessary to test them.

The laboratory of CERER carry electronic ballast testing accordingly standard document of the TÜV-RHEINLAND base on the CEI 901,925 and 458 standards.

The tests carried are listed below:

- Pre-tests
- Operation tests
- Detailed tests

5) Standardization of SHS Capacity

From the technical aspect, the capacity of SHS should be determined based on the energy demand. However from the viewpoint of market oriented dissemination strategy, a user-acceptability should be considered which, can be obtained from social and economical study. Although there are no energy consumption-data based on practical experience in developing areas, but actual capacity selected by large scale projects were 40-50Wp. Quoting from the "Universal Technical Standard for Solar Home System-Thermie B:SUP-995-96 page 31)", "This is because PV designers know that such systems are generally well accepted by the users, and the scenarios elaborated by them must therefore be interpreted as explanation exercises, rather than as designs for systems starting from an evaluation of actual needs". Imaging a SHS as a complete DC system with 12V batteries that energize lights, radio and B/W TV, we need 16V(power max.) or higher voltage PV panels to charge the batteries which means 36 unit cells series connected module. As a mater of fact these modules were popular in the world market at that time as 40-50W modules for a battery charge. It seems they selected 40-50Wp modules from the availability at the market as well.

However, it is essential to define "standard SHS for large scale PV projects, not only for users needs but to establish a technical reference for tenders and Q.A., QC. Procedures etc.

The "Universal Technical Standard for Solar Home System-Thermie B:SUP-995-96 page 31" recommends that "the energy design daily consumption value must be selected in the range 120-160 Whs day" as the it is equivalent to 40-50Wp.

Since the SHS shall be installed remote area where is not easy to access for maintenance, from the view point of reliability lager is better but, lager is higher at cost. It is a paradox of reliability and cost. Best solution for the system sizing is a trade-off to find between reliability and cost, referring social condition of the installation area.

Thanks for the technology improvement the amperage of each call is coming up while the voltage is not changed, so the modules suitable for battery charging have improved its wattage from 50W to 55W or more. Now 50 watt or under is a not realistic option at the market.

Considering average production of the industry and users needs two types of systems could be proposed:

- Level 1: 50 Wp class (for lighting, radio and B/W TV)
- Level 2: 100 Wp class with inverter (for lighting, radio and color TV)

Some people say it better to have much smaller system for the PV the diffusion, but it is not economical by mean of cost performance, because of O.M cost and electrical loss, and once they get use to the equipment they want to have much higher performance. Consequently, it is easy to break down caused by improper operations like direct connection into the battery terminal to get extra power. It is recommendable to use solar lanterns for the purpose of smaller than 50 W SHS for lighting purpose only.

6) Installation and Operation

As defined by the Strategy of ASER, the direct actors of rural electrification will be:

- The rural electrification operators including SENELEC
- The supplying and installation companies
- The users and local communities
- The project operator should come from private or associate sectors.

The operator can be an individual entrepreneur or a consortium of entrepreneurs. The operator will intervene within the scope of a protocol of accord passed with the village(s), the local community.

ASER will periodically open tender call for the allocation of the rural electrification concessions. The areas covered by the concession could be one rural community or several rural communities. The tender will be called based upon schedule of conditions previously prepared by ASER. Those schedules of conditions will specify the legal, financial and technical responsibilities of the operators. Operators who have prepared their own project may as well submit for a concession to ASER. The model of concession could be of integrated type either horizontally or vertically so that several operators can intervene in various specific electrification fields: installation, operation, and maintenance. Local technicians trained in the respect can carry maintenance of PV equipments and who will relate to the operator on specific contract basis.

Documentations of the concession to be issued and evaluated in ASER, all of above activity need to be standardized.

7) Training of the local technicians

The training of the local technicians will be carried by specialized training institutions, CFPT and CNQP, offering variety of training program that can be adapted to the applicants who have different levels of education back-ground. In this regards the concept of quality control also needed to keep final skill of the attendant.

8) Conclusion

The wide scale PV electrification actions will be guaranteed by a symbiosis of the various components of quality assurance process described above. The quality policy assures all of participant activities to be harmonized for the success of the Senegal rural electrification.

7.2 Recommendations to ASER for Promoting Public-Private Initiative Rural Electrification

The recommendations for promoting the public-private initiative rural electrification are discussed in this section. The imminent recommendations already addressed in Chapter 4 are presented on Table 7.2 and the short-term, mid-term and long-term recommendations are presented on Table 7.3.

(1) Institutional Capacity Building of ASER

The institutional capacity building could be constructed, not through discussion and document writing, but through producing the outputs and direct contacts with the beneficiaries. In case of ASER, at this moment, the staff should produce appropriate range of tariff for "fee for service" to be adopted for the financial proposal by working on the proposed Business Model and after that have contact with as many rural community as possible at the field. Through such process of tariff setting, the institutional capacity will be built up and the reliable relationship will be hopefully created among the private sector.

Concerning "tariff setting", ASER as an executing agency for the rural electrification under the public-private sector initiative, should be allowed to exercise a proper discretion. In addition, taking the opportunity of continuous monitoring in Mar Island, ASER should be positively involved in the local capacity building (community empowerment) and be accustomed to take proper and flexible actions in cope with variable socio-economic situation of the local community by area. The final decision on tariff setting will be subject to the approval of Electricity Sector Regulation Commission (CRSE). Therefore, CRSE is also advised to be involved in this critically important subject from the outset.

In this context, it should be reminded that there is no better way to create partnerships and collaboration and lay the foundation for long-term success than through participatory development, that is the process that involves local people in determining needs, setting priorities, and planning for the future.

(2) Facilitation for Implementing PV Rural Electrification

Getting renewably generated electricity to the millions who need power is said to pose many challenges:

(a) Renewable energy technology often is not recognized as a viable alternative by government, business, and individuals within developing countries

(b) Government policies and business practices are designed to support traditional utility systems

(c) Without established markets, it is difficult to attract commercial renewable energy service and equipment providers

(d) Financing mechanisms that will help rural people purchase equipment are rare

(e) Support for entrepreneurs or businesses interested in developing renewable energy projects from both the private and public sectors is limited

(f) In-country experience for design, installation, service, and maintenance of renewable energy systems is weak.

The above (a) is well recognized as an important alternative by the Government. Thanks to the efforts of GTZ over a period of more than 10 years in Senegal, the above (f) has been already solved. Among others, first importance should be placed on the above (c) and (e), which are vital to realization of the public-private initiative rural electrification. The above (b) will be solved through the process of (c) and (e). The above (d) will be dealt with by the Government, in cooperation with financial institutions through the implementation of the real projects.

As addressed in Chapter 4, the tax and duty structure, related to the above (e), is recommended to be reviewed by the government for facilitation of this scheme. Governments should rationalize duty and tax structures, if these discriminate against PV development. Relatively high import duties and other taxes (particularly on PV modules) can severely limit the potential for commercially viable, market-driven solar home system programs. Duties and taxes on PV system components raise the financial costs of solar home systems. Political decision will be more or less, required to tackle the challenging task of public-private rural electrification.

The following remarks, related to the above (c), should be well addressed in the public relation campaign by ASER

"Grid-based electricity has only been the mainstay of rural electrification efforts. However, the increasingly high cost of serving isolated and remote communities burdens government budgets. A large proportion of rural needs for household lighting and small power requirements can be met by solar home systems at a lower economic cost than grid service. In locations where PV household electrification is the economically viable option, governments must explicitly consider and encourage solar home system diffusion in lieu of grid extension. Political reluctance to specify areas unlikely to be served by electricity grids within 5-10 years raises unrealistic expectations among consumers, who may believe that grid service will arrive in the near future. This expectation dampens efforts to market PV systems."

Consumers are reluctant to purchase what is perceived to be only a short-term solution. Instead, explicit government support of solar home system programs for isolated, or remote villages, or unserved portions of electrified communities can help PV meet low load demands and prevent uneconomic extension of the rural electrification grid. Therefore, private sector participation in such programs should be encouraged.

Apart from the scheme, by investing directly in PV equipment as part of education, health, and other social programs, governments can also play an important role in establishing the infrastructure needed to sustain PV systems. This task will be taken care of mainly by Direction of Energy, MMEH. This is also very important for diffusion of PV system.

Finally, for facilitating the public-private rural electrification, some per-cents, say 2 to 3 %, imposed on the electricity charges for urban population, which is intended to be exclusively used for the rural electrification, are very attractive for this scheme. Because the fund for subsidy and loan could be secured permanently and also this will contribute to acquire the confidence from the international financing institutions.

Furthermore, this will be a big incentive to the private sector, contributing to risk mitigation retained by to private sector.

(3) Human Resources Development -Effective Management and Support Services-

It should be noted that a successful PV program needs well-qualified PV experts and technicians. As verified in the Pilot Project in Mar Islands, local recruitment is advisable since people from the community who are known and trusted are more effective than workers from outside the area. This, however, will often necessitate extensive training. Managers need to be proficient in business, marketing, and financial operations and to have access to information, technical assistance and ongoing training to update their skills. Adequate salaries and benefits are also required to retain qualified managers in rural areas. That is why the private entity with such capable managers, should be fully engaged in the project at the outset in the present launching stage. This idea has been reflected in the project formation of the Business Model. In addition, technicians must be trained (and given periodic refresher courses) in order to assure responsive repair and maintenance services being an often under-emphasized aspect of PV programs. Technicians also need appropriate tools and transportation as well as locally available supplies of spare parts.

Table 7.2 Action Plan of ASER

ASER is now tackling a challenging and urgent task for the market arrangement for public-private initiative rural electrification.

To facilitate the tasks, among others, the first priority should be placed on the following three (3) items. Among the three items, the item 1) and 2) should be executed immediately. The execution shall be carried out in the order of number through communication and dialogue among the parties concerned.

1) Regular Dialogue with the Potential Operator and Private Sector

More dialogue with potential operator(s) and the private sectors such as PV suppliers, electrical companies, development consultants and NGOs, will be required at this moment in order to make more practical the Financial Model proposed in the previous section, which fund source for subsidy and loan shall be clarified to them.

2) Global Campaign for Rural Electrification by ASER

Explanation of the ASER's rural electrification strategy to un-electrified rural communities.

3) Early execution of a real project under the initiative of ASER

Procedure Manual should be improved through the implementation of the pilot project. ASER should take initiatives and implement the pilot project as soon as it could. The most important aspect of the PV market operation is to establish the common framework of the personnel concerned with the project through the implementation of the pilot project.

Continuous Monitoring of JICA Pilot Project

When the study is completed, the monitoring activity of the JICA pilot project will be transferred to ASER. The budget for monitoring should also be arranged by ASER. The result of monitoring should be reflected not only on the O & M of PV electrification, but also on the progress of rural development and the pilot project in Mar Island. In particular, it should be recognized that the community empowerment is one of the most important aspects in this process.

Table 7.3 Toward PV Market Arrangement for Rural Electrification

		Short-term	Short/Mid-term	Mid/Long-term
1	Sustainability of Pilot Project	• Set-up of monitoring unit, named" Mar Islands follow-up unit", after transfer to ASER • Support for Capacity Building in Mar Lothie (Community Empowerment) • Training of Local Technician for advanced course (10 days) in CNQP • Allocation of sufficient budget for continuous monitoring	• Preparation of information system on proper utilization method of electric appliances (efficient utilization method of LED lamp, electric appliance due to change in option, etc.) (Operator/MATFORCE) • Preparation of logistics point for spare parts in rural area (This should be taken care of by the private entity through actual business activities, from his own marketing strategy) • Public relation of "Model Village" for PV rural electrification	• Reinforcement of existing institutions for training and education of local technician, which is advised to be promoted to the authorized one capable of issuing certificate to the technicians (Training the local technician so as to become an external technician with similar capability) • Dissemination of banking mechanism inherent in banks (savings and loan) and establishment of fee collection system through banking mechanism in Pilot Project (Dialogue among ASER, Operators and Banking Institutions) • Business activities such as sales of other electric appliances like color-TV, refrigerator, etc. (These kinds of activities should be promoted by the private sector with support of ASER from the viewpoint of rural development, particularly in institutional capacity aspect)

		Short-term	Short/Mid-term	Mid/Long-term
1	Facilitation of mutual understanding between the private sector and ASER	Dialogue between ASER and Potential Operators, focusing on Business Model		
2	Clarification of incentives to the private sector	Clarification of fund sources for subsidy, loan guarantee, etc.		
3	Public commitment of rural electrification policy to the population	Global campaign of the rural electrification under the initiative of ASER, focusing on the role and the responsibility of the rural population and necessity of "Community Empowerment" (Objective of human resources development in rural community)		
4	Public Consultation (Role and significance of PV rural electrification)	Public relation on impact of PV rural electrification and necessity of "Community Empowerment" for the rural development	Continuous monitoring in Mar island and economic/technical support toward self-sustainable society	Selection of Mar Island as Model Village for PV Rural Electrification (Due attention to the current evolution of development related to business activities of the private operator, and the perspective of the future development)
5	Community Empowerment	Public consultation on necessity of "Community Empowerment"	*Technical and financial support for* development of community coordinator	
6	Training of local technician and reinforcement of existing training center	Training and education of PV Technical Experts	Training and education of PV Technical Experts through actual project implementation	
7	Dissemination activity for financial mechanism penetration into rural community		Public relation activities for financial mechanism and its relation to the rural development	

		Short-term	Short/Mid-term	Mid/Long-term
8	Standardization of PV system and Certification 1. Obligation of attachment of test report for major components 2. Obligation of quality certification by the authorized institution 3. Capacity reinforcement of CERER	1. Applicant of subsidy (Specifications of system component, manufacturer, testing institution, etc.)	2. Legalization of CERER as publicly authorized institution and assignment of authority for document appraisal, execution of necessary tests, etc.) 3. Staff reinforcement and participation in seminar for technology standard to the international level	2. Legalization of CERER as publicly authorized institution and assignment of authority for document appraisal, execution of necessary tests, etc.) 3. Staff reinforcement and participation in seminar for technology standard to the international level
9	Training of local technician and Maintenance of technology level 1. Set-up of repair center in the rural area 2. Issuance of license to certified technicians		1. Set-up of PV center in the existing public facilities (ex. school), for education purpose as well 2. Contribution to creation of job opportunity for the certified technician as teacher and Provision of regular level-up training course in Dakar	1. Set-up of PV center in the existing public facilities (ex. school), for education purpose as well 2. Contribution to creation of job opportunity for the certified technician as teacher and Provision of regular level-up training course in Dakar
10	Establishment of organization for exchange of technology and information among the institutions concerned		• Publication of news letter and magazine (introduction of technicians activities in project site • Public relation activities by ASER (introduction of past performance of PV rural electrification)	• Publication of news letter and magazine (introduction of technicians activities in project site • Public relation activities by ASER (introduction of past performance of PV rural electrification)