5. Installation of Pilot Plant

5.1 Purchase and Transportation of Material

5.1.1 Purchase of Material

(1) Domestic Procurement

Solar Cell Module (Poly crystal and Monocrystal)	138
Pole for Module Mounting	67
Controller	63
Storage Battery	69
Battery Box	59
Nonfuse Breaker	60
Main Switches	185
Cable (two cores, three cores)	7,400m
Sulfuric acid (included in battery)	25bottles

(2) Local Procurement

Fluorescent Light with Tube (20w,11w,7w)	177
Switch with 1/4w LED Light	58
Switches	238

5.1.2 Transportation of Material

(1) Japan to South Tarawa

Transported by cargo ship in three wooden container.

(2) South Tarawa to North Tarawa (Abaokoro)

Transported by boats as depacked each compornents.

(3) Abaokoro to each villages

Transported by JICA truck, boat and cart.

Table 5.1-1 Transportation of passengers and materials

Date	From, To,	Kind of boat	No. of Passenger	and kind of Materials
Jan.10	S.to N.to S.Tarawa	Trimaran	8	Battery,Cable,etc.
11	ibid.	ibid.	7	Sulfric acid, etc.
12	ibid.	ibid.	7	Panel,Pole, etc.
14	S.Tarawa-N.Tarawa	Speed boatx2	9	Assembled parts
16	N.Tarawa-S.Tarawa	Canoe	4	
17	ibid.	Speed boat	3	
18	S.Tarawa-N.Tarawa	Speed boatx2	9	Assembled parts
23	N.Tarawa-S.Tarawa	Speed boat	4	
24	N.Tarawa-S.Tarawa	Canoe	3	
25	S.Tarawa-N.Tarawa	Speed boatx2	8	Assembled parts
29	N.Tarawa-S.Tarawa	Canoe	2	
31	N.Tarawa-S.Tarawa	Canoe	1	
	S.Tarawa-N.Tarawa	Canoe	3	Purchased materials
Feb. 3	N.tarawa-Kainaba	Trimaran,Canoe 4WD Car	17	Panel,Pole, etc. Battery,Sulfric acid,
5	Kainaba-N.Tarawa	Trimaran	12	
	Kainaba-S.Tarawa	Trimaran	5	Reserve parts
6	N.Tarawa-S.Tarawa	Trimaran	2	
8	S.Tarawa-N.Tarawa	Trimaran	7	
9	N.Tarawa-S.Tarawa	Trimaran	5	Reserve parts
	N.Tarawa-S.Tarawa	4WD Car	2	Reserve parts

5.2 Installation of PV System

(1) Assemble works of parts

a. Assemble of night light(1w)

Number: 60

Assembled by SEC

b. Assemble of control board

Number: for Maneaba(24V) 2

for household(12V) 55

Assembled by SEC and Study team

c. Assemble of fluorescent light

Number: 20w(24V) for Maneaba 4

11w(12V) for household 55

7w(12V) for household 110

Assembled by SEC and Study team

(2) Installation of Systems in each villages

PV systems were installed after assembling of some compartment at SEC office in South Tarawa and transported to North Tarawa, the installation schedule is shown on Table 5.2-1.

(3) Learning from the installation works

a. Transportation

The means of transportation from South Tarawa to the place of installation should have surveyed at the pre survey study and have to be arranged before the installation team arrived.

The material should be packed in the size and weight that can be handled by less than two workers.

The four wheel driven truck was very convenient and useful in this study.

the transportation was much affected by the state of tide so the tide table was an important information for this study.

b. Procurement of local material

The fluorescent lamps were purchased in local but the distinction of fittings of 12V type and 24V type was not clear that they were mixed and after installation some were obliged to be replaced by SEC staff and the study team.

There are shops dealing electric parts, wiring kits and tools in South

Tarawa but the quality is not enough such as so salty atmosphere or hard use.

Coconut rope(string) was very useful for fixing or binding cables and light fittings.

c. Installation

The ground is sand or coral rock that was difficult to dig a narrow deep hole for installing the PV panel/pole using simple tool and the level of underground water was about 80cm to one meter below ground surface.

It was difficult to get the gravel washed by fresh water so the strength of concrete mixed with such gravel should be less than normal one.

Some of lumber used for the columns and beams of houses were very hard that screw nail was hardly fixed by handy screw driver.

d. Technicians and Workers

They were good workers through the all installation period, the study team was satisfied their work.

For the technicians, they had a keen interest in the technology of the PV system and learned the know-how of installing the PV system that should be applied for succeeding EC PV project.

Table 5.2-1 Installation schedule of the PV system

P: Installation of PV panel/pole
W: Wiring of PV system

Date	Abaokoro	Notoue	Taratai	Marenanuka	Tabonibara	Kainaba
Jan.14	P					
15	P W					
16	P					
17						
18						
19	W	P				
20	W	P	P			
21	W			P		
22	W				P	
23						
24						
25						
26	W					
27	w	W				
28		W				
29		W				
30		W	W			
31						
Feb. 1				W	W	
2					W	
3						P W
4						P W
5						W

Number of PV system installed

	Abaokoro	Notoue	Taratai	Marenanuka	Tabonibara	Kainaba
Household	25	15	2	3	6	4
Maneaba						1

5.3 Changes in between the Planned and Executed Design and their Causes

The following summarizes the changes in wiring design from that originally planned and the reason for change.

(1)Basic Concept of the Initial Wiring Design

At the time of initial planning, the system that would be installed in each applicant's houses was investigated by the study team. This survey considered the following items and applicant's wishes at the time.

(a)For selecting the PV module installation site, the following items were considered.

- As close to applicant's house as possible.
- Not affected by shade from trees, etc.

(b)For locating the switchboard, the following items were considered.

- Out of children's reach and operation and maintenance is easy.
- Not likely to interrupt the applicant's daily activities.
- Installation is easy.

(c)For locating the battery and its storage case,the following items were considered.

- Out of children's reach and access and maintenance is easy.
- Not likely to interrupt applicant's daily activities.
- Well ventilated and far from any open fire
- Close to the switchboard
- Installation is easy.

(d)For locating the fluorescent lamps, the following items were considered.

- Even lighting in the room.
- Out of children's reach and access and maintenance is easy.
- Installation is easy.

(e)For location of the on/off switch, the following items were considered.

- Near the entrance of each lighted room (basically).
- Installation and operation is easy.

(f)For the wiring, jointbox etc location selection, the following items were considered.

- Installation is easy.
- Inconspicuous

(2)Conclusion

The electric system of each applicant was designed based on the above criteria. Between the time of the design survey and the installation, several changes took place.

- Cancellation and change of applicants

・A change in the applicant's place of residence
・A change in the environmental condition (interior layout, trees etc.)
・A change in the applicant's wishes which occurred after seeing the actual equipment.

During the construction based on the initial plans, we discussed the location of all components again with the customer and then located the components according to the customer's requests.

Through this experience, we learned that before planning for component locations the customers need to be aware of the actual equipment and consideration must be given to changes in environment, etc.

(3)Type of Changes from Original Plans and their Reason

(a)House

①Alternation of houses to receive the PV system

The following Table 5.3-1 shows the details of how houses changed from the original survey to the actual installation as classified by villages.

Table 5.3-1 Number of Change in Houses in Each Village

Name of Village	Number of House (actual)	Number of House (planned)	Type of Change in house		
			Increase (from plan)	Decrease (from plan)	Difference (from plan)
Taratai	2	5	1	4	- 3
Notoue	15	12	5	2	+ 3
Abaokoro	25	20	8	3	+ 5
Marenanuka	3	5	0	2	- 2
Tabonibara	6	4	3	1	+ 2
Kainaba	4	9	0	5	- 5
Total	55	55	+ 17	- 17	0

·Reason for Change:

As explained by the SEC,

*Contract money (A$50) was not provided.

*Monthly payment was not continued.

For these financial reasons, some applicants decided not to install a PV system though at the time of the initial survey they requested a system.

(b)Changes in the location of system components

A survey was made to determine the changed reason for changing the location of the system components by sampling 26 houses out of the 36 houses of users requesting a change.

The result is shown in Table 5.3-2.

Table 5.3-2 Number of Changed Location

Reason of change	Number of change
Place of residence itself etc.	13
Furniture placement, Interior changes, Changes in trees etc.	5
Householder's demands	8

(b)Maneaba

①Change of Lamp Circuits

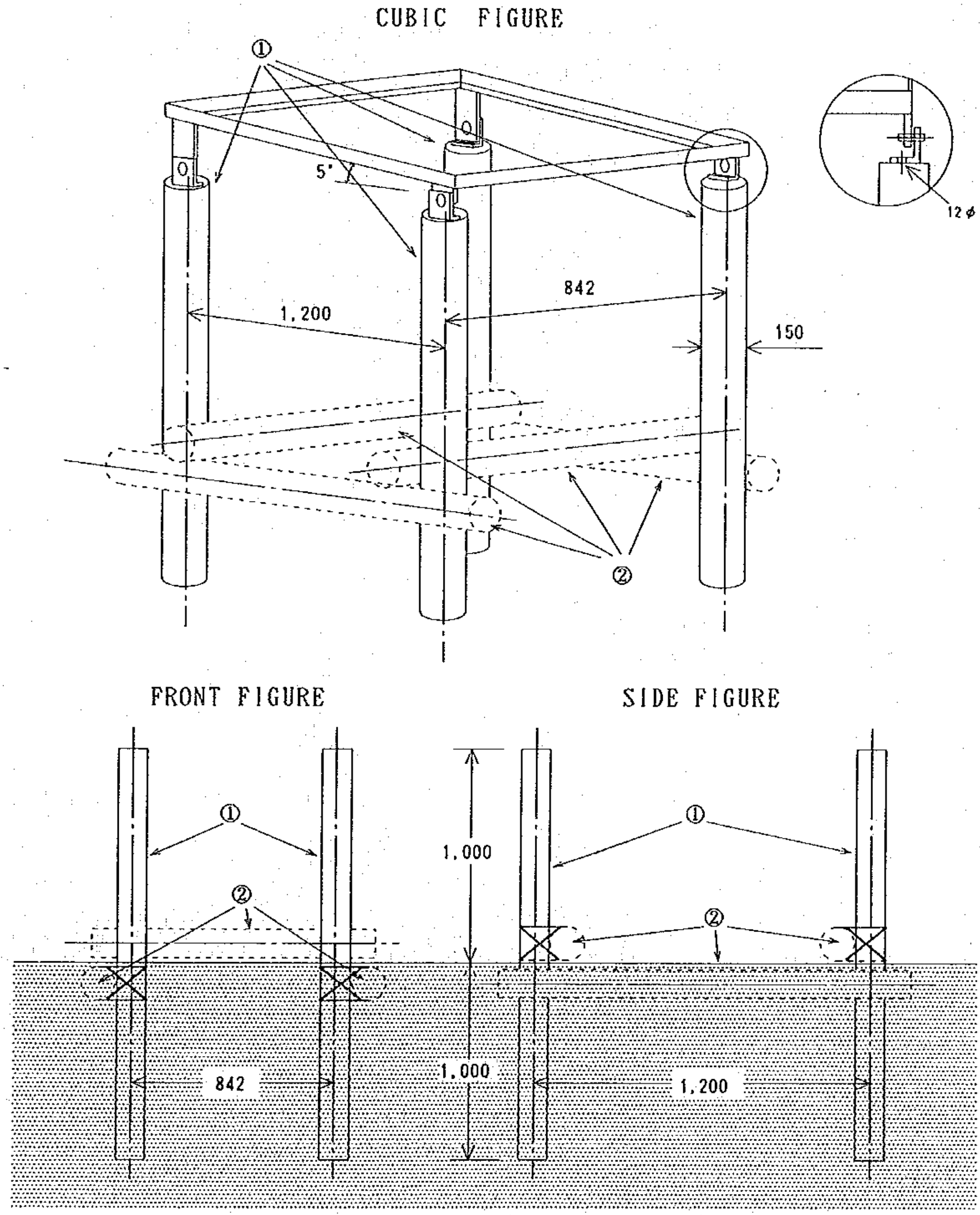
The elders and villagers of Kainaba Village stated that:

·The Maneaba is a place used jointly by many villagers, and it is best that the lamp switch be near to the area to be illuminated so it is easily controlled by the persons using the light.

Based on this request, the initially planned "3-way circuit" having two switches controlling each lamp was changed to four lamp circuits each with 1 fluorescent lamp and switch.

②Changes in the method of mounting the modules:

The original plan of using coconut logs to support the modules was changed to PVC pipe filled with concrete because of problems with rotting of the wood. Also the post holes were dug with a mechanical digger and the planned beam between the posts was not needed so each post has an independent foundation. The detail of this structure is shown in Fig 5.3-1.



①:Vinyl Chloride Pipe(concrete filled)
②:Not Provided

Fig 5.3-1 The Detail of Structure

5.4 Installation of Meteorological Observation System

(1)Siting Place of Meteorological Observation System

This observation system has been sited on North Tarawa in the Republic of Kiribati

(a)Installation Date : June, 1992

(b)Installation Site : To the side of government branch office Abaokoro, North Tarawa

(c)Recording Method : Data recorded every 10 min.

Site is shown in Fig 5.4-1.

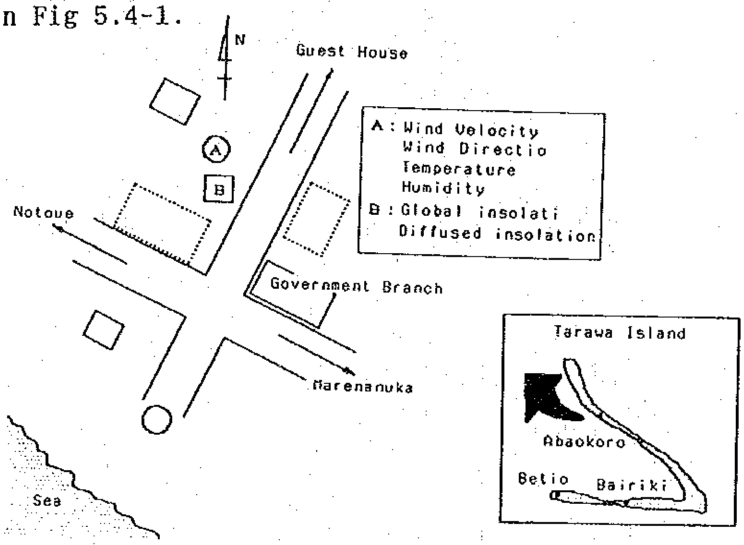


Fig 5.4-1 Site of Meteorological Observation System

(2)Parameters Measured

Parameters measured by meteorological observation system are shown in Table 5.4-1.

Table 5.4-1 Parameters measured by meteorological observation system

Instrument	Remarks
Wind Direction Wind Velocity Temperature Humidity Global Isolation Diffused Isolation	In Kiribati, it is inevitable to find shading from coconut trees so a measure of diffuse radiation is needed to allow estimation of the effect of shade on solar power generation. Records of the level of diffuse solar radiation are not available in Kiribati.

(3)Specification of Meteorological Observation Equipment

(a)Solar Radiation

- ·Radiation Sensor (with 10(m)-cable)
  Measuring range : 0~2.0(kW/m²)
  Output : 0~10(mV)
- ·Sensor holder
- ·Date-recorder (voltage integration type)
- ·Handy Card
- ·IC card 64kbyte 1 piece

(b)Direction and Velocity of Wind

- ·Wind-velocity Sensor (with converter)
  Wind direction measuring range : 0~360(°)
  Wind velocity measuring range : 0~40(m/s)(max. 60(m))→0~1(V)
- ·Pole (6m)
- ·Data-recorder (voltage integration type)
  for wind velocity
  for wind direction
- ·Data-recorder (strain, voltage type)

(c)Temperature and Humidity

- ·Temperature and Humidity sensor
  Atmospheric temperature measuring range -30~70°C / 0~1(V)
  Humidity measuring range 0~100(%)/ 0~1(V)
- ·Natural ventilation tower
- ·Power regulator 12(V),50(mA) lithium battery : 2pcs.
- ·Date-recorder (voltage type) for temperature
  Date-recorder (voltage type) for humidity
- ·IC card 64Kbyte 2 pcs.

(d)Softwares (for pc-9800)etc.

- ·Housing box of recording unit
- ·Control box : 7 pcs.
- ·Handy card IC card 64kbyte 8 pcs.
- ·Lithium battery (UM3-type)
- ·Standard software
- ·Software for wind-direction and velocity
- ·Software for voltage and solar radiation processing
- ·Gas-soldering iron 1 set
- ·Water-proof connector 7 sets

(4)State of Meteorological Observation Equipment

The state of meteorological observation equipment is shown in Fig 5.4-2.

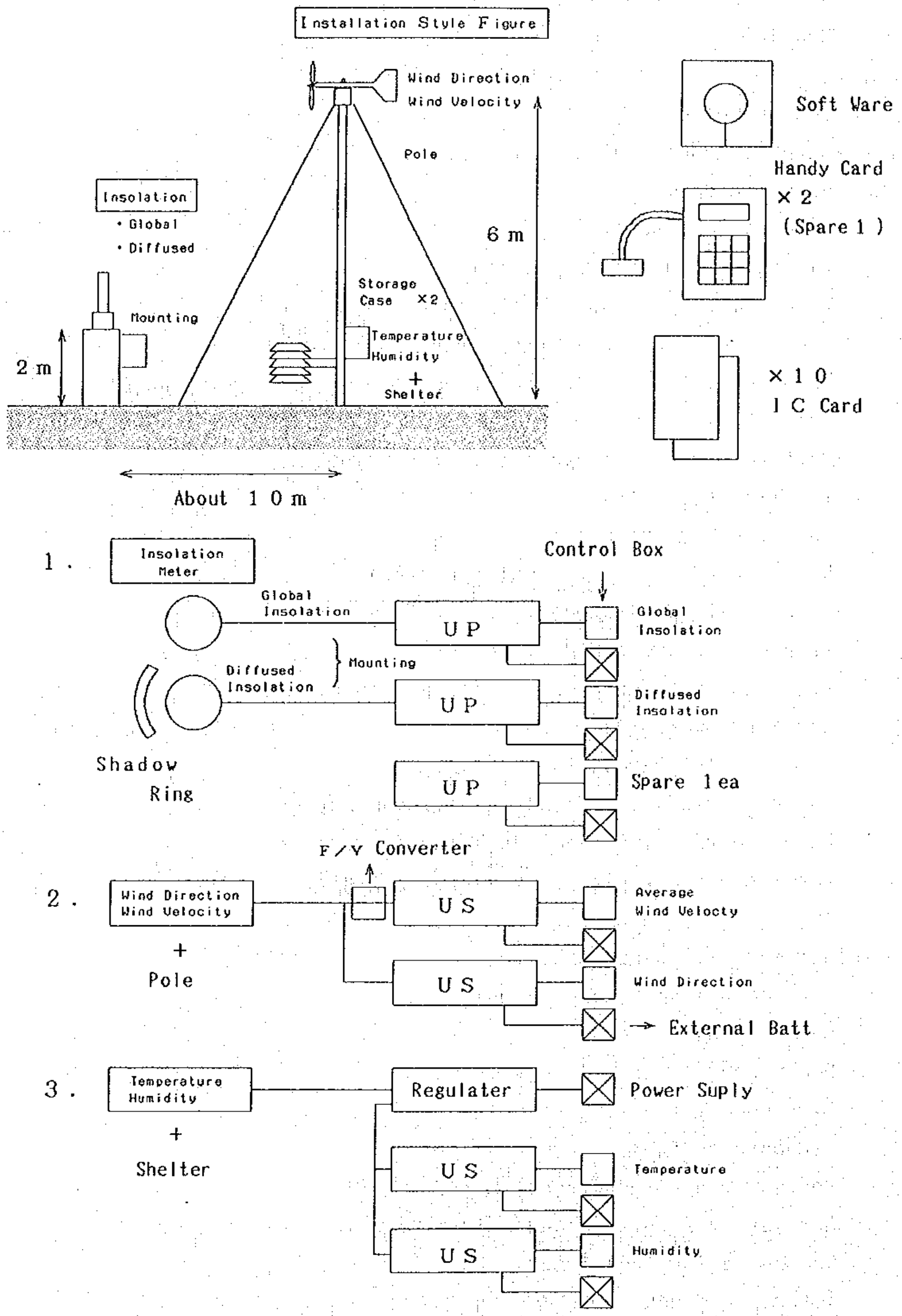


Fig 5.4-2 The State of Meteorological Observation Equipment

6.Maintenance and Fund Collection

6.1Maintenance

6.1.1Training for SEC Personnel

(1)Training for SEC Technical Management Personnel

The training for Kiribati's technical management personnel in Japan has been carried out on the following schedule.

(a)Schedule as a Series of 「A Study on Utilization of Rural Electrification in Republic of Kiribati」

Training executing plan

Person trained : Mr.Terubentau Akura

Training Schedule : Table 6.1.1-1

Table 6.1.1-1 Training Schedule (by Yonden Consultants (4C) 1992)

No	Date	Week Day	Training Items	Lodging Site	Person in charge
11	Sept.30	Wed	Moving Tokyo/Takamatsu Visit Kanden Rokko Island	Takamatsu	IEEJ /4C
12	Oct.1	Thur	Salutation 4C, Shikoku Research Ins Seeing Central Power Supply Commanding Station (10:30--11:30)		
13	Oct.2	Fri	Seeing Sakaide Thermal Power Plant (10:00--12:00)	Takamatsu	
14	Oct.3	Sat	Data Arrangement	Takamatsu	
15	Oct.4	Sun	Seeing Saijo Photovoltaic Power Plant	Saijo	
16	Oct.5	Mon	Seeing Saijo Thermal Power Plant and Honkawa Hydro PS	Matsuyama	
17	Oct.6	Tue	Seeing Ikata Nuclear PS	Takamatsu	
18	Oct.7	Wed	Practice : Electric Work Inc KK Shinsei Densetsu Co.,LTD	Takamatsu	
19	Oct.8	Thur	Practice	Takamatsu	
20	Oct.9	Fri	Practice	Takamatsu	

21	Oct.10	Sat	Data Arrangement	Takamatsu	
22	Oct.11	Sun	Data Arrangement	Takamatsu	
23	Oct.12	Mon	Practice : Electric Work Inc	Takamatsu	
24	Oct.13	Tue	Practice	Takamatsu	
25	Oct.14	Wed	Practice	Takamatsu	
26	Oct.15	Thur	Lecture, PVSystem Designing	Takamatsu	4C/
27	Oct.16	Fri	Moving: Takamatsu/Tokyo	Tokyo	IEEJ

KK Shinsei Densetsu Ind.

President Otohachi Sato, Vice Manager of Takamatsu Electric Work Union

Address : 2-21, 3chome, Matsushima-cho, Takamatsu City

TEL 0878-31-7691 Employees : 9 members

(b)Items for Practice at KK Shinsei Densetsu Ind.

①Schedule controlling from order-receiving to execution
②Schedule controlling for operations and workers
③Inventory control methods
④Product-ordering methods
⑤Corresponding with the clients
⑥Corresponding with the suppliers
⑦Fee-requesting method
⑧Fee-collecting method

(c)Items for Practice at Shikoku Electric Power Co.,LTD(Shikoku E.P.C)

The Items for Practice at Shikoku E.P.C is shown in Table 6.1.1-2.

Table 6.1.1-2 Items for Practice at Shikoku E.P.C Co.,LTD

Seeing Site	Necessary hour	Detail Area of Seeing Site
Saijo Solar PS	2.00	Solar Module, Control Room
Saijo Thermal PS	2.00	PR-Hall,Central Control Station
Honkawa Hydro PS	2.00	PR-Hall,Generator,Hydro-turbine, Peripheral Structure
Ikata Nuclear PS	3.00	Visitor's House,Central Control Station, TurbineHouse,LiftingWharf,WaterReleasing Route
Central Power Supply Commanding Station	1.00	Commanding Room,Simulator

(d)Training in Japan for Installation Work

The training is intended to cover the local tasks in installation of the solar electric systems as in [A Study on Utilization of Rural Electrification in Republic of Kiribati], and also, it is intended to improve the efficiency of the local work by training in the use of tools for the installation.

①Performing Time : Oct. 15, 1992

②Site : Bicycle-Placing site in Shikoku Research Institute.

③Participants of the Training

Takahashi, Semba, Hashizaki(4C), Tani(IEEJ), Takagishi,Yagi(Shoseki)
Akura(Kiribati)

④Training Items

Simulation is made of the constitution of local coconut-trees(trunk), and the following items are checked.

- Check of the components and tools
- Check of the materials and suitability
- Training for the mounting of components, distribution panels and cables.

⑤Mounting Site : Mounting Site is shown in Fig 6.1.1-1.

⑥Components,Materials, and Tools

Components, materials and tools that is used in this training is shown in Table 6.1.1-3.

Table 6.1.1-3 The List of Component, Material, Tool

	Items	Specification	Remarks
Compo-nent	Fluorescent lamp 11w Controller Battery	Purchased in Kiribati Made by Siemens	Sequence of mounting Components
Materials	Switch Cable Rack 3Way Switch Branch Box	15A Frame 10A VA 2.6mm*2c,3c	Procedure of work Mounting of materials
Tools	Compressing- pliers Pliers, Screw Driver Sack for Pliers Safety Belt		Proper using method of tools

The outline of Training site(Bicycle-placing)

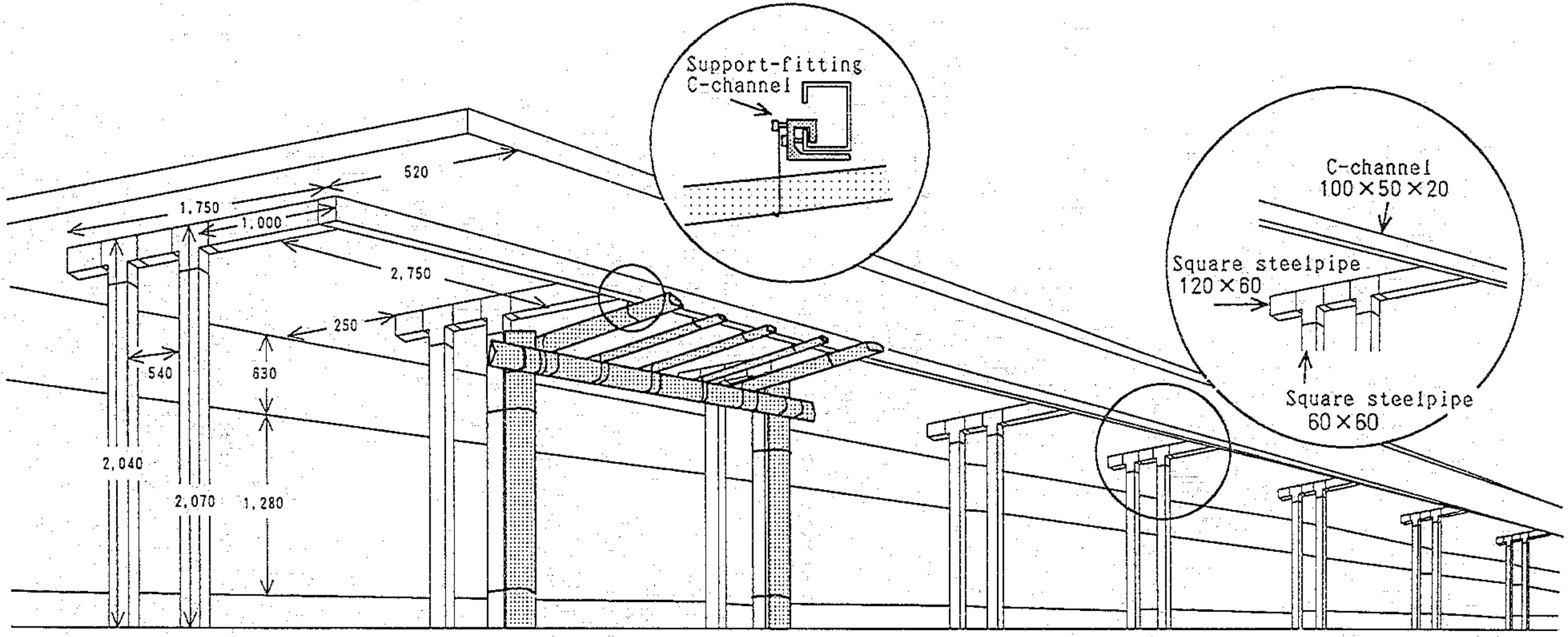


Fig 6.1.1-1 The Outline Of Training Site

(2)Technical Training for Local Operator

Local operator training was provided in construction, maintenance and inspection methods through the following practical works.

(a)Contents of technical training on construction

1)Solar Module Array

- Assembling and installation method for the pole mount for a house and the above-ground mount for a Maneaba.

2)Switchboard

- Mounting the charging-discharging controller, NFB, main switch and protective device.
- Terminal treatment and method of wiring between each component.
- Actuating and handling method for the charging-discharging controller, NFB, main switch and protective device.

3)Storage Battery

- Handling method for storage battery electrolyte and electrolyte filling apparatus.
- Method of electrolyte filling and level ascertainment.

4)Electrical Equipment

- Mounting and wiring method for each component.

5)Interior and Outdoor Wiring

- Suitable use and method to use with each wiring material.
- Terminal treatment method and wiring using cable.
- Design and actual wiring method for 3way and single-cut type switches.

6)General Matters for Other Work

- Suitable method of use for general tools.
- Suitable place of use for materials.
- Work safety and custody method for materials and tools.

(b)Contents of Technical Direction on Maintenance of the Equipment and Inspection (observation) Method

Regarding maintenance of the equipment and inspection method, training for the local operator was directed with regard to the following.

- A periodic inspection should be done.
- Suitable measure should be carried out when defects were found during the inspection.
- When it is impossible for the local operator to take proper measures, he must immediately contact the SEC's technicians.

The items to be checked during each inspection are as follows

1)Solar Module Array

·To check for damage to the solar modules and looseness in their mounting.

2)Switchboard

·To check for looseness in the mounting of the charge-discharge controller NFB, main switch and protective device.

·To check for loose connections at each component.

3)Storage Battery

·To check liquid level and refill as needed.

·To visually inspect(To check and see whether or not there is a deformation or dirt on the main body of the storage battery.)

·To check and see whether or not connections are loose.

·Carry out equalizing overcharging when scheduled.

·Other matters as required by the battery as installed.

4)Electrical Equipment

·To check for loose connection at the fluorescent lamp.

·To check for proper operation of the fluorescent lamp.

·To check for proper operation of 3way and single-cut type switches.

5)Interior and Outdoor Wiring

·To check for damage to cables and wiring materials.

·To check for an unauthorized change in the house.

·To clarify the system operation policy of the SEC.

(3)Maintenance Direction for the SEC's Technician at the Site

(a)Direction at the Site

The technicians of the SEC were instructed using the construction and maintenance procedure which was prepared in Japan, in order to instruct the local operator in the construction and maintenance of the PV system.

These items are shown in Table 6.1.1-4.

Table 6.1.1-4 Items of Measures and Execution

Items	Contents of Measures and Execution
Patrol	·The state of the solar module and shade. ·The state of the lighting equipment and a check to see whether there have been unauthorized changes in the house wires or not. ·The level of liquid in the storage battery. ·The condition of the lighting equipment.
Inspection and Replacement	·Measure the terminal voltage of the solar module and the storage battery. (To check the state of system operation.) ·Refilling cells of the storage battery with water. ·Execution of equalizing overcharging.(To do over-charging with current less than 10A to 120[%] for the whole capacity of the storage battery at one month intervals.) ·Replacement of the storage battery.(If it is prop-erly used, replacement will be done five years later as scheduled.) ·Replacement of damaged lighting equipment.
The Others	·User education on the importance of the restriction of unnecessary energy use. (Saving electricity) ·Consultation on electricity. ·Fee collection.

And just for reference, the construction and maintenance procedure which was prepared in Japan is shown in Reference.

(b)Additional Direction from Japan

The storage batteries which have been provided as spare parts at the site, must be kept charged and the SEC's technician was requested to charge the storage battery by the following method to maximize its life.

1)Procedure

- The storage battery which has been provided as spare parts at the site is first refilled with electrolyte after removing a cell cap.
- It is then charged with solar modules using a charging/discharging controller which was also provided as spare parts.
  The first charging will be done for approximately two days.
- Later charging is to be done at one-month interval.

2)Circuit Block Diagram

The circuit block-diagram to charge the storage battery is shown in Fig 6.1.1-2.

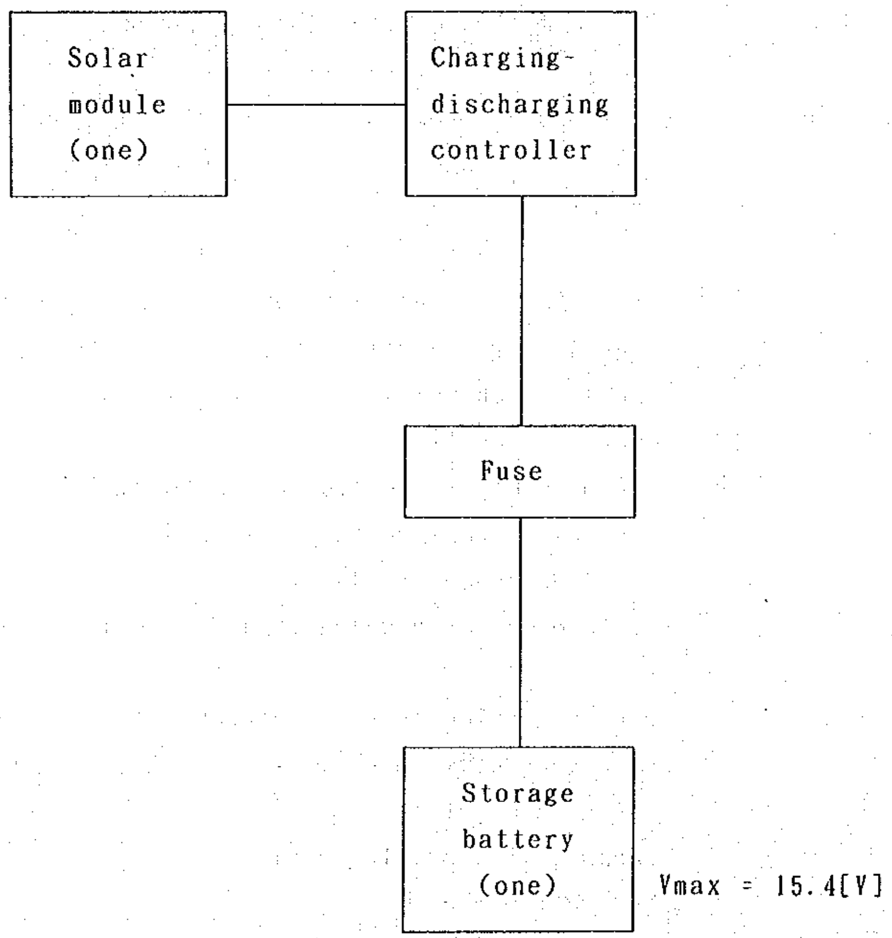


Fig 6.1.1-2 Circuit Block Diagram of Charging

6.1.2 Check List for Maintenance

The study team has recommended to use the check list as below:

1 Location ______________________________

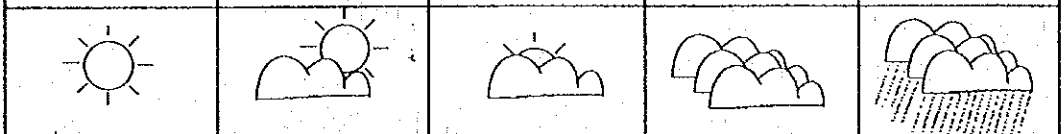
2 Date of Visit: ___/___/___

3 Time of Visit: __________

Weather

4 Weather At The Time of the Visit:

A	B	C	D	E
Very Sunny	Mostly Sunny	Mostly Cloudy	Very Cloudy	Raining
A	B	C	D	E

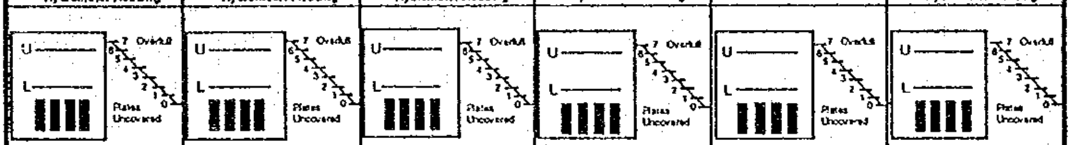


5 Average Weather for the Day Before The Visit:

6 Battery Electrolyte

(+) (−)

1	2	3	4	5	6
A Hydrometer Reading	A Hydrometer Reading	A Hydrometer Reading	A Hydrometer Reading	A Hydrometer Reading	A Hydrometer Reading
B Electrolyte Level	B Electrolyte Level	B Electrolyte Level	B Electrolyte Level	B Electrolyte Level	B Electrolyte Level
C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition	C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition	C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition	C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition	C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition	C 1 Clean ☐ 2 Dirty ☐ Electrolyte Condition



7 VOLTAGE READINGS

A Battery (at the Controller, appliances OFF) ______ V

B Panel (at the Controller, applainces OFF) ______ V

C Load (at the Controller, appliances OFF) ______ V

D At the Battery Posts (appliances OFF) ______ V

E At the Battery Posts (appliances ON) ______ V

8 PANEL SHADE

A No shade

B Half or less shade

C More than half shade

D Fully Shaded

E Cloudy, can't tell

9 RECEIPT FOR SERVICE

Signature of Person Receiving Service ______________________________

Printed Name of Person Signing as Recipient of Service ______________________

6.2 Funds Collection

(1) Delinquent Payment

As of July 1993 twelve of the North Tarawa users were delinquent more than two months. While some of the delinquent users may actually be unable to pay, many of the delinquent users are government employees with greater access to cash than most of the users who have been paying on time. This situation is not unusual and other projects have observed that the problem of getting the wealthier users to pay is often more difficult than the poor ones. It is clear that this is a time of testing of the willingness of the SEC to actually perform disconnects for non-payment.

As of July 28th, these twelve users were to be disconnected unless payment was received by the disconnecting technician. When the technician arrived to actually make disconnections, all but five made payments on the spot. The process used for disconnection was to remove the fuse and in most cases, remove the PL bulbs, but if the fixtures are turned on without a bulb for more than a few seconds, the electronic ballast may be destroyed and strong overcharge causes rapid loss of water of batteries.

The best method of disconnection for one to two months is to disconnect the battery and lock the battery box, and after two months of disconnection and further non-payment, the battery should be reconnected, charged and again disconnected in preparation for moving to another user location.

(2) Funds management

The SEC learned that the family of the field technician who is in charge of maintenance of the system and collecting the monthly payment on North Tarawa "borrowed" the moneys from the collected funds.

The basic problem is not one of dishonesty but rather of accessibility of cash. There are several ways to make alternate arrangements for funds collection using third parties but those all involve additional cost.

If a process can be devised which makes the more secure between collection time and banking time, the field technician is most available for funds collection. The approach recommended is to use a locked cash box with the key held only by the Island Council Treasurer and the SEC in South Tarawa. The money along with the SEC copy of the receipt would be placed in an envelope and slid through a slot in the cash box in the presence of the user. Then after the days collections, the box would be taken to the Island Council Treasurer for deposit of the money and forwarding of the receipts to South

Tarawa.

The Kiribati culture makes it very difficult for a young person to refuse the request of an older person, particularly a family member and if the money is available, the SEC money will be "lent" to the request person. BY placing it in a locked box, the technician can truthfully say that he is sorry but he cannot provide the money and to break open the box would clearly be theft, which is certainly not a culturally acceptable action.

The system, of course, requires the cooperation of the Island Council Treasurer, who would hold the box key and this cooperation will need to obtained immediately. also, users will need to be informed of the need to provide payment in exact amounts and that they should require a receipt personally witness the insertion of the money and copy of the receipt into the cash box.

7. Evaluation of the Project

7.1 Installed System

(1)Monitoring and Evaluation of PV system:

For monitoring PV systems, continuous measurement is generally made for voltage and current, but to do this a mains AC power supply is usually needed. On North Tarawa, a mains type AC power supply is not available to operate the measuring equipment and conventional measuring instruments were not provided.

Recently, a controller has been developed which makes it possible to estimate the remaining service life of the storage battery and to measure the integrated flow of current out of the battery. Two of these units were installed for monitoring the operating state of two systems, and the date from these measurements are used in evaluating this project.

The outline of the controller characteristics is in Table 7.1-1.

Table 7.1-1 Summary of Parameters Monitored by the Special Charge Controller

Monitoring Parameters	Measurement and Control Range	
Battery Temperature	Below 55°C	Over 55°C
Battery Capacity	Less than 30%--90%	Above 90%
Solar array Voltage	Over 19V	
Battery Voltage	(10.9V)	Above 14.4V
	Charging from Solar Turned On	Charging from Solar Turned Off
Battery Temperature	Below 55°C	Over 55°C
Battery Capacity	Over 30%	30%
Solar array Voltage		
Battery Voltage	Over 10.9V	10.9V
	Switch on at Load side	Switch off at Load side

Data Available for Evaluation

Summation of Charging and Discharging Ampere-hours

Calculation of Estimated Remaining Battery Life

Monitoring of Temperature

Detection of Battery Faults (temperature or low voltage)

Accumulation of Remaining Battery Life Estimates for Management

(2)State of System Monitoring and Evaluation Equipment

(a)Setting place

- Name of Village : Abaokoro
- Name of Householder

1) Makin Ngatau (A27) 2) Bauro(Tika)

(b)State of monitoring systems (7/28 measurement)

State of the systems are as follows:

The remaining life estimate has been reduced from initial value:26,280 hours (3 years), and was 2.98 years (A27) as of July 28, 1993, and the deference between this and 2.55 years(Bauro) July 24 and 28, each shows 92 hours (A27) and 95 hours (Bauro). Thus, the system is operating properly with respect to the load conditions.

The monitoring results are shown in Table 7.1-2.

Table 7.1-2 The Monitoring Results from Evaluation Equipment

1)Makin Ngatau (A27)

	After charge (Jul.28 evening)	Before charge (Jul.28 morning)	During charge (Jul.24 daytime)
Remain Capacity (Ah)	57.223	53.434	73.338
Charging or discharging Current Value (A)	- 0.3	+ 0.1	+ 1.9
Battery Voltage (V)	13.1	13.0	13.5
Battery temperature(°C)	29	26	28
Expected Available Life (hour:minute)	26116:04	26125:02	26208:12
LED Indication	60	60	80

2)Bauro(Tika)

	After charge (Jul.28 evening)	Before charge (Jul.28 morning)	During charge (Jul.24 daytime)
Remain Capacity (Ah)	75.413	59.582	79.564
Charging or discharging Current Value (A)	- 0.2	- 0	+ 3.59
Battery Voltage (V)	12.6	12.2	13.4
Battery temperature(°C)	30	26	30
Expected Available Life (hour:minute)	22332:56	22342:31	22427:25
LED Indication	80	60	80

7. Evaluation of the Project

7.1 Installed System

(1)Monitoring and Evaluation of PV system:

For monitoring PV systems, continuous measurement is generally made for voltage and current, but to do this a mains AC power supply is usually needed. On North Tarawa, a mains type AC power supply is not available to operate the measuring equipment and conventional measuring instruments were not provided.

Recently, a controller has been developed which makes it possible to estimate the remaining service life of the storage battery and to measure the integrated flow of current out of the battery. Two of these units were installed for monitoring the operating state of two systems, and the date from these measurements are used in evaluating this project.

The outline of the controller characteristics is in Table 7.1-1.

Table 7.1-1 Summary of Parameters Monitored by the Special Charge Controller

Monitoring Parameters	Measurement and Control Range	
Battery Temperature	Below 55°C	Over 55°C
Battery Capacity	Less than 30%--90%	Above 90%
Solar array Voltage	Over 19V	
Battery Voltage	(10.9V)	Above 14.4V
	Charging from Solar Turned On	Charging from Solar Turned Off
Battery Temperature	Below 55°C	Over 55°C
Battery Capacity	Over 30%	30%
Solar array Voltage		
Battery Voltage	Over 10.9V	10.9V
	Switch on at Load side	Switch off at Load side

Data Available for Evaluation

Summation of Charging and Discharging Ampere-hours

Calculation of Estimated Remaining Battery Life

Monitoring of Temperature

Detection of Battery Faults (temperature or low voltage)

Accumulation of Remaining Battery Life Estimates for Management

(2)State of System Monitoring and Evaluation Equipment

(a)Setting place

·Name of Village : Abaokoro

·Name of Householder

1) Makin Ngatau (A27) 2) Bauro(Tika)

(b)State of monitoring systems (Measurement Date:28/Jul/93 and 4/Feb/94)

State of the systems are as follows:

The remaining life estimate has been reduced from initial value:26,280 hours (3 years), and was 2.98 years(A27) and 2.55 years(Bauro) as of July 28, 1993, and was 2.53 years(A27) and 2.73 years(Bauro) as of Feb 4, 1994 respectively.

In this case of Bauro, the remaining life estimate reduction is alittle because of absence.

The deference between this July 24 and 28, each shows 92 hours (A27) and 95 hours (Bauro). Thus, the system is operating properly with respect to the load conditions.

These 2sets of evaluation equipments weres changed to normal type controllers and batteries that are same type as used in general houses at Feb,94. This should be easy to check and maintain each equipments at site.

The reasons of change are shown below.

*The battery for this system adopted the sealed type and is not necessary to supply water, but the life of this type is generally shorter than ordinal type of batteries used for other households.

*The maintenancewill be complicate if the controller will happen to down in future, the system is better that they are consisted by same components.

The values in the table 7.1-2 mean as follows:

*The upper values are data gained at July 28 1993

*The lower values in ( ) are data gained at February 4 1994

*Each values were noted at atbthe time of checking (not an average value)

*The LED indication was also noted by checking at the survey time.

The monitoring results are shown in Table 7.1-2.

Table 7.1-2 The Monitoring Results from Evaluation Equipment

1)Makin Ngatau(A27)	After charge (Jul.28 evening)	Before charge (Jul.28 morning)	During charge (Jul.24 daytime)
Remain Capacity (Ah)	57.223	53.434 (78.419)	73.338
Charging or discharging Current Value (A)	- 0.3	+ 0.1 (+ 0.3)	+ 1.9
Battery Voltage (V)	13.1	13.0(13.1)	13.5
Battery temperature(°C)	29	26(28)	28
Expected Available Life (hour:minute)	26116:04	26125:02 (22136:04)	26208:12
LED Indication	60	60(80)	80

2)Bauro(Tika)	After charge (Jul.28 evening)	Before charge (Jul.28 morning)	During charge (Jul.24 daytime)
Remain Capacity (Ah)	75.413	59.582	79.564
Charging or discharging Current Value (A)	- 0.2	- 0	+ 3.59
Battery Voltage (V)	12.6	12.2	13.4
Battery temperature(°C)	30	26	30
Expected Available Life (hour:minute)	22332:56	22342:31	22427:25
LED Indication	80	60	80

(c)Terminal Voltage Measurement of Solar Module and Storage Battery

For the solar power generation systems in North Tarawa, measurement is made for the terminal voltage of the module and battery after 6 months, and an analysis is made to see if the system is operating properly.

1)Performance of Voltage Measurement

Voltage has been measured for the storage before, after and during charging.

- ·Voltage Measurement after Charging : PM 5:30 ～ 7:00
- ·Voltage Measurement before Charging : AM 7:00 ～ 9:00
- ·Voltage Measurement during Charging : AM 11:00 ～PM 3:00

2)Results of Measurement

On this system, battery terminal voltage is controlled by the charge/discharge controller within the voltage show on the following Table 7.1-3.

Table 7.1-3 Control Voltage of Charge/discharge Controller for General House (Unit:V)

Protection against Over-charge		Protection against Over-discharge	
Charge stop	15.6	Discharge stop	11.4
Charge restart	12.6	Discharge restart	12.6

Data from Abaokoro is used for this analysis. The example data is shown in Table 7.1-4.

Table 7.1-4. The Example of State of Operation in Abaokoro

			AFTER CHARGING (evening)		BEFORE CHARGING (morning)		DURING CHARGE (daytime)		
NO	CODE NO	CUSTOMER NAME	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
3	A 5	EKEIETA	19.5	13.6	21.6	12.9	23.0	12.7	15.4

The Example shows that the terminal voltage is controlled within the voltage range of Table 7.1-3. Note that during charge, the panel voltage is lower than the battery terminal voltage indicating that the parallel type controller has stopped charge from following to the battery.

Table 7.1-5 shows the results of measurements performed in July and here shows the results in Notoue village as example.

Table 7.1-5 System Voltage Data for Each Cuatomer

VILLAGE NAME : TARATAI

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULTS OF SYSTEM VOLTAGE						
			AFTER CHARGING (evening)		BEFORE CHARGING (morning)		DURING CHARGE (daytime)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	R17	TETIKA	21.6	13.7	21.5	13.6	23.5	15.0	14.3
2		TABOBO	20.5	13.9	21.6	13.1	22.4	14.8	14.1

VILLAGE NAME : NOTOUE

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULT OF SYSTEM VOLTAGE						
			AFTER CHARGING (evening)		BEFORE CHARGING (morning)		DURING CHARGE (daytime)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	N 1	AREBONTO	20.0	13.4	23.9	13.5	22.9	15.9	14.3
2	N 3	BENTARA	20.0	13.8	23.2	13.8	22.7	15.0	14.3
3	N 10	KEETI	20.5	13.7	22.2	13.6	22.1	14.3	13.9
4	N 16	MIKAERE TIMAIA	20.9	13.9	23.7	14.1	23.5	15.6	14.5
5	N 30	TERINAKI	21.4	13.7	23.2	13.4	22.6	14.3	13.9
6	N 32	TIKANRO	21.3	14.1	22.5	13.3	22.4	15.5	14.4
7	N 35	UTIMAWA	20.8	13.4	23.0	13.2	22.8	14.9	14.0
8	N 36	WAIRE	UNDER ABSENCE						
9	N 37	IOTEBWA	19.8	13.5	21.8	12.9	23.4	14.0	13.5
10	N 38	AIRIN	21.1	13.9	23.0	13.3	22.3	15.7	14.3
11		RONIITI TETABO	21.7	13.7	23.0	13.2	22.7	14.6	14.0
12		TAUKABAN IOANE	21.3	13.7	22.6	13.1	22.9	14.7	14.2
13		TAMUERA KAREBANGA	20.3	13.7	23.6	13.6	23.3	14.5	14.1
14		TEBIKE NENEIA	21.5	13.8	22.4	13.2	22.4	14.7	14.1
15		TIIBAU	21.2	13.7	22.6	13.4	22.4	14.5	14.0

VILLAGE NAME : ABAOKORO

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULT OF SYSTEM VOLTAGE						
			AFTER CHARGING (evening)		BEFORE CHARGING (morning)		DURING CHARGE (daytime)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	A 1	ABAKUKA	21.7	12.8	22.1	12.5	23.1	13.8	13.2
2	A 4	BEIA TOARA	19.5	12.8	22.5	12.7	22.1	13.4	13.1
3	A 5	EKEIETA	19.5	13.6	21.6	12.9	23.0	12.7	15.4
4	A 9	LOUI NAMANE	19.5	13.2	22.3	12.8	22.8	15.6	15.0
5	A 10	NATIRIA TAMTON	20.3	13.5	23.0	12.6	23.1	14.9	14.4
6	A 11	OBETA	18.5	12.5	23.4	12.3	23.3	13.2	12.7
*7	A 16	IERUBAARA (TEBARINE)	21.6	13.4	22.5	12.8	23.6	15.6	15.0
8	A 17	TEBUAKA	5.6	12.8	23.5	12.9	23.1	14.5	14.0
9	A 18	TEKAKIABO	20.5	13.6	23.6	13.5	22.8	15.3	14.6
10	A 21	TEMARAWA KAWITU	21.6	12.9	22.5	12.6	23.1	15.8	15.2
11	A 27	MAKIN NGATAU 「APPARATUS FOR EVALUATION」		13.1		13.0		13.6	13.2
12	A 29	TAUKABAN	5.7	13.4	22.6	13.4	22.6	15.7	15.2
13	A 32	RIBATI	18.6	13.6	23.1	13.4	22.8	15.0	14.5
14 *	A 33	TIOTI (BOUA)	2.7	12.8	23.0	13.0	23.4	15.5	14.9
15	A 35	ABAUA	21.5	13.6	22.5	13.3	22.7	13.9	13.5
16 *	A 36	DANNY (BWENAWA)	UNDER ABSENCE		UNDER ABSENCE		23.2	15.2	14.7
17	A 37	MATIOTA	20.4	13.9	21.9	13.3	22.7	14.5	14.0
18		AMBOU	19.8	13.4	22.3	13.1	22.7	14.8	14.4
19		BAURO 「APPARATUS FOR EVALUATION」		12.9		12.2		23.6	13.0
20		KAOBUNANG	UNDER ABSENCE						
21		TEKATAU	19.1	13.4	23.8	13.3	22.7	15.1	14.7
22		TEKERAOI	20.6	13.4	22.5	13.1	23.5	14.6	14.2
23		TENAGIMAU	11.5	13.2	23.8	12.9	22.9	15.2	14.5
24		TETAKE	20.8	13.1	21.8	12.6	23.2	14.6	14.0
25		BIITA	17.7	13.1	23.6	13.0	23.2	13.7	13.3

*MARK : SHOWS HOUSES WHICH HAS CHANGED OWNER
(( ) SHOWS THE FORMER OWNER)

VILLAGE NAME : MARENANUKA

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULT OF SYSTEM VOLTAGE						
			AFTER CHARGING (EVENING)		BEFORE CHARGING (MORNING)		DURING CHARGE (DAYTIME)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	M 1	BEIA RUAIA	16.8	13.3	21.9	13.0	23.5	15.3	14.5
2	M 4	MOAUEA	14.7	13.3	22.4	13.1	23.8	13.9	13.5
3	M 7	TEN TATERAKA	16.9	13.1	22.4	13.6	23.2	15.4	14.5

VILLAGE NAME :TABONIBARA

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULT OF SYSTEM VOLTAGE						
			AFTER CHARGING (EVENING)		BEFORE CHARGING (MORNING)		DURING CHARGE (DAYTIME)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	T 6	RABANGAKI MATIMARA	17.5	13.1	22.3	12.6	24.3	13.9	13.3
2	T 18	TOANI TAKAIO	17.3	13.2	21.8	13.5	23.9	15.0	14.8
3	T 23	TEAOTI NGAIA	18.4	13.2	21.2	12.7	23.1	13.9	13.3
4		MAEUEA	17.2	12.8	21.9	12.3	24.1	13.4	12.9
5		TABEIA	19.1	12.6	21.6	12.1	22.8	13.4	12.8
6		TUTU TIRIBO	18.3	13.2	21.7	12.9	23.4	14.9	14.3

VILLAGE NAME : KAINABA

NO	CODE NO	CUSTOMER NAME	MEASUREMENT RESULT OF SYSTEM VOLTAGE						
			AFTER CHARGING (EVENING)		BEFORE CHARGING (MORNING)		DURING CHARGE (DAYTIME)		
			PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	BATTERY TERMINAL VOLTAGE (PV OFF) (V)	PV Voc (V)	PV CHARGE VOLT-AGE (V)	BATTERY TERMINAL VOLTAGE (PV ON) (V)
1	K 4	BIRIKAUA TABOKAI	22.0	13.9	22.3	13.2	22.8	11.5	15.4
2	K 10	TAAKE TETAUA	21.1	13.9	21.3	13.0	22.5	14.6	13.9
3	K 11	TEBUATEI ABIETE	21.6	13.4	21.9	13.5	22.5	15.6	14.9
4	K 14	UEANNA TEMANIKAAI	22.4	13.7	23.1	13.4	22.8	15.5	14.7

MANEABA(MEETING PLACE)

1		MANEABA NO1 SYSTEM (SEA SIDE)	45.0	27.0	44.1	26.8	46.4	26.7	30.8
2		MANEABA NO2 SYSTEM (ROAD SIDE)	44.9	26.7	44.1	27.9	46.0	30.1	29.4

(3)State of Liquid in the Storage Battery

For the solar power system in North Tarawa, the level of liquid in each storage battery was surveyed to help extend the service-life of the system.

(a)Details of the Survey

·Solar power systems in 6 villages of North Tarawa:

General Users: 55 houses Maneaba : 1 house

·Period of Execution: July 24 ~ 30, 1993

(b)Results of Survey

The results show that there were many cases showing a decrease in liquid in the storage battery with about 80% showing a very low level.

It was necessary to ask the SEC for an improvement in their procedures for maintenance to insure that water levels did not fall too greatly in the future. Further, this will be again checked during the technical follow up by the JICA team. Table 7.1-6 shows data from the survey of House. Table 7.1-7 shows data from the survey of the Maneaba.

Table 7.1-6 Battery Liquid Survey of House

Phenomena	Taratai	Notoue	Abao koro	Marena nuka	Taboni bara	Kainaba	TOTAL
Detection of decrease in battery liquid		12	7				19
Water-supplied by SEC technician		1	10	2	6		19
Detection of decrease in battery liquid water-supplied by JICA team	1					3	4
Good condition in battery	1	2	5	1		1	10
No-check (absence)			1				1
Water-supply not necessary (seal type)			2				2
TOTAL	2	15	25	3	6	4	55

Table 7.1-7 Battery Liquid Survey of Maneaba

Phenomena	Taratai	Notoue	Abao koro	Marena nuka	Taboni bara	Kainaba	TOTAL
Detection of decrease in battery liquid water-supplied by JICA team						4	4
TOTAL						4	4

For 2 out of 4 batteries, SEC-technician supplied the water on June 3, but, the battery liquid was reduced at the time checked by the JICA-team on July 29.

(c)Probable reasons for the rapid decrease in battery liquid:

For the above phenomenon "decrease of battery-liquid", the following conditions are estimated.

- The solar modules provide much more energy than is used by the load leading to an excessive amount of charge.
- Users are absent and do not use the load, causing an excessive charge to the battery.

(d)Availability of Replacement Water

In Kiribati, the distilled water cost is 1A$/l, and is higher than gasoline at 70¢/l. Accordingly, rain water is to be tried with water quality tested for the distilled water, rain water and water from a well.

- Date of Analysis : Sept. 1993
- Place of Analysis : Furukawa Battery Inc.
- Result of Analysis:

The result of analysis is as follows. The analysis result of the water samples is shown in Table 7.1-8.

1)Result of Water Analysis

Table 7.1-8 Results of Water Analysis for Types of Water Available

Kind of Water / Item	Distilled Water	Rain Water (South Tarawa) Restaurant Roof of Otintaai	Rain Water (North Tarawa) On Plastic Bucket	Well Water (North Tarawa) Guest House	SBA4001 Standard Purified Water for Battery
PH	3.70	5.75	5.70	7.20	5.8~8.6
Cl-	Below 0.5	Below 0.5	Below 0.5	4.0	Below 1.0
Fe+	Below 0.1	Below 0.1	Below 0.1	Below 0.1	Below 0.1
Organic matter	1.42	2.84	1.89	2.85	Below 50

(Unit) PPM (Parts per Million)

2)Suggestion

In comparison with the SBA-specification of purified water for the storage battery, there was no problem with rain water on all items.

However, water from the well contained excess Cl and is unsuitable. Rain water should have no problem as a supply-water though it should be used after removing solid impurities.

(e) Survey results in February 1994

According to the survey results in July 1993 and the analytical result of rain water, the study team check the condition of batteries again.

The result shows that all batteries are well maintained and the water level in batteries were kept as proper as the team recommended and trained the field technician before.

The survey results are shown in Table 7.1-9 shows the amount of water supplied from June 1993 to January 1994.

Table7.1-9 State of Battery Liquid Level and Charging Condition

CHECKING DATA OF EACH SYSTEM (4/FEB~6/FEB)

VILLAGE	NAME	CHARGE(PV) ON PV VOLTS	CHARGE(PV) ON BATT VOLTS	CHARGE(PV) OFF PV Voc	CHARGE(PV) OFF BATT VOLTS	BATTERY WATER LEVEL	REMARK
TARATAI	TETIKA(R17)	15.16	14.47	23.6	13.75	UPPER	GASSING
	TABOBO	13.80	15.33	23.5	14.2	UPPER	CUT OFF
NOTOUE	AREBONTO(N1)	12.70	12.45	23.3	12.41	UPPER	*GASSING
	BENTARA (N3)	13.98	13.38	23.2	13.2	UPPER	*GASSING
	KEITI (N10)	13.15	12.82	22.7	12.80	UPPER	
	MIKAERE (N16)	13.13	12.81	22.6	12.79	UPPER	*GASSING
	TERIRIAKI(N30)	13.21	12.88	22.8	12.85	UPPER	
	TIKANRO (N32)	13.18	12.88	21.9	12.85	UPPER	
	UTIMAWA (N35)	12.95	12.75	23.3	12.64	UPPER	
	WAIRE (N36)	14.50	13.78	23.0	13.5	UPPER	*GASSING
	IOTEBWA (N37)	14.47	13.86	23.2	13.59	UPPER	*GASSING
	AIRIN (N38)	12.98	12.65	22.8	12.61	UPPER	
	RONIITI	14.42	13.73	23.7	13.36	UPPER	*GASSING
	TAUKABAN	14.08	13.37	23.3	13.16	UPPER	*GASSING
	TAMUERA	14.38	12.92	23.6	13.76	UPPER	*GASSING
	TEBIKE	14.17	13.47	22.9	13.24	UPPER	*GASSING
	TIIBAU	14.05	13.41	23.2	13.12	UPPER	*GASSING
ABAOKORO	ABAKUKA(A1)	8.78	15.39	22.5	14.03	UPPER	CUT OFF
	BEIA (A4)	14.71	14.11	22.8	13.64	UPPER	GASSING
	EKEIETA(A5)	9.21	15.36	22.8	14.06	UPPER	CUT OFF
	LOUI (A9)	13.20	12.93	22.7	12.45	UPPER	
	NATIRIA(A10)	13.30	12.63	23.3	12.41	UPPER	
	OBETA (A11)	14.13	13.36	23.6	13.15	UPPER	
	IERUBAARA(A16)	15.60	14.79	23.1	13.92	UPPER	GASSING
	TEBUAKA(A17)	15.66	14.91	23.0	13.78	UPPER	GASSING
	TEKAKIABO(A18)	15.70	14.93	23.4	14.03	UPPER	GASSING
	TEMARAWA(A21)	8.78	15.36	23.2	14.28	UPPER	CUT OFF
	MAKIN (A27)	13.35	12.66	23.5	12.43	UPPER	
	TAUKABAN(A29)	15.72	14.94	22.5	13.96	UPPER	GASSING
	RIBATI (A32)	15.04	14.28	22.7	13.62	UPPER	GASSING
	TIOTI (A33)	13.54	15.26	23.5	13.87	UPPER	CUT OFF
	ABAUA (A35)	15.53	14.75	22.9	13.97	UPPER	GASSING
	BWENAWA (A36)	15.62	15.03	23.3	13.94	UPPER	GASSING
	MATIOTA (A37)	14.45	13.71	23.0	13.46	UPPER	GASSING
	AMBOU	12.44	15.30	22.8	13.91	UPPER	CUT OFF
	BAURO		ABSENCE				
	KAOBUNANG		ABSENCE				
	TEKATAU	14.65	15.2	23.3	14.23	UPPER	CUT OFF
	TEKERAOI	15.96	15.14	23.1	13.86	UPPER	GASSING
	TENAGIMAU	15.87	15.07	22.7	14.05	UPPER	GASSING
	TETAKE	9.78	15.33	22.7	14.36	UPPER	GASSING
	BIITA	13.98	13.22	23.6	12.93	UPPER	
MARENANUKA	BEIA(M1)	13.95	15.28	22.7	14.14	UPPER	CUT OFF
	MOAUEA(M4)	UNDER MOVING (SYSTEM SW OFF)					
	TATERAKA(M7)		ABSENCE				

VILLAGE	NAME	CHARGE(PV) ON		CHARGE(PV) OFF		BATTERY	
		PV VOLTS	BATT VOLTS	PV Voc	BATT VOLTS	WATER LEVEL	REMARK
TABONIBARA	RABANGAKI(T6)	14.37	15.39	23.6	14.35	UPPER	CUT OFF
	TOANI(T18)	14.26	13.92	22.7	13.63	UPPER	GASSING
	TEAOTI(T23)	13.68	15.29	22.8	14.25	UPPER	CUT OFF
	MAEUEA	15.41	14.66	23.3	13.75	UPPER	GASSING
	TIRIBO	14.41	14.09	22.0	13.64	UPPER	GASSING
	TABEIA	15.53	14.89	22.7	13.90	UPPER	GASSING
KAINABA	BIRIKAUA(K4)	8.20	15.38	23.8	14.25	UPPER	GASSING
	TAAKE(K10)	10.80	15.28	24.5	14.18	UPPER	GASSING
	TEBUATEI(K11)	15.50	14.70	23.5	13.80	UPPER	GASSING
	UEANNA(K14)	13.25	12.99	20.7	12.96	UPPER	
	MANEABA		SYSTEM STOP				

SUPPLY DATA OF DISTILLED WATER

UNIT:LITER

					1993							1994	
VILLAGE	NAME	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	TOTAL
TARATAI	TETIKA(R17)								3.5		1.0		
	TABOBO								3.5		0.75		
NOTOUE	AREBONTO(N1)						2.8		4.0		1.25		
	BENTARA (N3)						3.0		3.0		1.5		
	KEITI (N10)						2.8				0.75		
	MIKAERE (N16)						3.0		4.0		1.5		
	TERIRIAKI(N30)						1.5		0.5		1.75		
	TIKANRO (N32)						2.8				0.25		
	UTIMAWA (N35)								1.0		1.25		
	WAIRE (N36)						3.0		1.0				
	IOTEBWA (N37)				3.0				2.0				
	AIRIN (N38)						2.8				0.5		
	RONIITI						1.5			2.0	0.75		
	TAUKABAN									2.0	0.5		
	TAMUERA						3.0				1.5		
	TEBIKE						1.5			2.0	1.0		
	TIIBAU						2.8		2.5		2.25		
ABAOKORO	ABAKUKA(A1)							1.5			1.5		
	BEIA (A4)								1.5		2.0		
	EKEIETA(A5)							1.0			1.5		
	LOUI (A9)				2.0		0.7				4.0		
	NATIRIA(A10)						1.5	1.0	1.0				
	OBETA (A11)						1.0		1.0		0.25		
	IERUBAARA(A16)						1.5				4.5		
	TEBUAKA(A17)				3.0		3.0			3.5	0.25		
	TEKAKIABO(A18)				4.0			1.5		1.5			
	TEMARAWA(A21)				1.5		0.5						
	MAKIN (A27)												
	TAUKABAN(A29)				2.5		3.0			3.5			
	RIBATI (A32)						2.8				1.3		
	TIOTI (A33)						1.5			2.0			
	ABAUA (A35)				3.5		3.0			2.0			
	BWENAWA (A36)									3.5			
	MATIOTA (A37)						2.8			3.5			
	AMBOU				1.5						4.0		
	BAURO												
	KAOBUNANG						2.0		2.0		1.5		
	TEKATAU						2.8			3.5	0.25		
	TEKERAOI										4.5		
	TENAGIMAU						3.5			3.5			
	TETAKE				2.0						1.0		
	BIITA								2.0		1.3		
MARENANUKA	BEIA(M1)				2.0				2.0		1.5		
	MOAUEA(M4)								2.0		1.5		
	TATERAKA(M7)				2.5				3.5		3.5		

					1993							1994	
VILLAGE	NAME	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	TOTAL
TABONIBARA	RABANGAKI(T6)					2.0			2.0		1.0		
	TOANI(T18)					2.0					2.5		
	TEAOTI(T23)					2.0			2.0		1.0		
	MAEUEA					2.0			2.0		3.0		
	TIRIBO					2.5			2.0		2.0		
	TABEIA					2.0			1.0		0.5		
KAINABA	BIRIKAUA(K4)										1.6		
	TAAKE(K10)										1.6		
	TEBUATEI(K11)										4.5		
	UEANNA(K14)										1.6		
	MANEABA					6.0					9.5		

(3)Evaluation on the illuminance

Illumination by the solar systems varies due to the different structures of houses, thus the same level (20~100lux) as measured in existing installations was adopted.

Among the 6 villages, Abaokoro Village has the most houses, survey and was chosen as the site for illuminations measurements.

The measured result was as expected and the results shown in Table 7.1-9 [Measured Illuminance].

- Name of Village: Abaokoro
- Used Illuminometer
  Maker Hioki Electric Inc.
  Type Lux Hi Tester 3421(3000, 1000, 300 lux, 3 points range shifting system)
- Measured position : At each position, measurement was made in a horizontal position just under the light fixture. Based on that measurement, the values were then converted to illumination at a standard position of 1.5m.

Measured position illumination and converted position illumination is shown in Fig 7.1-1.

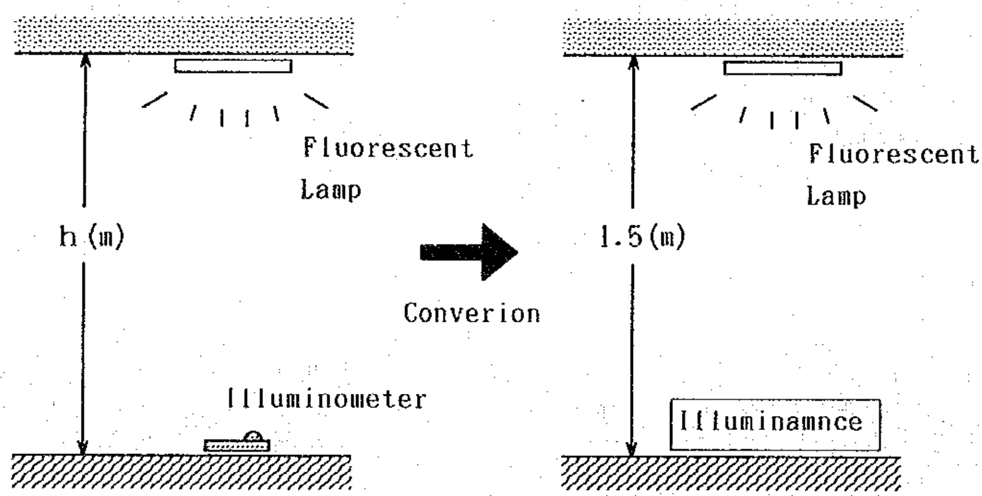


Fig 7.1-1. Illumination at the Measured position and converted position

Table 7.1-10 Illumination as Measured Unit:Lux

NO	CODE NO	CUSTOMER NAME	Illuminance in Each Room 11(W)	 7(W) Sleeping Room	 7(W) Dining Room
1	A 4	BEIA TOARA	88.0	21.0	45.0
2	A 9	LOUI NAMANE	49.0	26.0	16.0
3	A 10	NATIRIA TAMTON	54.0	40.0	22.0
4	A 11	OBETA	60.0	26.0	36.0
5	A 17	TEBUAKA	100.0	40.0	14.0
6	A 18	TEKAKIABO	58.0	23.0	25.0
7	A 21	TEMARAWA KAWITU	64.0	10.0	18.0
8	A 27	MAKIN NGATAU	50.0	14.0	24.0
9	A 29	TAUKABAN	56.0	24.0	19.0
10	A 32	RIBATI	33.0	24.0	25.0
* 11	A 33	TIOTI(BOUA TEKAAI)	77.0	32.0	23.0
12	A 35	ABAUA	60.0	24.0	26.0
13		BAURO		15.0	48.0
14		TEKATAU	68.0	35.0	32.0
15		TEKERAOI	56.0		21.0
16		TENAGIMAU	84.0		53.0 [11(W)lamp attached]
17		TETAKE	45.0	19.0	24.0
18		BIITA	44.0		12.0

·* mark:Householder was changed(Inside of( ) is Old householder's name)
·Open space means [no measurement] because persons were sleeping.

(4)Damage of Other Materials and Components:

A survey was made on the condition of each component and materials after 6 months of use of the solar power systems in North Tarawa, and service life of the system was estimated.

(a)Survey of The State of The System

The present survey revealed problems in the systems as follows:

·For Houses

11W fluorescent lamp: 1 unit

7W fluorescent lamp: 1 unit

·For Maneaba

20W fluorescent lamp: 1 unit

(5)Measurement of Voltage and Current of System

Measurement shall be made on the voltage and current of the representative present solar power generation system and the system-operation state shall be evaluated.

(a)Measurement Item

·Charge/Discharge Current of Battery

·Terminal Voltage of Battery

(b)Equipment Specification and Measurement Circuit

1)Equipment Specification

*Charge/Discharge Current Measurement

·Current Data Recorder

Type : KADEC-US 2sets

Measurement Range : 0~10(A)/0~20(mV)

·Standard Shunt Resistance

Type : 5204 2sets

Resistance Value : 0.002(Ω)

*Terminal Voltage Measurement

·Voltage Data Recorder

Type :KADEC-US 2sets

Measurement Range :0~20(V)/0~20(mV)

·Voltage Divider

Type :S-30

Dividing Range :0~20(V)/0~20(mV)

2)Measurement Circuit

Measurement circuit connection for using equipment of item 1)is shown in Fig 7.1-2.

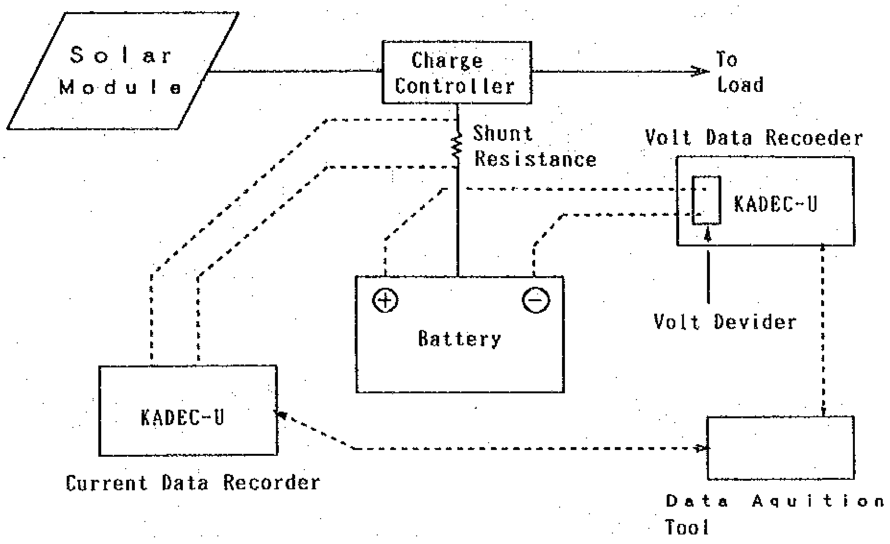


Fig 7.1-2 Measurement Circuit

(c)Selection of The Measurement Sites:

1)Structures of houses shall be strong.

- Structure of roof, posts etc shall not be easily broken.
- Submerging due to rain water shall not occur.
- The space housing the measuring instruments shall be easily accessed, and the survey team shall be able to easily access the space at the time of data collection to check the instruments.

2)Theft or damage of the measuring instruments is unlikely.

3)The site should be located near the Island Council Office in Abaokoro so it is convenient for checking and controlling the instruments and for data collection.

4)The difference shall be considered for the load in its using state.

5)Users shall cooperate for the evaluation and setting of the measuring instruments.

(d)Sites Selected

Based on the selecting standards in item (c), selection has been made of the users which will have the measuring instruments for evaluating system as follows:

1)Name of Village: Abaokoro

2)Name of User:

- Natiria Tamton (Code No: All)
  Feature: Used for illumination at general house and shops
- Beia Toara (Code No: A-4)
  Features: Used for illumination in general house

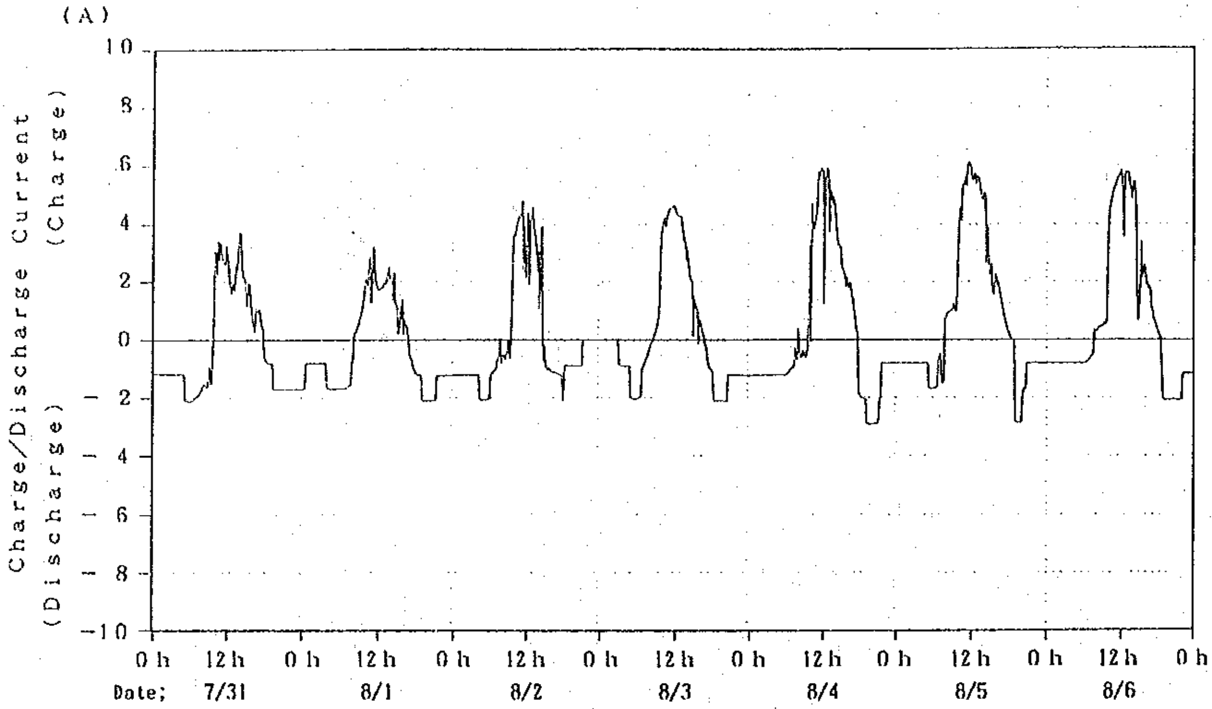


Fig 7.1-3 The load cycle of customer 'Natiria Tamton'

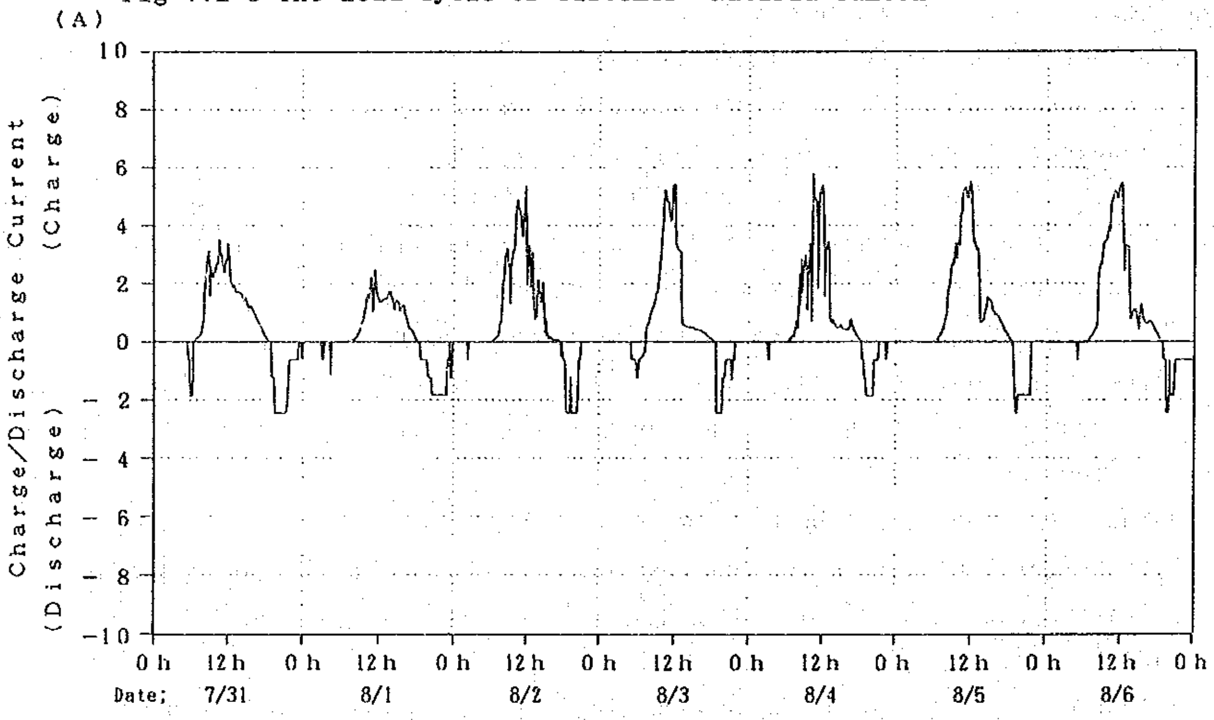


Fig 7.1-4 The load cycle of customer 'Beia Toara'

Comparing these two charts Natiria used at least one lamp through the night in his house or shop but Beia has used to put off lights in the night.

·Fluctuation of terminal voltage of batteries

Analyze the voltage and current under the different conditions of customer in three cases.

a) Charge current is larger than discharge one (charge > load)

Figure 7.1-5 and 7.1-6 show a week in the customer 'Beia', from fig 7.1-5, the charging current is obviously larger than the discharge current and in this case, the voltage of battery during the sun shining showed peak and it supposed as over charging.

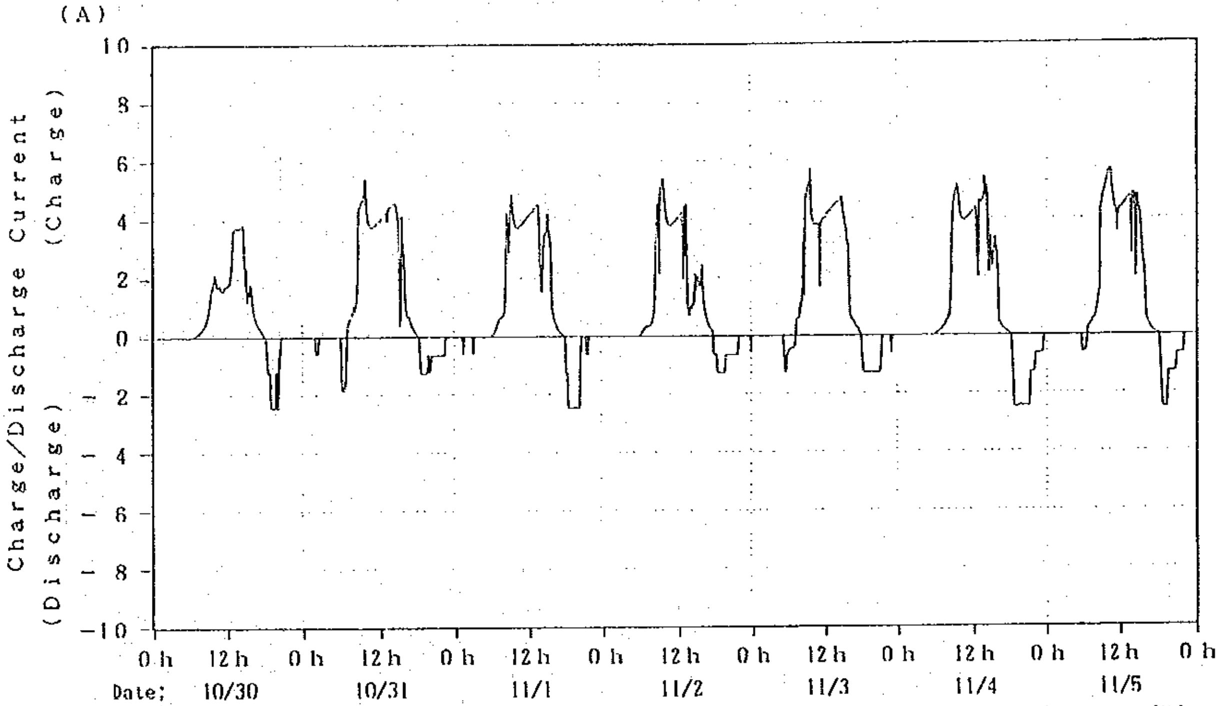


Fig 7.1-5 The charge/discharge current at customer 'Beia' (10/30--11/5)

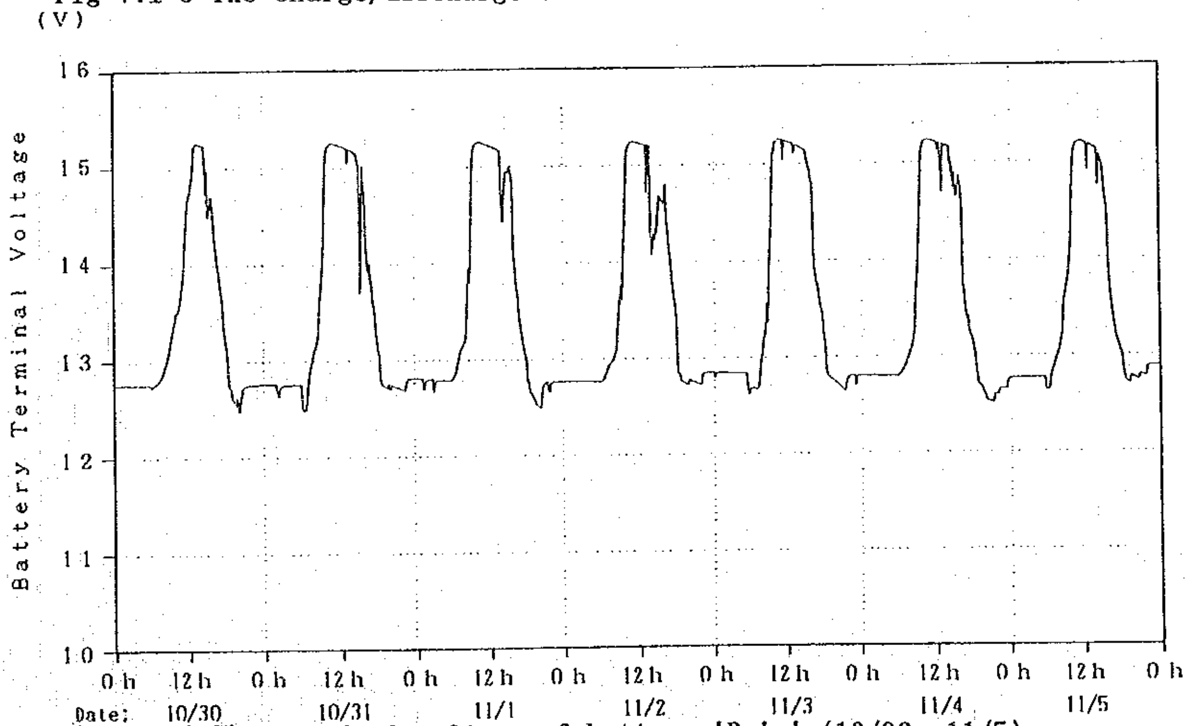


Fig 7.1-6 The terminal voltage of battery 'Beia' (10/30--11/5)

b)The charge current and discharge current are nearly same(charge = load)

Fig 7.1-7 and Fig 7.1-8 are from a week at customer 'Natiria', charging and discharge are nearly equal as 8/7 to 8/7 the peak terminal voltage kept in same level and as 8/10 to 8/13 the charge current increased a little than discharge one, the peak terminal voltage also increased.

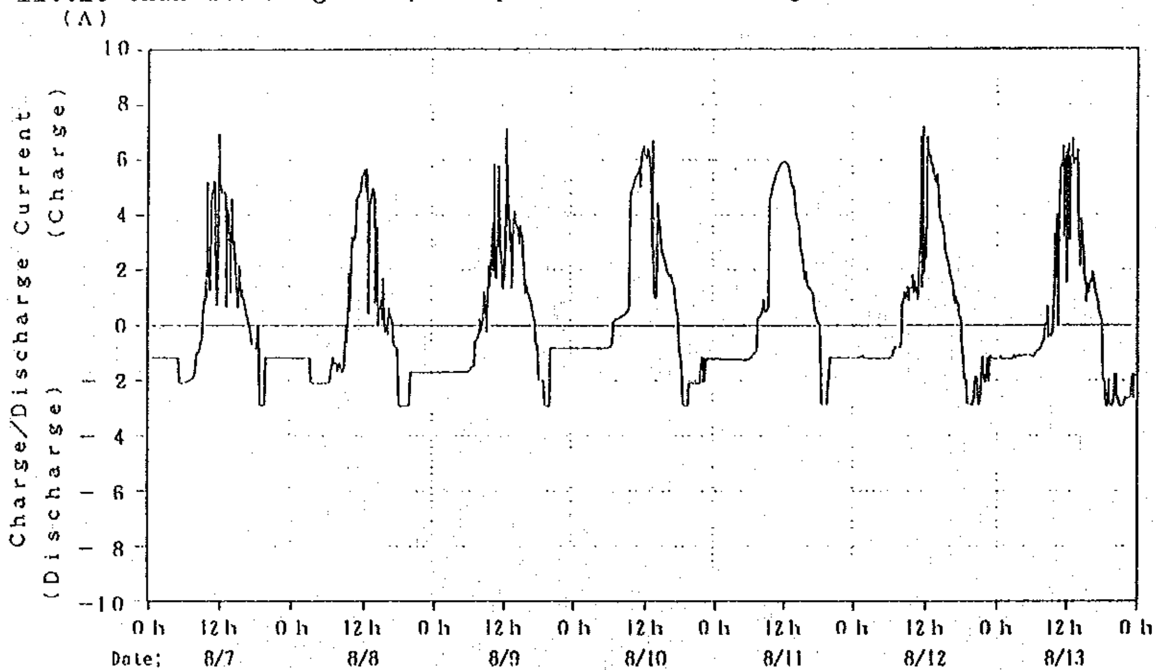


Fig 7.1-7 Charge/discharge current of 'Natiria' (8/7 to 8/13)

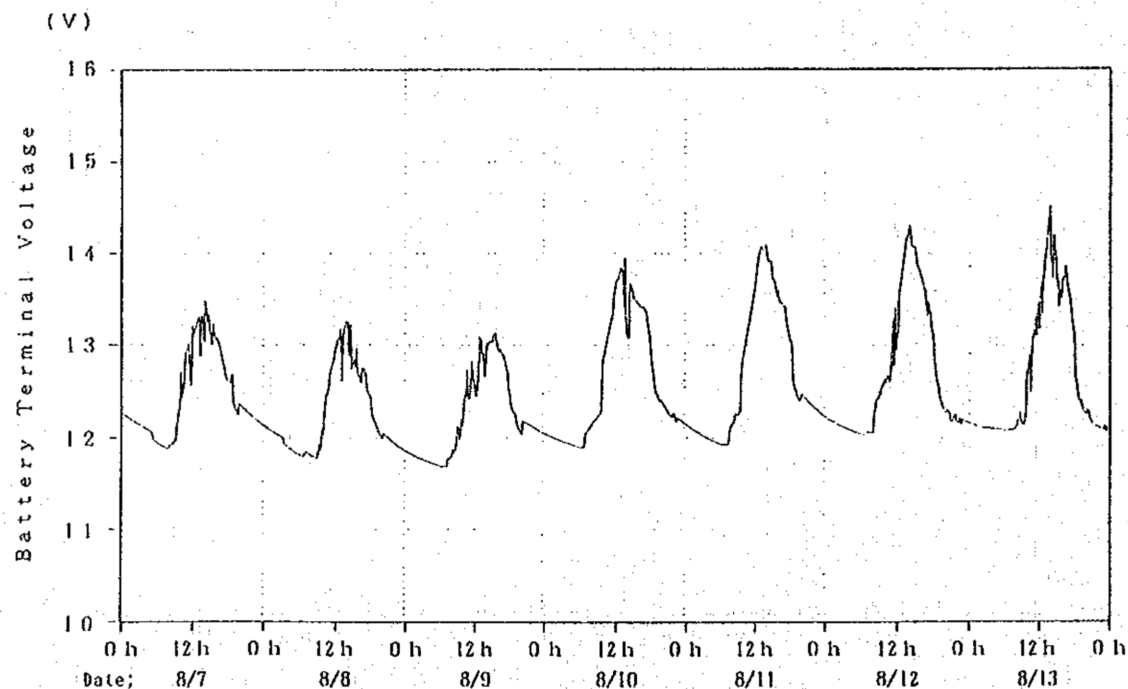


Fig 7.1-8 Terminal voltage of battery at 'Natiria' (8/7 to 8/13)

c) Charge current is less than discharge current (charge < discharge)

The load is high or the charge is less as insufficient sunshine, Fig 7.1-9 and Fig 7.1-10 from a week of 'Natiria' 10/23 to 10/29.

As Fig 7.1-9, 10/24 to 10/29, the discharge current is higher than charging current so the peak terminal voltage came lower but as the charge current came over to discharge one, the peak voltage also get back to natural level.

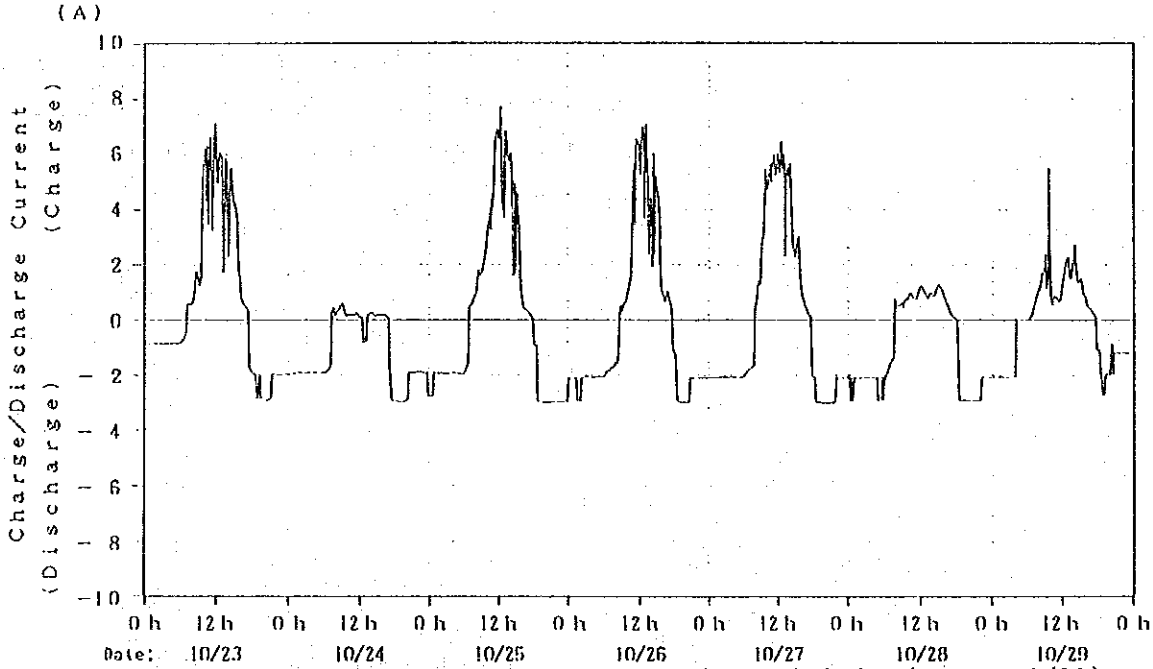


Fig 7.1-9 Charge/discharge current of 'Natiria' (10/23 to 10/29)

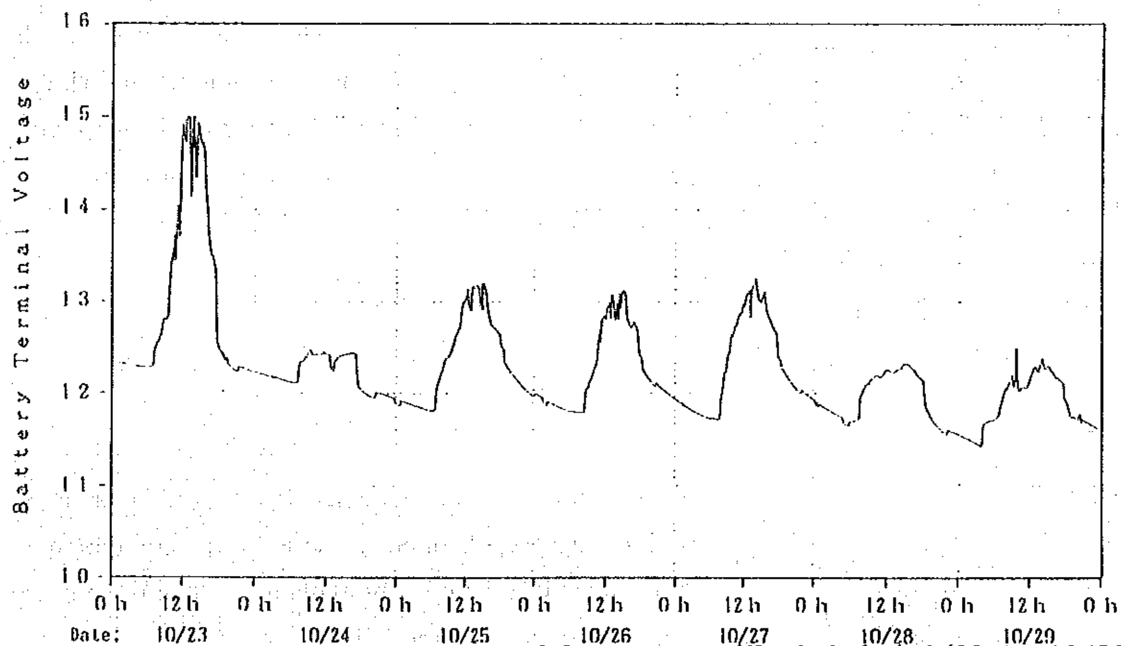


Fig 7.1-10 Terminal voltage of battery at 'Natiria' (10/23 to 10/29)

7.2 Evaluation of SEC Technical Capability

With regard to the recently installed solar power system, the technical capability of the SEC to do work in the fields of operation and maintenance has been reviewed.

(1)Construction

Work Item	Evaluation of SEC Technology
Assembly, Setting of Solar Array (1)General house ·Pole-mount assembly ·Module mounting (2 pcs) ·Setting after assembly (2)Maneaba ·Mount assembling (3 sets) ·Module assembling (12 pcs) ·Setting after assembling	With the technical guidance provided and the previous experiences, the SEC is technically capable of performing these work item.
Assembly of the Distribution Panel (1)Mounting Components ·Charging/discharging controller...1 set ·NFB..........1 set ·Main SW......3 sets (2)Wiring of components (3)Mounting of Distribution panel	By having participated in the earlier UN training courses and our technical guidance, the SEC is competent in the mounting of each component, wiring of the components on the board and the mounting of distribution panel at the installation site without outside assistance.
Mounting of Electric Components (1)General House ·Battery : 1 unit	As a result of our recent technical training and prior experience of the SEC, the component mounting can be performed without outside technical assistance.

·11W Fluorescent Lamp : 1 unit ·7W Fluorescent Lamp : 2 units ·1W LED Lamp: 1 unit ·3-way SW : 2 pcs ·On/Off SW : 2 pcs ·Wiring branch box: 3 pcs (2)Maneaba ·Battery: 2 units ·20W Fluorescent Lamp : 4 unit ·On/Off SW : 4 pcs. ·Wiring branch box: 6 pcs.	As a result of our recent technical training and prior experience of the SEC, the component mounting can be performed without outside technical assistance.
Wiring Execution ·Solar Module -- Distribution Panel ·Distribution Panel -- Battery ·Distribution Panel -- Each Electric Components	Our recent technical training and the SEC's participation in the UN training program has increased their level of technical capability and it has been observed that SEC technicians can properly process cable terminals, clamp wiring connections and properly connect the terminal board wiring without outside help.
Control of tools	During installation, tool control was maintained by assigning custody of tools to technicians and by requiring return to a designated place. However, future tool can be handled by the SEC alone.

(2) Maintenance, Control

Components Concerned	Check List	SEC Technical Requirement
Solar Module	·Damage of Module ·Looseness of Terminal Connections ·Looseness of Module-Mounting Rack ·Dirty module surface (tree-leaves,etc.)	A check is made if there is any damage, loosened connections or dirt. If there is any defect, counter-measures can be taken for removing the dirt,retightening of terminals or replacement of the module.
Pole Mount	·Leaning pole ·Loose clamping bolts	Counter-measures can be taken by checking for leaning or loose bolts, then by tightening of bolts straightening the pole if a defect is found.
Charge/ discharge Controller	·LED display, charging and discharging operation. ·Measurement of charging /discharging voltage ·Troubleshooting and replacement	·By checking the LED display and measuring the charging/discharging voltages, operational problems can be located.. ·Repair is not possible by the SEC and if troubleshooting efforts find there are problems, the controller has to be replaced.
Storage Battery	·Measurement of terminal voltage ·Check for liquid level and loss through vents ·Measure cell specific gravity by hydro meter ·Damage of housing box ·Judgment of deterioration and replacement.	·The SEC can check battery terminal voltage, measure specific gravity check liquid level, check for acid discharge from the caps, visually check and clean the case. ·The SEC will need further training to determine the level of battery deterioration and to decide if replacement is necessary.

Fluorescent Lamp	・Bulb Failure/Damage ・Damage to Lighting Fixture	・These materials are available locally and the SEC fully understand there operation and characteristics and can perform the necessary checks and repairs on their own.
Cable Switches Other Wiring components	・Damage to Switches ・Damage to other Wiring components ・Damage to Cable	・Replacement components are locally available and the SEC can perform troubleshooting and repairs. ・Training was provided at the time of installation in proper wiring procedures and using that training SEC technicians can locate cable problems and perform repairs.

7.3Meteorological Observation System

On this Meteorological Observation System that has been sited on North Tarawa, observation data was collected at this time survey(July,93).

Item of collected data is shown in Table 7.3-1.

Also, each observation data after processed by computer is shown in Table 7.3-2～Table 7.3-7.

Table 7.3-1 Item of Meteorological Observation Data

Item of Observation Data		Table No
1	Global Radiation	Table 7.3-2
2	Diffused Radiation	Table 7.3-3
3	Wind Direction	Table 7.3-4
4	Wind Velocity	Table 7.3-5
5	Temperature	Table 7.3-6
6	Humidity	Table 7.3-7

For example, global radiation from collected data this time, it shows not much global radiation data than expected value. It seems influenced by rainy climate all over the world through this year.

Table7. 3－2 Global solar radiation year table

Place. :
Term : 1 9 9 3
Unit : KW/m2

Day\Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	5.728	2.434	2.980	4.614	4.800	2.354	6.044	3.770	5.516	4.368	
2	***	***	5.482	4.040	4.388	5.016	4.258	4.380	5.864	2.862	5.100	5.448	
3	***	***	5.416	3.094	1.950	4.056	5.346	5.432	5.782	3.068	5.924	2.636	
4	***	***	4.762	2.462	0.892	5.050	3.268	5.488	5.202	5.184	5.674	1.626	
5	***	***	2.104	4.702	2.428	2.222	2.158	5.408	4.932	3.178	5.864	3.648	
6	***	***	2.132	3.246	5.142	1.918	1.948	5.304	5.740	3.504	5.222	5.134	
7	***	***	5.340	4.992	3.148	2.092	5.116	4.978	5.396	5.478	2.642	4.044	
8	***	***	3.418	5.274	2.496	2.316	5.494	4.832	5.090	5.868	5.554	5.150	
9	***	3.558	1.052	5.418	5.350	3.560	4.742	4.444	5.868	5.998	5.550	4.888	
10	***	4.260	5.088	1.960	2.456	4.780	3.674	5.636	4.436	5.930	5.612	3.464	
11	***	0.922	3.558	3.986	1.666	3.694	4.926	5.884	0.508	5.260	5.236	4.510	
12	***	0.876	6.142	3.242	3.728	5.154	5.522	5.050	4.622	3.540	5.152	2.838	
13	***	4.782	5.300	4.480	5.070	3.846	5.260	4.816	4.364	4.658	5.792	4.528	
14	***	5.294	5.494	5.086	4.896	5.276	4.122	4.352	5.012	1.586	5.548	4.394	
15	***	5.346	5.664	3.834	4.140	3.930	4.954	5.468	4.828	0.428	5.736	5.426	
16	***	3.762	4.312	5.938	4.312	4.430	4.284	4.100	1.168	3.806	5.500	3.782	
17	***	3.926	3.802	2.766	2.912	3.736	2.886	1.930	5.992	4.328	5.654	5.068	
18	***	5.148	5.468	2.498	1.152	2.876	1.030	5.374	6.062	4.542	5.756	1.402	
19	***	3.322	2.658	5.468	3.364	2.258	3.138	4.422	4.806	3.600	5.436	3.790	
20	***	2.540	0.336	4.058	1.444	3.304	2.788	1.024	2.984	5.680	5.458	5.616	
21	***	4.854	4.872	2.330	3.888	5.436	3.822	5.458	1.704	5.678	5.508	5.016	
22	***	4.764	1.886	2.488	2.138	5.080	5.108	6.250	5.704	3.824	5.710	2.662	
23	***	4.096	4.184	4.624	3.952	4.898	5.042	5.906	5.690	5.104	3.040	5.222	
24	***	5.842	5.698	4.610	5.430	0.696	3.550	4.230	6.148	0.326	3.134	4.558	
25	***	5.834	4.832	4.980	3.938	3.576	4.728	5.488	4.890	5.030	5.184	1.124	
26	***	5.990	4.718	0.540	4.718	5.132	5.406	5.888	5.594	3.974	3.814	1.096	
27	***	3.404	1.720	4.186	0.872	2.948	0.752	5.286	3.464	5.290	1.540	3.114	
28	***	1.706	5.998	5.080	3.812	5.428	4.576	5.842	4.518	1.230	5.148	3.822	
29	***		6.120	4.212	2.490	5.526	5.498	3.846	5.498	2.118	5.724	4.358	
30	***		4.438	2.702	4.638	5.206	5.206	4.684	4.500	3.260	5.674	2.718	
31	***		4.160		5.174		4.334	5.866		5.586		4.934	
Hour statics													
Monthly total	***	80.226	131.882	114.730	104.964	118.054	127.742	149.422	142.410	123.688	152.402	120.384	1365.904
Monthly maximum	***	0.880	0.886	0.840	0.816	0.788	0.832	0.866	0.866	0.884	0.872	0.808	0.886
Date	***	2/26	3/12	4/16	5/24	6/29	7/12	8/22	9/24	10/ 9	11/ 3	12/20	3/24
Monthly minimum	***	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Date	***	2/12	3/20	4/26	5/27	6/24	7/27	8/20	9/11	10/24	11/27	12/26	12/31
Number of data	***	471	744	720	744	720	744	744	720	744	720	744	7815
Daily statics													
Monthly total	***	80.226	131.882	114.730	104.964	118.054	127.742	149.422	142.410	123.688	152.402	120.384	1365.904
Monthly maximum	***	5.990	6.142	5.938	5.430	5.526	5.522	6.250	6.148	5.998	5.924	5.616	6.250
Date	***	2/26	3/12	4/16	5/24	6/29	7/12	8/22	9/24	10/ 9	11/ 3	12/20	8/22
Monthly minimum	***	0.876	0.336	0.540	0.872	0.696	0.752	1.024	0.508	0.326	1.540	1.096	0.326
Date	***	2/12	3/20	4/26	5/27	6/24	7/27	8/20	9/11	10/24	11/27	12/26	10/24
Number of data	***	20	31	30	31	30	31	31	30	31	30	31	326

Example *** : No data

Measured by KADEC-U(R) series

Place :
Term : 1 9 9 4
Unit : KW/m2

Day\Month	1	2
1	4.354	5.394
2	4.904	5.754
3	5.516	5.410
4	5.362	0.654
5	3.716	***
6	4.674	***
7	4.438	***
8	3.678	***
9	4.794	***
10	4.880	***
11	2.118	***
12	2.440	***
13	3.866	***
14	4.248	***
15	4.258	***
16	3.846	***
17	5.386	***
18	4.694	***
19	1.380	***
20	3.074	***
21	5.416	***
22	5.062	***
23	5.368	***
24	3.450	***
25	4.520	***
26	4.840	***
27	5.566	***
28	5.316	***
29	5.654	
30	3.566	
31	3.598	
Hour statics		
Monthly total	133.982	17.212
Monthly maximum	0.840	0.852
Date	1/29	2/ 2
Monthly minimum	0.000	0.000
Date	1/19	2/ 4
Number of data	744	82
Daily statics		
Monthly total	133.982	17.212
Monthly maximum	5.654	5.754
Date	1/29	2/ 2
Monthly minimum	1.380	0.654
Date	1/19	2/ 4
Number of data	31	4

*** : No data

Table7. 3－3 Diffused solar radiation year table

Place :
Term : 1 9 9 3
Unit : KW/m2

Day＼Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	7.648	3.154	2.480	2.274	1.508	2.646	8.342	5.026	7.650	2.506	
2	***	***	7.334	5.274	1.818	1.580	2.178	3.212	8.060	3.718	7.026	1.774	
3	***	***	7.232	4.022	1.960	3.020	1.212	3.724	7.932	4.042	8.216	2.254	
4	***	***	6.310	3.158	1.078	2.114	1.640	4.446	7.106	7.076	7.890	1.988	
5	***	***	2.686	6.284	2.286	2.304	1.890	5.782	6.602	4.188	8.166	3.368	
6	***	***	2.736	4.194	2.574	1.738	2.344	6.032	7.868	4.610	7.226	2.030	
7	***	***	7.132	6.670	3.244	2.244	1.724	5.612	7.270	7.458	3.492	2.270	
8	***	***	4.368	7.112	2.722	2.464	1.338	5.974	6.854	8.126	7.700	2.052	
9	***	4.446	1.330	7.294	4.060	2.856	2.342	5.178	8.070	8.260	7.736	2.678	
10	***	5.390	6.676	2.546	2.858	2.062	3.054	7.082	5.828	8.204	7.786	3.832	
11	***	1.196	4.568	5.246	2.048	2.244	1.934	7.710	0.664	7.148	7.272	2.872	
12	***	1.118	8.324	4.268	3.802	1.944	1.314	6.538	6.156	4.610	7.126	3.024	
13	***	6.180	7.124	6.026	6.064	2.676	1.922	6.326	5.734	6.196	8.108	2.994	
14	***	6.996	7.254	6.892	6.028	1.544	1.968	5.780	6.790	2.018	7.720	4.378	
15	***	7.066	7.690	5.094	5.088	1.582	1.892	7.320	6.432	0.550	8.044	2.524	
16	***	4.902	5.642	8.090	5.432	2.204	1.958	5.148	1.496	4.994	7.666	3.074	
17	***	5.146	5.114	3.588	3.582	2.994	2.698	2.498	8.294	5.712	7.850	3.226	
18	***	6.796	7.316	3.300	1.436	2.258	1.338	7.178	8.390	6.086	8.016	1.750	
19	***	4.302	3.494	6.422	4.200	2.272	2.276	5.816	6.428	4.768	3.582	3.372	
20	***	3.264	0.462	3.432	1.798	2.978	2.348	1.316	3.888	7.810	1.558	1.820	
21	***	6.380	6.458	2.444	5.030	1.344	2.176	7.350	2.210	7.806	1.392	1.834	
22	***	6.186	2.428	2.408	2.608	1.880	1.712	8.596	7.830	5.132	1.074	2.796	
23	***	5.276	5.566	3.574	5.022	2.114	1.756	8.096	7.808	6.950	2.764	1.612	
24	***	7.848	7.684	1.934	7.238	0.906	2.290	5.540	8.498	0.432	2.886	2.816	
25	***	7.960	6.478	2.994	5.032	2.786	1.874	7.468	6.524	6.876	1.428	1.448	
26	***	8.124	6.304	0.674	6.278	1.712	1.534	8.092	7.516	5.358	1.634	1.456	
27	***	4.362	2.174	3.618	1.116	2.136	0.920	7.066	4.518	7.264	1.890	3.104	
28	***	2.226	8.176	2.436	4.168	1.096	2.286	8.056	6.098	1.554	1.838	2.806	
29	***		8.396	2.938	2.494	1.124	1.292	5.008	7.496	2.750	1.116	2.400	
30	***		5.926	3.034	1.946	1.530	2.138	6.194	6.102	4.322	1.074	2.734	
31	***		5.476		1.774		3.180	8.072		7.700		2.702	
Hour statics $]													
Monthly total	***	105.164	175.506	128.120	107.264	61.980	60.036	184.856	192.804	166.744	156.926	79.494	1418.894
Monthly maximum	***	1.220	1.202	1.144	1.060	0.460	0.520	1.188	1.198	1.212	1.220	0.664	1.220
Date	***	2/26	3/29	4/16	5/24	6/ 3	7/31	8/22	9/24	10/ 9	11/ 3	12/14	11/ 6
Monthly minimum	***	0.004	0.000	0.002	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Date	***	2/12	3/20	4/26	5/ 4	6/24	7/27	8/20	9/11	10/24	11/30	12/25	12/31
Number of data	***	471	744	720	744	720	744	744	720	744	720	744	7815
Daily statics													
Monthly total	***	105.164	175.506	128.120	107.264	61.980	60.036	184.856	192.804	166.744	156.926	79.494	1418.894
Monthly maximum	***	8.124	8.396	8.090	7.238	3.020	3.180	8.596	8.498	8.260	8.216	4.378	8.596
Date	***	2/26	3/29	4/16	5/24	6/ 3	7/31	8/22	9/24	10/ 9	11/ 3	12/14	8/22
Monthly minimum	***	1.118	0.462	0.674	1.078	0.906	0.920	1.316	0.664	0.432	1.074	1.448	0.432
Date	***	2/12	3/20	4/26	5/ 4	6/24	7/27	8/20	9/11	10/24	11/30	12/25	10/24
Number of data	***	20	31	30	31	30	31	31	30	31	30	31	326

Place :
Term : 1 9 9 4
Unit : KW/m2

Day＼Month	1	2
1	3.008	2.000
2	1.712	2.228
3	1.722	2.760
4	1.742	0.718
5	2.342	***
6	2.460	***
7	2.232	***
8	3.300	***
9	2.320	***
10	2.512	***
11	2.482	***
12	2.670	***
13	3.440	***
14	2.668	***
15	3.086	***
16	3.112	***
17	1.776	***
18	2.624	***
19	1.760	***
20	3.076	***
21	2.464	***
22	1.978	***
23	1.964	***
24	2.804	***
25	2.952	***
26	2.938	***
27	1.798	***
28	2.434	***
29	1.724	
30	3.658	
31	3.112	
	77.870	7.706
	0.548	0.386
	1/30	2/ 3
	0.000	0.000
	1/ 2	2/ 4
	744	82
	77.870	7.706
	3.658	2.760
	1/30	2/ 3
	1.712	0.718
	1/ 2	2/ 4
	31	4

Example *** : No data

Measured by KADEC-U(R) series

Table7. 3－4 Wind direction year table

Place :
Term : 1 9 9 3
Unit : 16 Direction

Day\Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	N W	N W	NNE	ENE	NNW	ENE	SSE	NNW	NNW	ESE	
2	***	***	N E	NNE	N E	ENE	SSW	N W	N W	NNW	S W	ENE	
3	***	***	E	N	ESE	N E	E	NNW	NNE	NNW	WSW	NNE	
4	***	***	E	NNW	ENE	E	N	N E	NNE	NNE	ESE	NNE	
5	***	***	SSW	N W	ENE	E	NNW	N	NNW	S E	N E	S	
6	***	***	NNW	ENE	ENE	E	NNW	N	NNE	N	N	N	
7	***	***	S	NNW	ENE	E	NNW	N	NNE	NNE	ESE	N W	
8	***	***	S W	NNE	ENE	E	NNW	NNW	NNW	N E	NNW	NNW	
9	***	N W	S W	N W	N E	SSE	NNW	W	NNE	NNW	NNW	ENE	
10	***	N W	WSW	N E	N E	E	S W	NNW	N	N	N	N E	
11	***	NNW	ENE	NNE	S	NNW	S W	NNW	N	SSW	SSW	S	
12	***	N W	SSW	ENE	NNW	E	ESE	NNW	S	S	NNE	NNE	
13	***	NNW	ENE	N E	NNW	SSW	ESE	N	NNW	SSW	N E	N	
14	***	SSW	N E	NNW	S	N	NNW	S W	N	SSW	NNE	N W	
15	***	NNE	ENE	S	N W	NNW	E	N	N W	WSW	N	N	
16	***	NNE	N	S	N W	SSE	ENE	NNW	N W	SSW	N E	NNE	
17	***	NNE	N E	NNE	N W	NNW	S E	SSW	N W	S W	NNE	NNE	
18	***	NNE	NNE	WNW	ENE	WSW	N E	SSW	N	SSW	ENE	N E	
19	***	ESE	N E	NNE	ENE	SSW	ENE	SSW	N	S	S E	N	
20	***	ESE	NNE	NNE	S E	N	N W	SSW	N	E	W	N	
21	***	NNW	NNW	N	S W	NNW	SSE	N W	SSE	N	S	N	
22	***	N E	ENE	N	SSW	N E	ENE	NNW	N	NNE	N	N	
23	***	N W	ENE	N E	E	S W	NNW	NNW	NNE	NNW	N	N E	
24	***	NNE	NNE	NNE	N E	S	SSW	SSE	E	S W	N W	ENE	
25	***	N E	N E	ENE	N E	N E	WSW	WNW	E	WSW	N	N	
26	***	ENE	ESE	N E	ENE	ENE	N	SSW	WNW	S	ENE	NNW	
27	***	NNW	NNW	ENE	NNE	NNW	N	SSW	N W	ENE	S	NNE	
28	***	NNW	N	N E	ESE	NNW	N W	N W	N	NNE	W	NNE	
29	***		N E	ENE	SSE	SSW	N E	NNW	NNW	S	N E	NNE	
30	***		NNE	N E	ENE	SSW	E	N W	NNE	S W	NNE	N E	
31	***		N		E		S	NNE		S		SSW	
Monthly most	***	NNE	N E	N E	ENE	NNW	NNW	NNW	N	SSW	N	NNE	NNW

Example *** : No data

Place :
Term : 1 9 9 4 年
Unit : 16 Direction

Day\Month	1	2
1	NNE	N E
2	E	ESE
3	N E	N E
4	E	N E
5	ESE	N
6	WNW	N
7	NNW	N
8	SSW	N
9	N	N
10	N E	***
11	NNE	***
12	N	***
13	NNE	***
14	N	***
15	NNE	***
16	NNE	***
17	ENE	***
18	N E	***
19	N	***
20	N	***
21	N E	***
22	ENE	***
23	N E	***
24	ENE	***
25	N E	***
26	N E	***
27	ENE	***
28	ESE	***
29	ESE	
30	ENE	
31	N E	
Monthly most	N E	N

Measured by KADEC-U(R) series

Table7. 3-5 Wind velocity year table

Place :
Term : 1 9 9 3
Unit : m/s

Day\Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	10.1	3.9	42.4	68.3	35.3	0.3	0.4	0.4	0.7	0.8	
2	***	***	24.7	0.9	60.6	49.1	61.2	0.5	0.6	0.5	0.5	0.9	
3	***	***	23.4	4.3	59.8	63.3	40.6	0.4	0.8	0.5	0.5	0.7	
4	***	***	27.2	1.0	65.0	65.0	38.2	0.7	0.6	0.4	0.9	0.7	
5	***	***	27.5	6.5	32.2	49.4	65.9	0.4	0.5	0.3	0.8	0.4	
6	***	***	42.5	7.0	27.8	60.5	58.8	0.4	0.5	0.5	0.6	0.9	
7	***	***	17.5	16.3	33.8	68.7	41.3	0.4	0.5	0.6	0.5	0.8	
8	***	***	15.9	8.4	39.2	68.2	17.7	0.4	0.5	0.7	0.9	0.8	
9	***	13.0	0.8	4.6	10.9	70.2	50.4	0.3	0.7	0.6	0.5	0.6	
10	***	8.0	23.0	10.7	17.2	64.0	36.9	0.5	0.5	1.5	0.5	0.4	
11	***	4.2	13.6	6.7	37.5	65.0	29.8	0.4	0.8	1.0	0.5	0.5	
12	***	4.9	10.7	4.1	57.3	62.5	30.4	0.5	0.6	1.5	0.6	0.6	
13	***	13.5	10.5	25.4	46.4	68.8	6.2	0.7	0.5	1.2	0.4	0.8	
14	***	47.5	15.0	6.8	60.1	56.8	20.5	0.6	0.5	0.5	0.4	0.7	
15	***	28.2	12.9	20.2	55.2	64.1	33.8	0.4	0.4	0.9	0.4	0.5	
16	***	38.1	34.6	8.0	64.4	61.5	9.7	1.1	0.5	0.7	0.7	1.0	
17	***	23.5	33.0	15.3	59.7	63.6	22.2	0.9	0.5	0.6	0.6	0.9	
18	***	29.2	16.2	17.1	65.2	63.3	2.2	0.6	0.5	0.8	0.5	0.8	
19	***	38.6	41.6	6.9	50.4	42.8	7.6	0.4	0.4	0.5	0.5	0.5	
20	***	18.9	64.8	22.7	63.2	68.2	3.3	0.6	0.6	0.8	0.7	0.5	
21	***	12.4	26.7	39.1	56.0	62.3	34.2	0.4	0.4	1.1	0.4	0.7	
22	***	32.1	17.1	47.9	68.0	59.5	6.2	0.5	1.2	0.4	0.6	0.7	
23	***	43.8	27.9	52.0	65.6	61.3	5.6	0.4	0.7	0.4	0.8	0.8	
24	***	19.7	12.6	36.1	38.6	67.6	4.3	0.6	0.7	0.7	1.0	0.9	
25	***	8.1	21.1	55.7	47.7	58.9	0.6	0.6	0.8	0.5	0.6	0.8	
26	***	10.5	8.9	47.2	55.1	56.4	0.7	0.5	0.9	0.6	0.9	0.8	
27	***	20.8	7.7	56.8	62.4	66.9	0.7	0.5	0.6	0.6	0.3	0.6	
28	***	13.4	9.7	43.1	54.5	51.2	0.3	0.5	0.4	0.5	0.5	0.4	
29	***		14.2	53.4	66.7	49.3	0.4	0.4	0.5	1.2	0.6	0.5	
30	***		6.5	47.2	55.2	28.4	0.4	0.6	0.6	0.5	0.5	1.2	
31	***		0.9		54.0		0.5	0.4		0.6		0.4	
Hour statics :													
Monthly total	***	21.6	20.0	22.5	50.7	60.2	21.5	0.5	0.6	0.7	0.6	0.7	18.0
Monthly maximum	***	77.7	78.2	72.9	77.5	80.0	81.0	3.8	3.9	6.0	3.0	3.7	81.0
Date	***	2/14	3/20	4/27	5/22	6/ 9	7/ 5	8/16	9/22	10/12	11/24	12/30	7/ 3
Monthly minimum	***	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Date	***	2/11	3/ 9	4/ 2	5/ 9	6/30	7/28	8/ 9	9/ 1	10/ 5	11/27	12/28	12/31
Number of data	***	472	744	720	744	720	743	744	720	744	720	744	7815
Daily statics													
Monthly total	***	21.4	20.0	22.5	50.7	60.2	21.5	0.5	0.6	0.7	0.6	0.7	18.0
Monthly maximum	***	47.5	64.8	56.8	68.0	70.2	65.9	1.1	1.2	1.5	1.0	1.2	70.2
Date	***	2/14	3/20	4/27	5/22	6/ 9	7/ 5	8/16	9/22	10/12	11/24	12/30	6/ 9
Monthly minimum	***	4.2	0.8	0.9	10.9	28.4	0.3	0.3	0.4	0.3	0.3	0.4	0.3
Date	***	2/11	3/ 9	4/ 2	5/ 9	6/30	7/28	8/ 9	9/ 1	10/ 5	11/27	12/28	7/28
Number of data	***	20	31	30	31	30	31	31	30	31	30	31	326

Example *** : No data

Place :
Term : 1 9 9 4
Unit : m/s

Day\Month	1	2
1	0.6	0.8
2	1.3	0.7
3	0.9	1.0
4	0.6	0.9
5	0.6	***
6	0.6	***
7	0.7	***
8	0.6	***
9	0.7	***
10	0.7	***
11	0.4	***
12	0.6	***
13	0.5	***
14	0.8	***
15	1.1	***
16	0.9	***
17	0.9	***
18	1.0	***
19	0.9	***
20	0.6	***
21	0.9	***
22	0.9	***
23	1.3	***
24	1.3	***
25	0.7	***
26	0.8	***
27	0.8	***
28	1.2	***
29	1.1	
30	0.8	
31	0.7	
	0.8	0.8
	6.0	1.6
	1/23	2/ 3
	0.1	0.0
	1/11	2/ 4
	744	82
	0.8	0.8
	1.3	1.0
	1/23	2/ 3
	0.4	0.7
	1/11	2/ 2
	31	4

Measured by KADEC-U(R) series

Table7. 3－6 Temperature year table

Place :
Term : 1 9 9 3
Unit : ℃

Day＼Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	27.3	27.1	26.6	26.9	27.6	26.5	28.3	26.8	27.0	47.4	
2	***	***	27.4	27.1	26.5	27.0	27.8	27.0	28.4	26.6	26.7	43.6	
3	***	***	27.4	27.0	26.5	27.2	28.0	27.8	28.5	26.5	28.5	58.7	
4	***	***	27.3	26.9	26.5	27.4	28.0	28.5	27.9	27.6	28.8	53.0	
5	***	***	27.3	26.8	26.5	27.6	27.7	28.4	27.7	26.6	28.9	43.2	
6	***	***	27.3	26.7	26.3	27.8	27.7	28.0	28.2	26.7	28.8	41.5	
7	***	***	27.3	26.7	26.1	27.9	27.9	27.8	27.5	28.6	27.6	44.7	
8	***	***	27.2	26.6	26.1	28.1	27.8	27.7	27.3	27.9	28.4	41.6	
9	***	26.6	27.2	26.6	26.1	28.3	27.8	27.0	28.7	27.8	28.6	48.4	
10	***	26.3	27.1	26.6	26.1	28.5	27.8	28.0	27.6	29.1	28.2	50.9	
11	***	25.1	27.0	26.7	26.2	28.7	27.8	28.1	25.0	27.8	28.4	50.4	
12	***	23.9	27.0	26.7	26.2	28.9	28.0	28.3	27.0	26.5	28.7	45.9	
13	***	28.0	27.0	26.7	26.1	29.1	28.0	26.9	27.2	26.9	28.0	49.6	
14	***	27.6	27.0	26.7	26.1	29.0	27.7	27.5	27.9	25.6	27.8	46.7	
15	***	27.3	27.1	26.7	26.1	29.0	27.8	28.4	27.6	24.9	28.5	50.4	
16	***	27.3	27.2	26.7	25.9	29.0	27.9	26.0	25.6	26.4	29.3	44.6	
17	***	27.3	27.3	26.7	25.1	29.1	28.1	25.9	28.0	27.0	28.4	46.8	
18	***	27.2	27.3	26.7	25.1	28.9	28.2	27.8	28.4	26.9	27.4	44.1	
19	***	27.1	27.3	26.8	25.2	28.8	28.3	27.6	28.1	27.0	24.7	45.3	
20	***	27.2	27.3	26.8	25.3	28.8	28.3	24.6	27.0	29.2	22.8	46.0	
21	***	27.3	27.3	26.8	25.5	28.7	28.4	27.2	26.1	29.2	20.8	45.2	
22	***	27.3	27.2	26.9	25.8	28.7	28.5	27.8	29.2	28.7	18.2	43.4	
23	***	27.3	27.2	26.9	25.8	29.0	28.7	28.2	29.5	29.3	9.3	44.9	
24	***	27.3	27.1	26.9	25.9	28.8	28.6	26.4	29.4	26.4	7.5	43.5	
25	***	27.2	27.1	26.9	26.1	28.7	28.2	26.5	27.5	28.7	13.2	41.7	
26	***	27.2	27.1	26.9	26.3	28.1	27.9	27.4	28.8	27.3	20.6	40.2	
27	***	27.2	27.1	26.8	26.4	27.7	25.4	27.7	28.0	27.8	43.1	40.3	
28	***	27.3	27.2	26.8	26.5	27.6	27.1	27.7	27.7	26.7	39.8	40.3	
29	***		27.2	26.7	26.7	27.6	28.1	27.2	28.7	26.9	44.8	40.8	
30	***		27.1	26.7	26.8	27.5	27.8	26.6	27.1	26.8	45.3	40.9	
31	***		27.1		26.8		27.9	28.0		26.9		40.4	
Hour statics													
Monthly total	***	27.0	27.2	26.8	26.1	28.3	27.9	27.4	27.8	27.3	27.3	45.3	29.0
Monthly maximum	***	30.8	27.4	27.2	139.7	29.2	31.9	32.7	33.1	33.1	74.1	74.1	139.7
Date	***	2/13	3/ 3	4/ 1	5/31	6/17	7/23	8/ 4	9/23	10/23	11/30	12/ 3	5/16
Monthly minimum	***	22.1	27.0	26.6	25.0	26.9	23.5	23.0	22.5	22.9	-5.8	-4.6	-5.8
Date	***	2/ 9	3/13	4/ 9	5/17	6/ 1	7/27	8/20	9/11	10/15	11/24	12/26	11/23
Number of data	***	472	744	720	744	720	744	744	720	744	720	744	7816
Daily statics													
Monthly total	***	27.0	27.2	26.8	26.1	28.3	27.9	27.4	27.8	27.3	27.3	45.3	29.0
Monthly maximum	***	28.0	27.4	27.1	26.8	29.1	28.7	28.5	29.5	29.3	45.3	58.7	58.7
Date	***	2/13	3/ 3	4/ 1	5/31	6/17	7/23	8/ 4	9/23	10/23	11/30	12/ 3	12/ 3
Monthly minimum	***	23.9	27.0	26.6	25.1	26.9	25.4	24.6	25.0	24.9	7.5	40.2	7.5
Date	***	2/12	3/13	4/ 9	5/17	6/ 1	7/27	8/20	9/11	10/15	11/24	12/26	11/24
Number of data	***	20	31	30	31	30	31	31	30	31	30	31	326

Place :
Term : 1 9 9 4
Unit : ℃

Day＼Month	1	2
1	40.6	-29.1
2	41.4	-29.1
3	31.9	-29.1
4	1.7	-29.4
5	-4.6	***
6	-5.0	***
7	-12.6	***
8	-11.7	***
9	-12.0	***
10	-8.2	***
11	-26.8	***
12	-25.5	***
13	-14.8	***
14	-15.6	***
15	-20.6	***
16	-19.1	***
17	-15.0	***
18	-20.2	***
19	-28.5	***
20	-29.2	***
21	-28.9	***
22	-28.9	***
23	-28.9	***
24	-29.3	***
25	-29.1	***
26	-29.0	***
27	-28.9	***
28	-29.0	***
29	-29.0	
30	-29.2	
31	-29.3	
Hour statics		
Monthly total	-15.3	-29.1
Monthly maximum	74.1	-28.2
Date	1/ 2	2/ 4
Monthly minimum	-29.6	-29.5
Date	1/31	2/ 3
Number of data	744	81
Daily statics		
Monthly total	-15.3	-29.2
Monthly maximum	41.4	-29.1
Date	1/ 2	2/ 1
Monthly minimum	-29.3	-29.4
Date	1/31	2/ 4
Number of data	31	4

Example *** : No data

Measured by KADEC-U(R) series

Table7. 3-7Humidity year table

Place :
Term : 1 9 9 3
Unit : %

Day\Month	1	2	3	4	5	6	7	8	9	10	11	12	Year
1	***	***	99.8	61.9	73.2	74.8	-5.3	91.2	75.4	87.2	88.7	59.7	
2	***	***	90.7	72.9	78.1	56.8	-2.7	87.6	75.0	88.1	88.1	55.7	
3	***	***	67.3	84.0	68.4	25.9	-1.6	83.4	75.7	89.1	81.2	58.1	
4	***	***	59.0	115.0	70.0	18.5	7.0	80.1	79.5	84.2	72.9	53.6	
5	***	***	27.4	138.1	99.4	-1.9	7.7	78.3	80.1	89.3	74.6	53.9	
6	***	***	38.8	181.3	125.9	-3.4	1.2	78.6	76.2	85.4	76.8	52.6	
7	***	***	77.3	190.7	120.7	17.5	3.6	79.3	78.9	77.9	83.9	50.8	
8	***	***	74.3	199.1	122.1	39.6	36.4	80.1	80.3	79.2	79.5	51.9	
9	***	168.9	71.8	200.1	135.2	74.5	39.5	84.9	75.6	80.2	77.5	51.9	
10	***	179.4	86.4	175.4	132.8	79.7	43.8	78.7	81.1	77.5	81.7	51.6	
11	***	190.1	115.3	174.3	118.0	51.5	62.7	74.4	92.8	84.6	79.5	50.8	
12	***	205.3	138.3	188.6	152.1	35.6	60.9	75.8	81.6	88.4	71.5	42.9	
13	***	224.5	115.0	200.7	149.1	47.5	26.2	86.4	82.3	87.6	73.0	45.9	
14	***	197.4	100.9	189.5	143.7	49.3	2.6	81.4	80.3	92.9	76.7	42.9	
15	***	229.2	62.6	180.5	84.8	46.1	6.4	78.4	81.2	94.4	73.1	45.9	
16	***	239.3	60.4	175.8	48.5	27.2	8.2	92.8	89.5	90.3	71.9	41.1	
17	***	218.9	41.4	163.8	16.4	6.2	13.2	91.8	79.6	85.0	68.4	43.1	
18	***	215.5	52.8	155.1	11.8	15.6	-5.5	79.3	72.4	89.5	66.0	42.7	
19	***	199.9	51.9	123.5	32.7	-4.2	14.8	82.2	74.5	89.2	70.9	45.7	
20	***	201.0	11.9	109.6	25.9	10.5	23.2	94.3	83.2	77.5	67.5	45.5	
21	***	220.1	64.2	77.6	40.9	20.4	45.5	81.2	89.4	77.6	60.8	44.5	
22	***	224.2	67.4	59.6	46.5	23.2	31.7	77.3	76.3	81.3	61.7	46.9	
23	***	202.7	85.4	54.1	72.4	3.9	25.9	76.8	76.2	81.7	64.8	45.4	
24	***	188.5	89.0	43.8	68.4	-12.2	8.3	87.2	71.1	90.5	62.5	45.3	
25	***	165.5	58.4	63.8	58.0	8.9	30.8	83.5	83.5	78.7	62.7	48.0	
26	***	147.5	52.4	50.6	63.9	10.3	82.6	78.7	71.8	84.6	69.3	43.7	
27	***	104.3	53.9	79.8	47.6	15.1	92.8	76.6	78.3	82.2	73.3	40.9	
28	***	80.5	79.9	96.1	55.5	25.3	84.2	74.6	79.7	86.8	64.2	38.3	
29	***		92.8	93.1	62.4	14.6	81.7	78.8	72.2	86.8	62.6	40.7	
30	***		67.5	77.4	81.8	-9.2	82.1	84.3	86.0	88.3	58.6	44.0	
31	***		65.7		80.1		83.4	77.8		89.8		37.4	
Hour statics 計													
Monthly total	***	190.4	71.6	125.9	80.2	25.6	32.0	81.8	79.3	85.3	72.1	47.1	77.3
Monthly maximum	***	271.1	194.7	253.5	218.4	157.8	151.4	101.6	101.1	103.5	102.4	80.3	271.1
Date	***	2/16	3/12	4/13	5/12	6/10	7/27	8/20	9/11	10/15	11/ 1	12/ 1	2/15
Monthly minimum	***	0.0	-1.5	-0.8	-12.7	-15.6	-15.6	54.1	52.5	58.5	44.3	23.3	-15.6
Date	***	2/28	3/20	4/24	5/18	6/24	7/18	8/11	9/24	10/10	11/30	12/31	6/24
Number of data	***	473	744	720	744	720	743	744	720	744	720	744	7816
Daily statics													
Monthly total	***	190.1	71.6	125.9	80.2	25.6	32.0	81.8	79.3	85.3	72.1	47.1	77.4
Monthly maximum	***	239.3	138.3	200.7	152.1	79.7	92.8	94.3	92.8	94.4	88.7	59.7	239.3
Date	***	2/16	3/12	4/13	5/12	6/10	7/27	8/20	9/11	10/15	11/ 1	12/ 1	2/16
Monthly minimum	***	80.5	11.9	43.8	11.8	-12.2	-5.5	74.4	71.1	77.5	58.6	37.4	-12.2
Date	***	2/28	3/20	4/24	5/18	6/24	7/18	8/11	9/24	10/10	11/30	12/31	6/24
Number of data	***	20	31	30	31	30	31	31	30	31	30	31	326

Place :
Term : 1 9 9 4
Unit : %

Day\Month	1	2
1	40.4	0.2
2	43.3	0.2
3	32.8	0.2
4	17.7	0.0
5	11.4	***
6	13.1	***
7	8.7	***
8	5.0	***
9	6.0	***
10	10.3	***
11	0.8	***
12	0.9	***
13	4.6	***
14	3.6	***
15	1.1	***
16	2.5	***
17	4.1	***
18	1.1	***
19	0.4	***
20	0.1	***
21	0.2	***
22	0.2	***
23	0.1	***
24	0.0	***
25	0.1	***
26	0.1	***
27	0.2	***
28	0.2	***
29	0.2	
30	0.1	
31	0.1	
Monthly total	6.8	0.1
Monthly maximum	103.5	0.5
Date	1/ 2	2/ 2
Monthly minimum	0.0	0.0
Date	1/24	2/ 4
Number of data	744	81
Monthly total	6.8	0.1
Monthly maximum	43.3	0.2
Date	1/ 2	2/ 2
Monthly minimum	0.0	0.0
Date	1/24	2/ 4
Number of data	31	4

Example *** : No data

Measured by KADEC-U(R) series

8. Evaluation of Solar Energy Company (SEC) Management

8.1 Organizational Analysis

8.1.1 Management system

The management of SEC is based on The Articles of Association which in conformity with The Companies Ordinance of the Republic of Kiribati.

(1) Stock holders of SEC

Minister of Works and Energy	495
Secretary of Works and Energy	1
Secretary of Home Affairs	1
Manager of Bank of Kiribati	1
Manager of Public Utility Board	1
Secretary of Finance	1

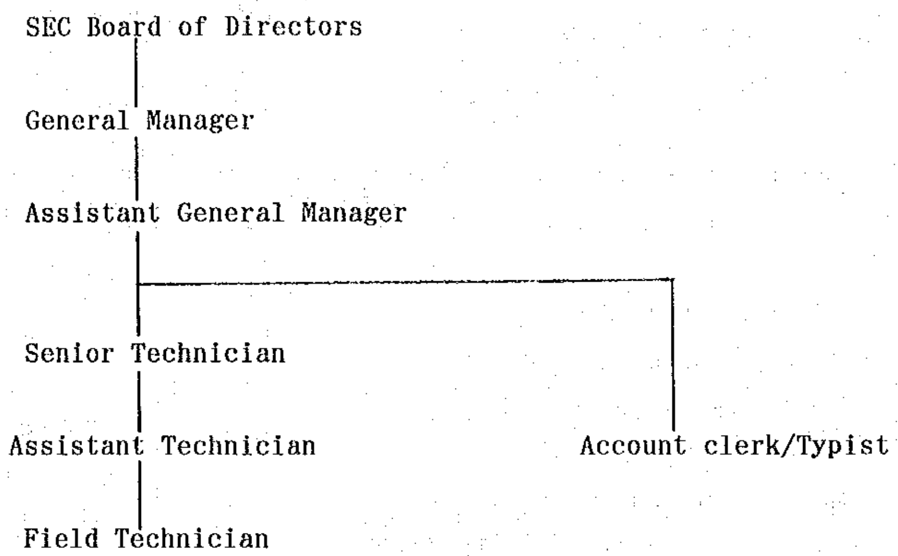
(2) Board of Directors

Chair person:	Mr. Abureti Takaio	Senior Assistant Secretary for MWE
Directors:	Mr. Tebwe Ietaake,	Public Finance Economist, MFEP
	Mr. Buibui Tiweri,	Electrical Engineer, PUB
	Mr. Toawea Tiweri,	Private Businessman
Secretary:	Mr. Terubentau Akura,	Manager of SEC
Auditors:	Office of the directors of Audit	

Power and Duties of Directors

a. Appoint the manager of company
b. Pay all expenses properly incurred in promoting the company
c. Appoint all officers and servants of the company as they may think necessary, and determine their duties,salaries and wages.
d. Exercise the powers conferred by the Companies Ordinance in necessary.

(3) Organizational chart of SEC



(4) Duties/Responsibilities of SEC members

a. General Manager: Responsible for day to day total management of the SEC

b. Assistant General Manager: Support general manager in total management and especially responsible for the implementation of Rural Electrification

c. Senior Technician: Responsible for the technical work on installation and maintenance of PV system and guide the assistant technician and the field technician to improve their technology

d. Assistant Technician: Install and Maintain the PV systems under the supervision of senior technician and train the field technician to be able to maintain the PV system

e. Field Technician: Stay at the rural area and maintain the PV system installed near by his place with supervision of the Assistant technician and Senior Technician

f. Account clerk/Typist: Responsible for the daily receipts and disbursement of SEC and support managers as secretary

The assistant general manager(AGM) and the field technician were appointed to implement the rural electrification and to expand the operations of SEC in 1993.

8.2 Financial Analysis

8.2.1 Profit and Loss Statement and Balance sheet

(1) Profit and loss statement

Items (A$)	1992	1991	1990	1989
Operating revenue	229,183	103,768	108,073	77,398
Operating expenses	225,123	109,339	113,660	92,384
purchased	186,043	79,362	85,355	59,073
maintenance	1,127	188	614	1,249
depreciation	657	818	2,096	2,097
salaries & wages	16,056	15,552	14,134	20,402
others	21,236	13,419	11,461	9,563
(trip & per-diem	10,037	8,768	4,028	)
(communication	2,588	1,236	2,386	)
(audit fee	2,375	- 50	950	)
(rental fee	2,170	--	--	)
Operating income	4,060	- 5,571	- 5,587	-14,986
Other income	625	214	0	950
Net profit	4,685	- 5,357	- 5,587	-14,036

The operating revenue is improving rapidly and the yearly balance has turned from a loss to a profit and this improved profitability is expected to continue.

(2) Balance Sheet

Items (A$)	1992	1990	1989
Fixed Assets	1,831	1,897	3,070
Current Assets	91,077	85,002	91,151
maintenance spares	35,749	30,437	57,570
bank and cash balances	51,264	25,580	17,143
accounts receivable	4,064	25,948	14,386
imprest accounts	0	3,037	2,052
Current Liabilities	21,776	17,459	19,023
short term debt	6,331	851	727
account payable	15,445	0	13,388
consumer financed project	0	16,680	4,908
Net Asset	71,132	69,440	72,128
Financed by			
Capital	500	500	500
Consumer deposit	2,364	0	0
Retained earnings	- 5,174	- 4,502	1,256
Long term debt	73,442	73,442	73,442

8.2.2 Audit system in Kiribati

Government owned Companies submit their Company Financial Statement each year to the Office of the Director of Audit.

The Office of the Director of Audit, audits the statements and check the documents, then prepares the Report of the Director of Audit on the Accounts of the Company and submits it to The Ministry of Financing and Economic Planning.

The Ministry of Financing and Economic Planning forwards them to the "Maneaba" for consideration.

8.2.3 Purchase and Inventory Control in SEC

In April 1993, the manager and assistant manager completed the training course held at SPIRE(South Pacific Institute for Renewable Energy, Tahiti, French Polynesia),on the preparation of technical specifications and tender documents and evaluation of tenders. By completion of this course, the SEC personnel should have an improved ability to purchase solar equipment.

The inventory is not now large enough to warrant control by computer but in the near future the users of PV system will increase and the SEC will manage a much larger and more complex inventory of PV parts and will need to introduce computer assisted management of inventory.

8.3 Medium-Term Estimation of SEC

The management system has been strengthened by recruiting an assistant general manager who is responsible especially for the Rural Electrification Project.

The system of accounting is being computerized with training by an external consultant and the computer with its software programs have been supplied by UNDP according to their Cooperation programme with the JICA project. The financial tables show that the financial situation of SEC is gradually improving and the trend is expected to confirm.

The JICA project and the succeeding EC project will provide the SEC about 300 new PV customers and their monthly payment (9 A$/month/user) will provide pretty amount of cash income to SEC.

A major concern of the SEC regarding PV electrification is the problem of collecting monthly fees from customers since a failure to collect will adversely affect the financial condition of the SEC.

8.4 Calculation when JICA and EC system have been installed

The simple calculation of financial effect for the SEC after JICA and EC PV systems have been installed shows that 9A$/month of maintenance fee will cover the field technicians' wages and a part of administration cost of SEC aside of exchane cost of battery and controller.

Preconditions of calculation are:

(1) Life of component; PV panel 20yrs, battery 5yrs, controller 10yrs.
(2) Unit cost; PV panel 350A$, battery 150A$, controller 120A$.
(3) Number of household; 300, Number of field technician 5.
(4) Wage of field technician; 2,000A$.
(5) Administration cost of SEC; 15% of field technician's wage.
(6) Discount rate; 10%

The result is shown in Table 8.4-1

Table 8.4-1 Case study of JICA and EC system had been installed

Profit & Loss Items		Cost		1	2	3	4	5	6	7	8	9	10	11	12--15	16	17--20
Policy & Environment	Unit cost of H.H	2000.0	A$														
	Unit cost of O.B	10000.0															
	Unit cost of panel	350.0															
	Unit cost of Battery	150.0															
	Unit cost of control	120.0															
	Wage of Field Tech.	2000.0															
	Inst. fee per Unit	50.0															
	Maint. fee per year	108.0															
Sales	No. of Inst. Unit H.H			300													
	No. of Inst. Unit O.B			5													
	accum H.H			300	300	300	300	300	300	300	300	300	300	300	300	300	300
	accum O.B			5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Sales of Install			15,250	0	0	0	0	0								
	Sales of Maintenance			32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940
	Total Income			48,190	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940	32,940
Variable cost	Number of panel	2.0	%		13	13	13	13	13	13	13	13	13	13	13	13	13
	Number of Battery	5years							320	0	0	0	0	320	0	320	0
	Number of controller	10years												310	0	0	
	Cost of panel			0	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900	3,900
	Cost of battery			0	0	0	0	0	48,000	0	0	0	0	48,000	0	0	0
	Cost of controller			0	0	0	0	0						31,000	0	0	0
	Total Var.Cost			0	3,900	3,900	3,900	3,900	51,900	3,900	3,900	3,900	3,900	82,900	3,900	3,900	3,900
Fixed cost	Number of Field tech			5	5	5	5	5	5	5	5	5	5	5	5	5	5
	Wages of Field Tech.			10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
	Administration	15.0	%	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
	Total Fixed Cost			11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500	11,500
	Total cost			11,500	15,400	15,400	15,400	15,400	63,400	15,400	15,400	15,400	15,400	94,400	15,400	15,400	15,400
	(Investment cost)			650,000	0	0	0	0	0	0	0	0	0	0	0	0	0
Income from Opn.				36,690	17,540	17,540	17,540	17,540	-30,460	17,540	17,540	17,540	17,540	-61,460	17,540	17,540	17,540
	Net Present Value	r=10%		102,457													