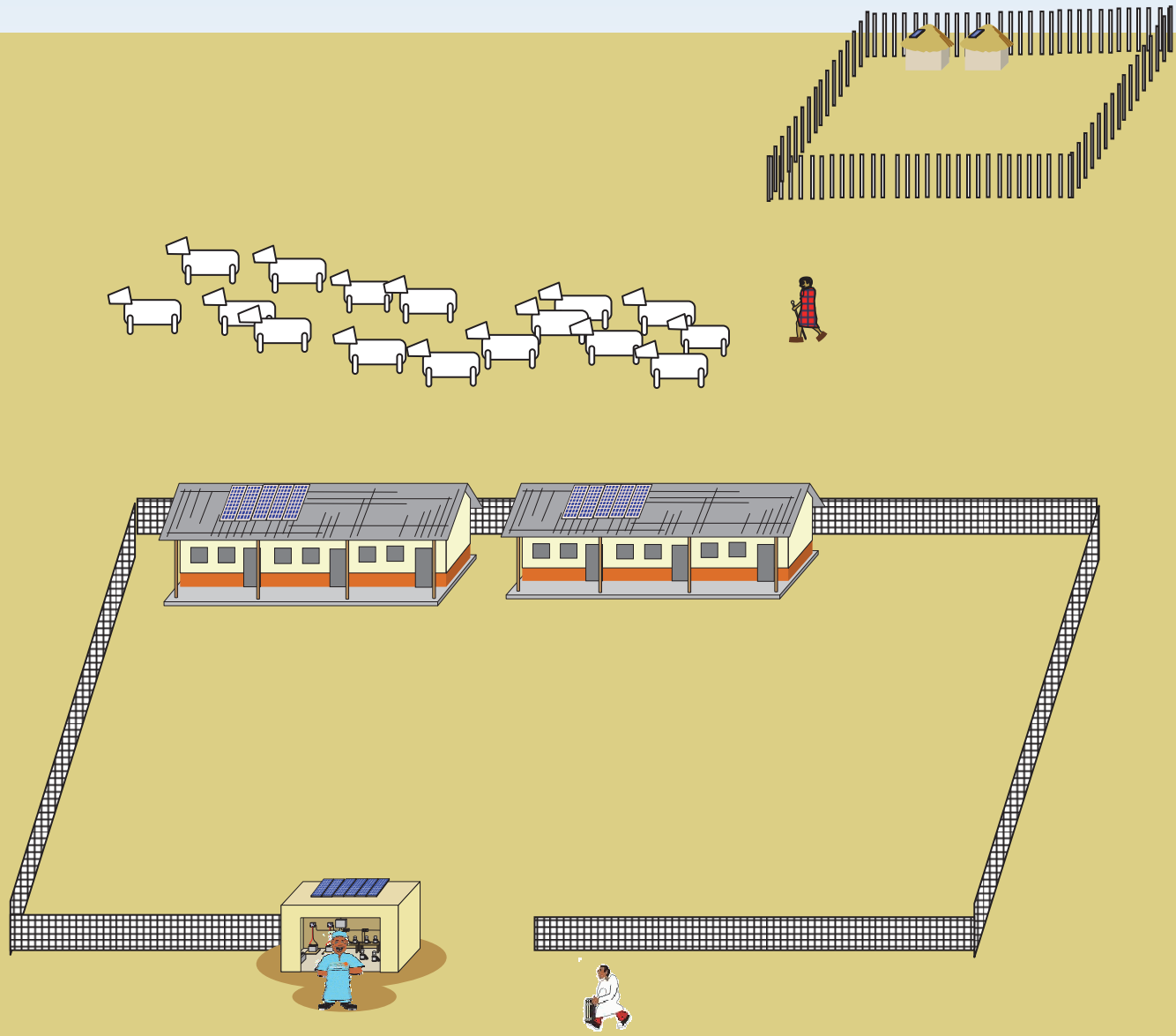
Solar PV Operation Manual



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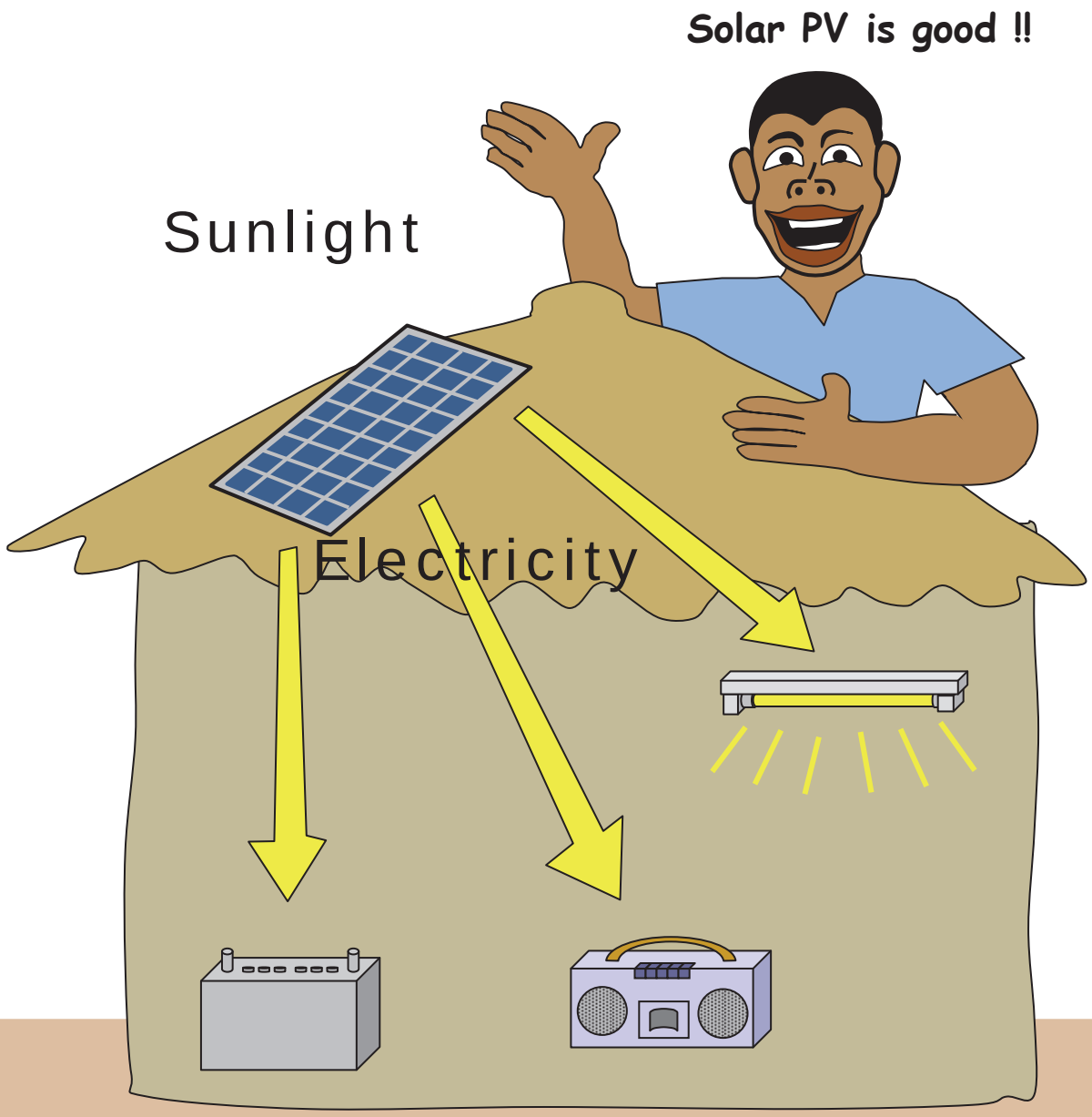
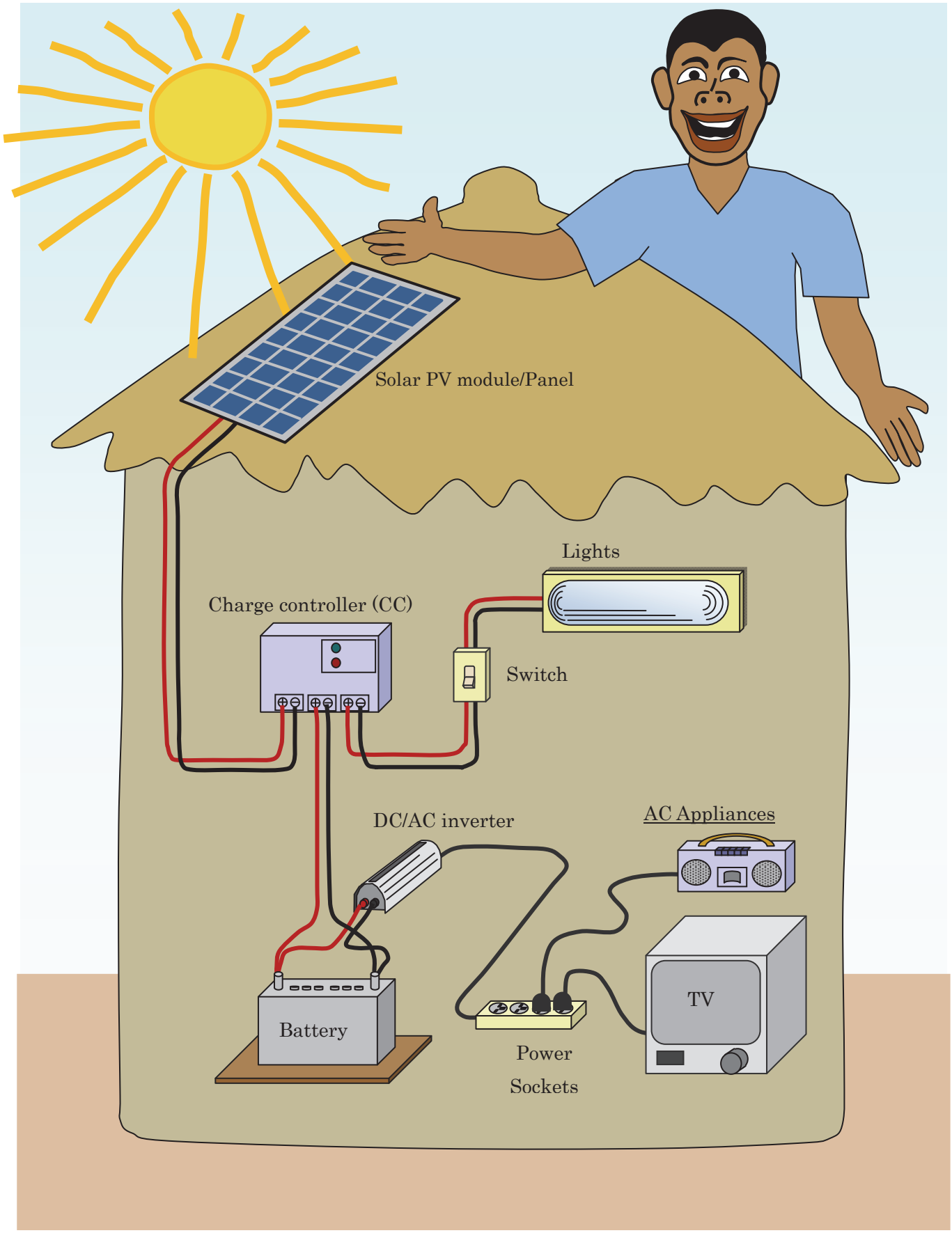
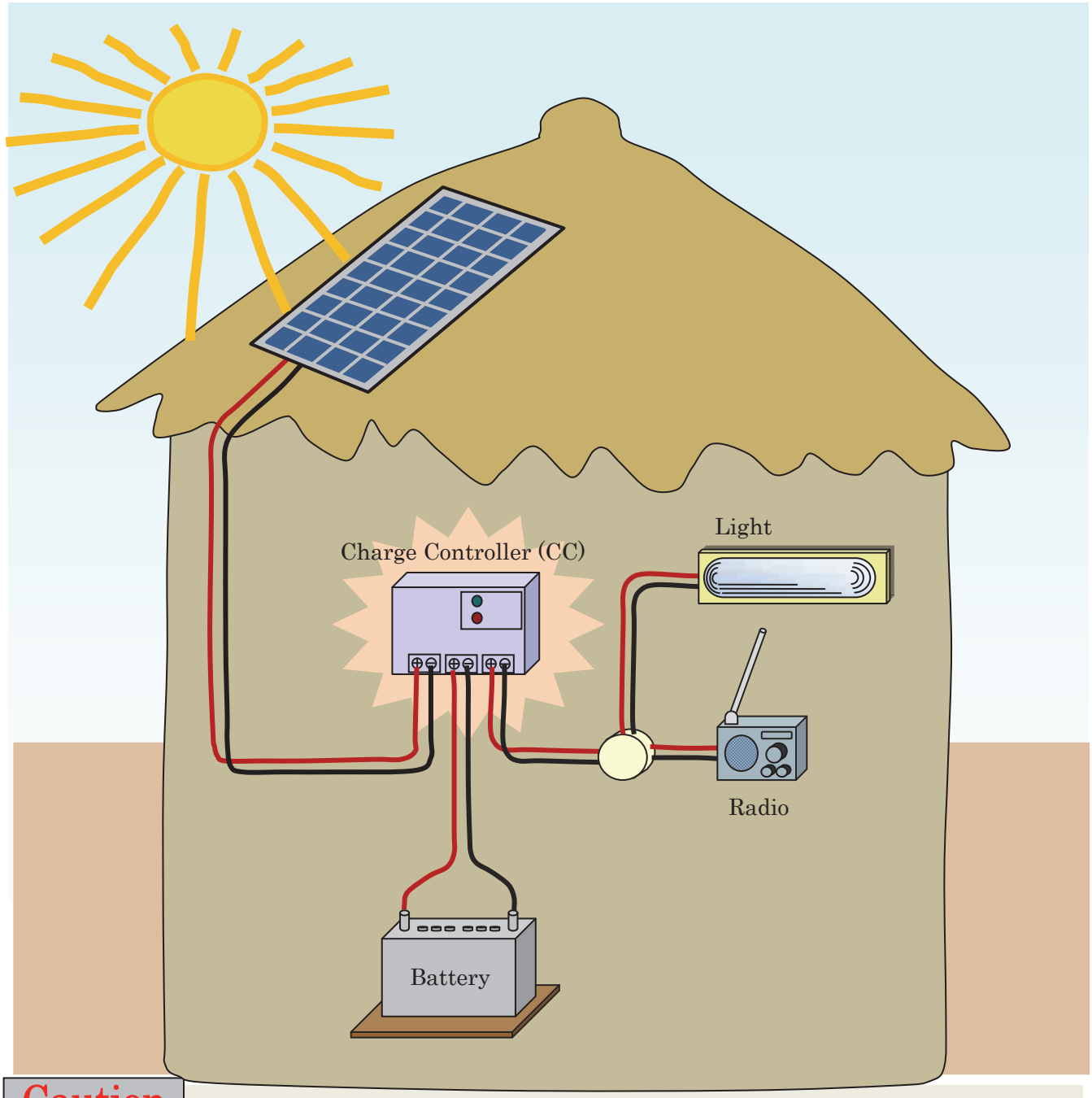


The solar PV is a device which changes light energy to electric energy. Solar PV does not store energy. The light energy (sunlight) acts as a "fuel" for conversion process to produce output (energy).

Basic configuration



DC system

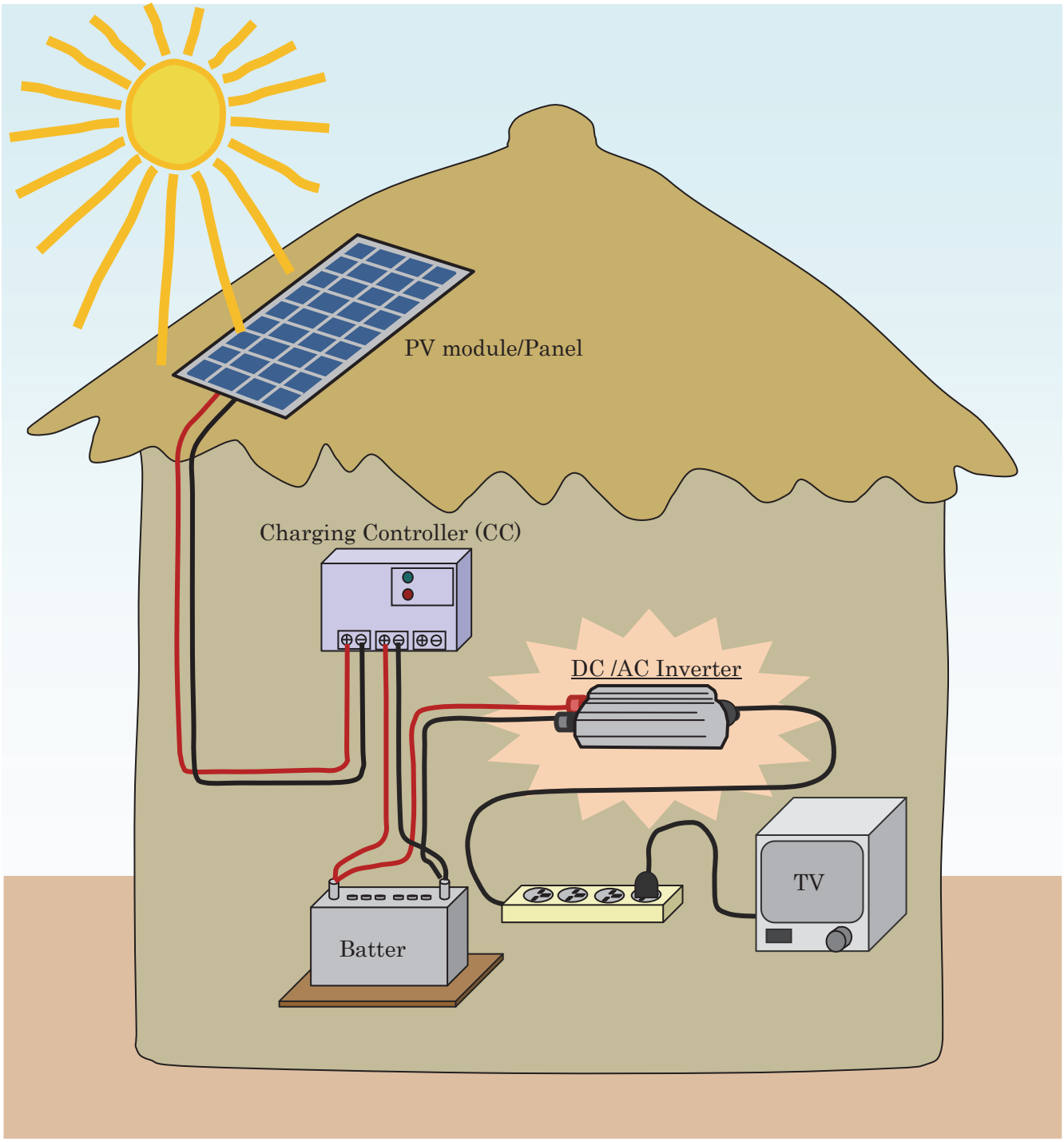


Caution

Direct Current (DC) systems have polarity ("Positive" and "Negative"). The Positive (+ tive) wire is red, while the negative (- tive) wire is black.

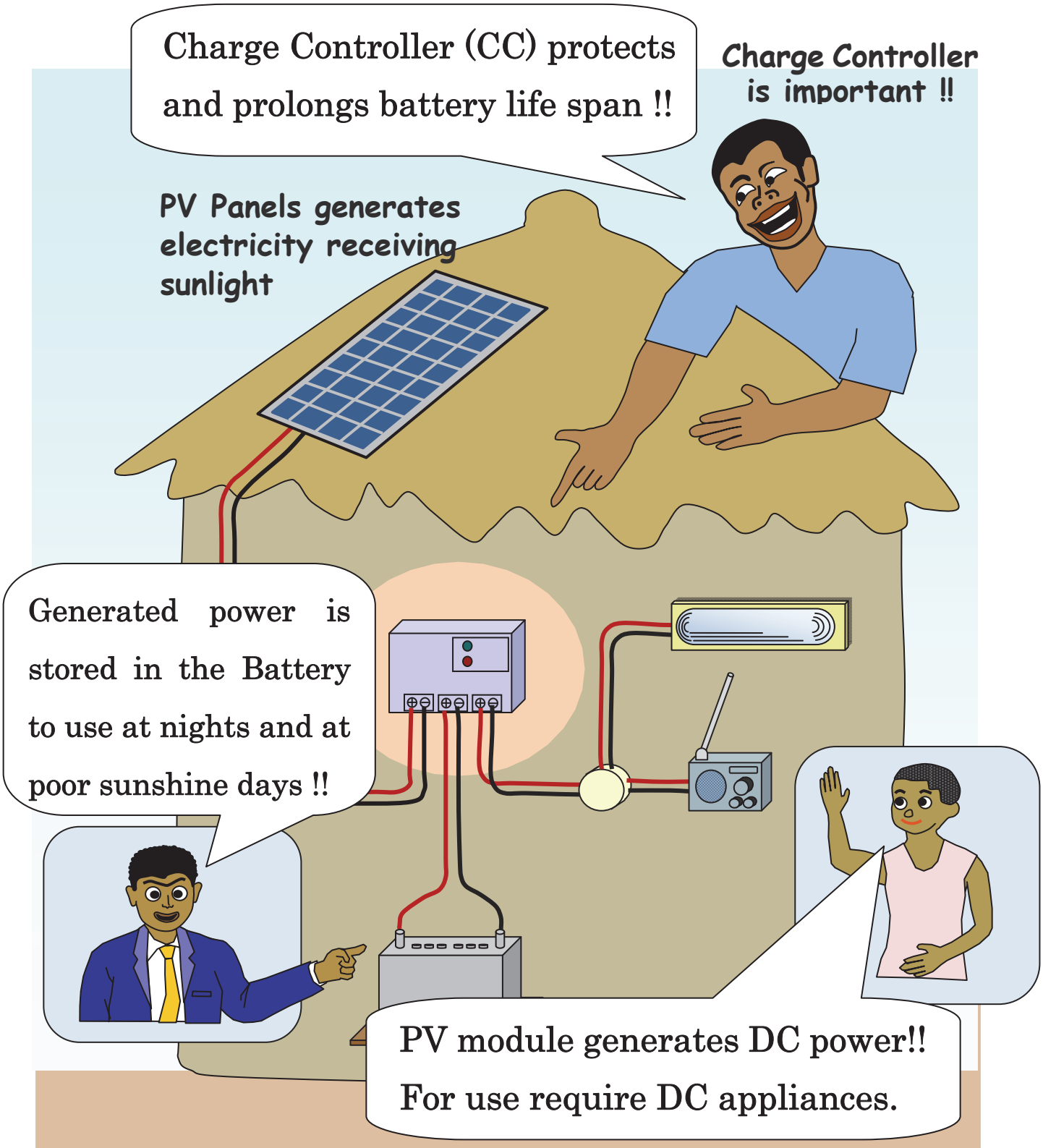
DC systems are similar to the car battery power supply

AC system



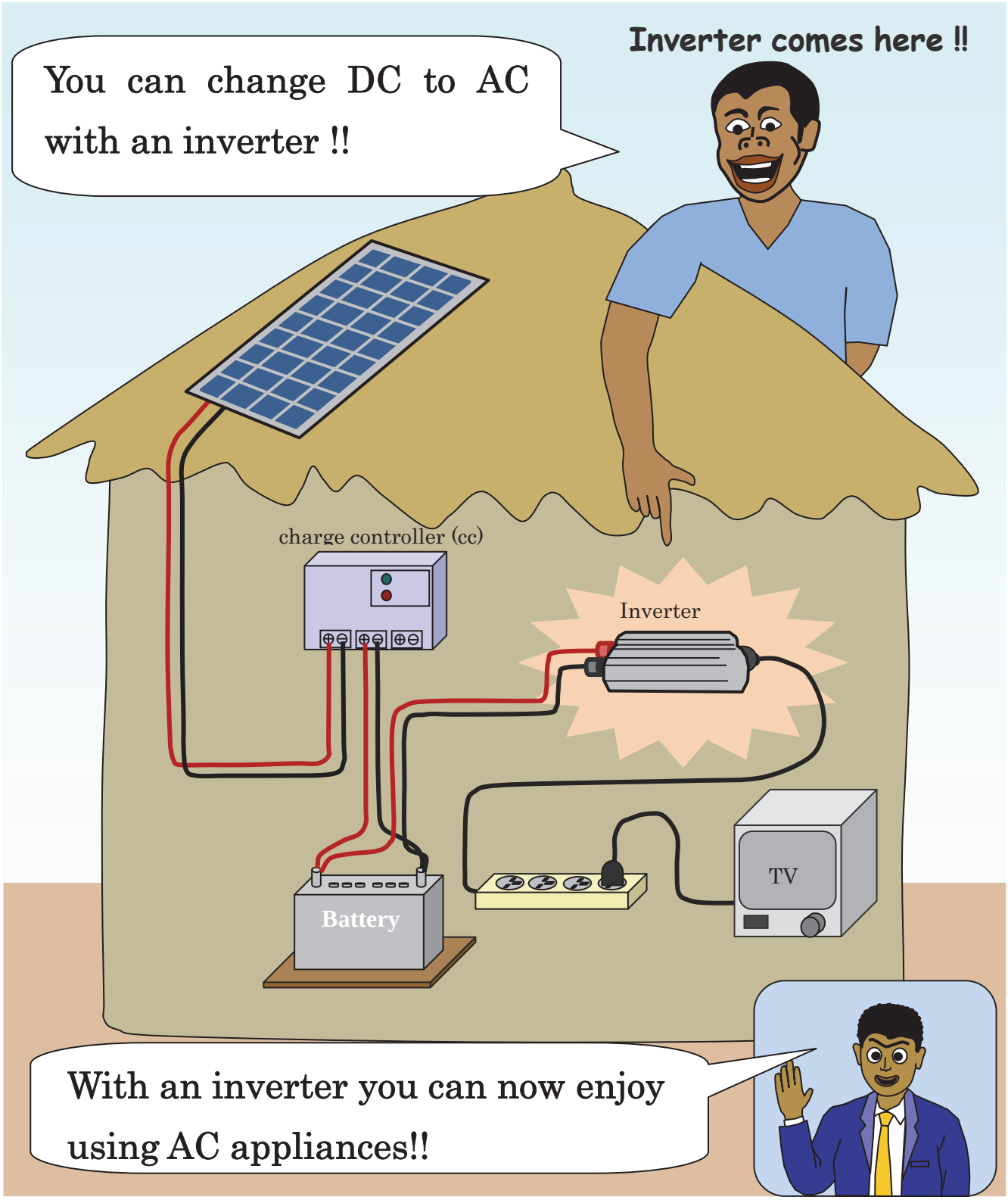
An inverter converts DC power to AC power. This means after the inverter (output), we recive AC power. Therefore, appliances which run on AC are possible to use.

Function of PV components

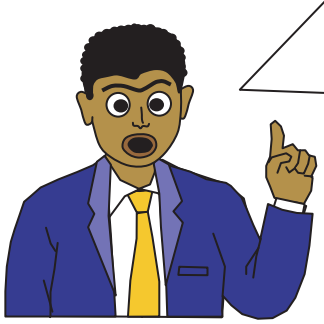


The equipment which runs on DC power does not need Inverter.
DC appliances need to match the DC system voltage to connect with installed PV system.

DC appliances are not so common in practice. But you can use AC appliances if you have an inverter



In a PV system,



The amount of electricity generation in a day depends on

1. Brightness and duration of Sun visibility.
2. Installation capacity of the PV module/panel

If

Brightness and sun visibility are limited!!

Panel capacity is limited!!

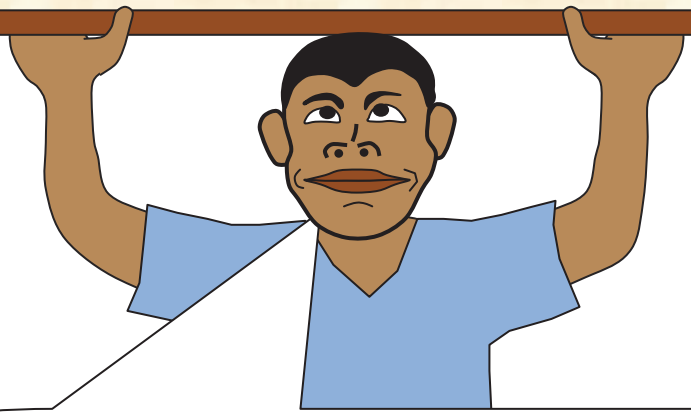
Battery capacity is limited!!

Then,

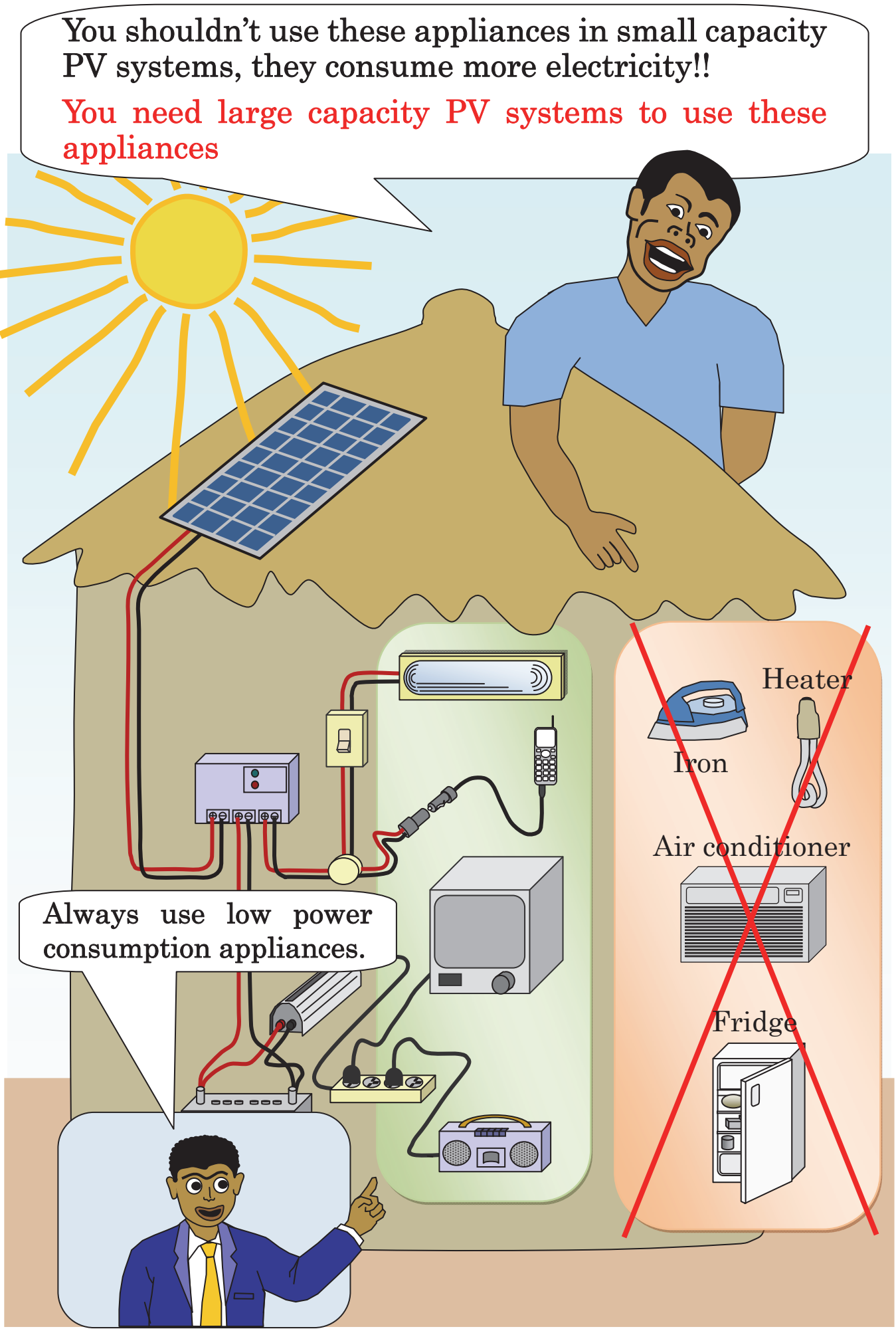
Electricity you can use is limited.

And,

Appliances you can use are limited.



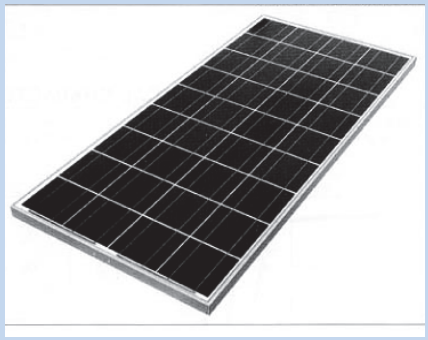
You have to be careful when you choose appliances to use in a PV system!!


You shouldn't use these appliances in small capacity PV systems, they consume more electricity!!
You need large capacity PV systems to use these appliances
Heater
Iron
Air conditioner
Fridge
Always use low power consumption appliances.

Components of PV systems

Panels





Panels generate electricity receiving sunlight.

Output: DC

Capacity: 70W–120W are popular

Lifespan: 20 – 25 years

Batteries

Batteries are use to store electricity for night and on poor sunshine days.

Sealed batteries (no refilling)

Flooded batteries (periodic refilling is necessary)

Capacity: 50 – 200Ah are popular

Lifespan: 3-8 years (depends on use conditions)

Charge Controllers (CC)

Controller protects batteries. They indicate battery condition (“battery full, battery empty, charging).

Capacity: 10-50 A are popular

Lifespan: Around 5-10 years

AC/DC Inverters

Inverters convert DC input to grid electricity (AC). You can use AC appliances with inverters.

Capacity: 300-700 W are popular

Lifespan: Around 5-10 years

Batteries

Battery is important in PV system.

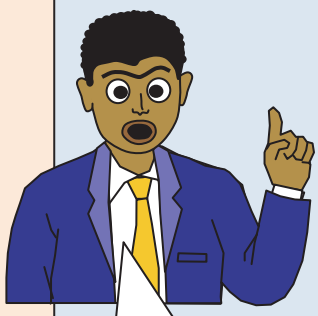
It needs **replacement** in every 3-8 years and it is very expensive. (Life of battery depends on type, intended use and use status).

Savings is necessary for replacement.

In addition, **some batteries** need special care.

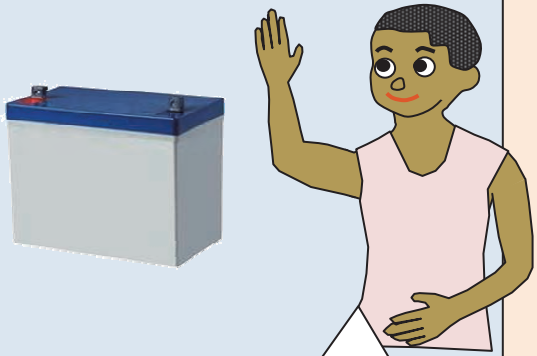
There are two types of batteries !!

Flooded type



This type needs maintenance, but cheaper comparing to sealed type

Sealed type

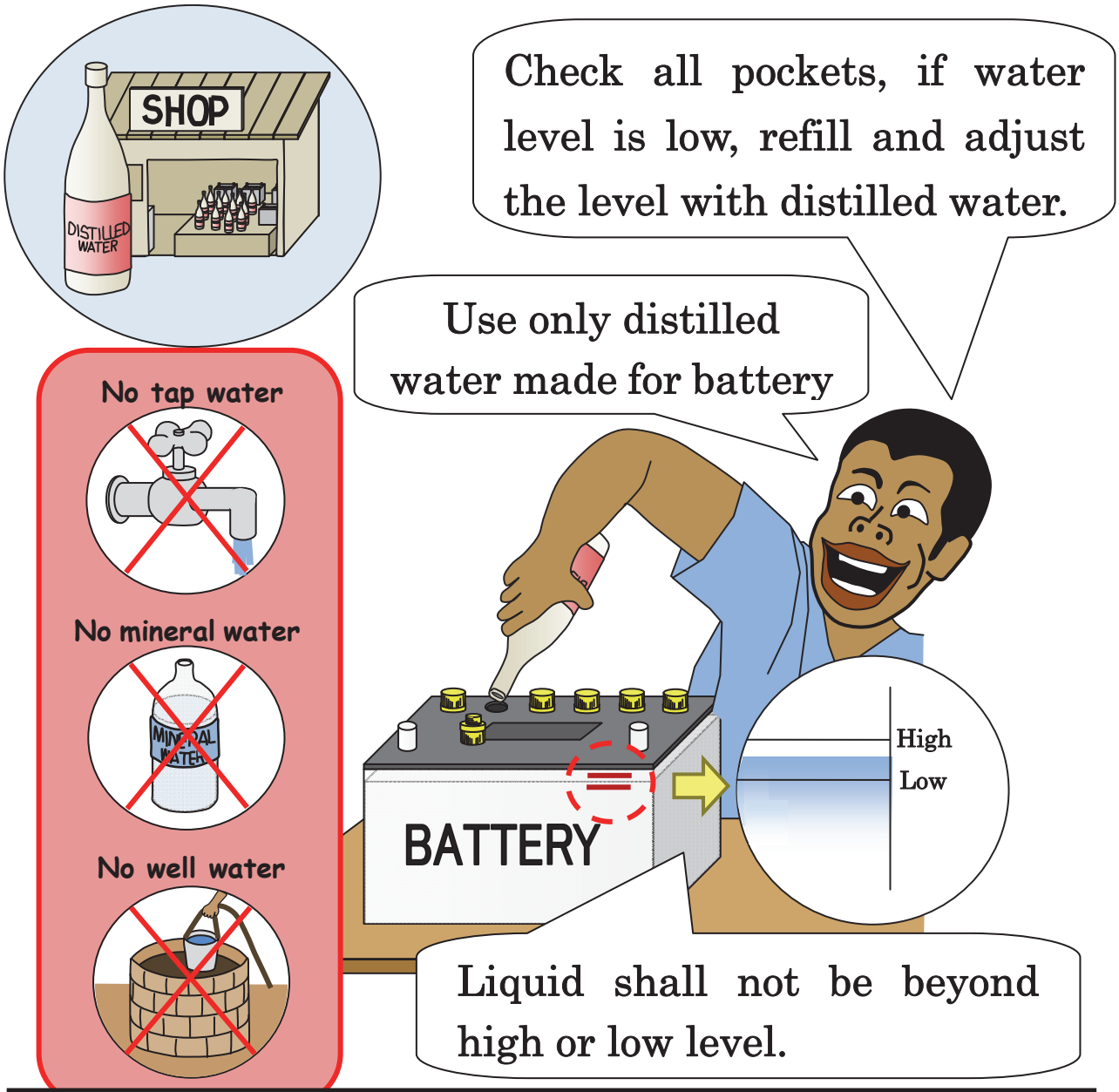


This type does not need maintenance but expensive comparing to flooded type

Battery maintenance

(Flooded type battery)

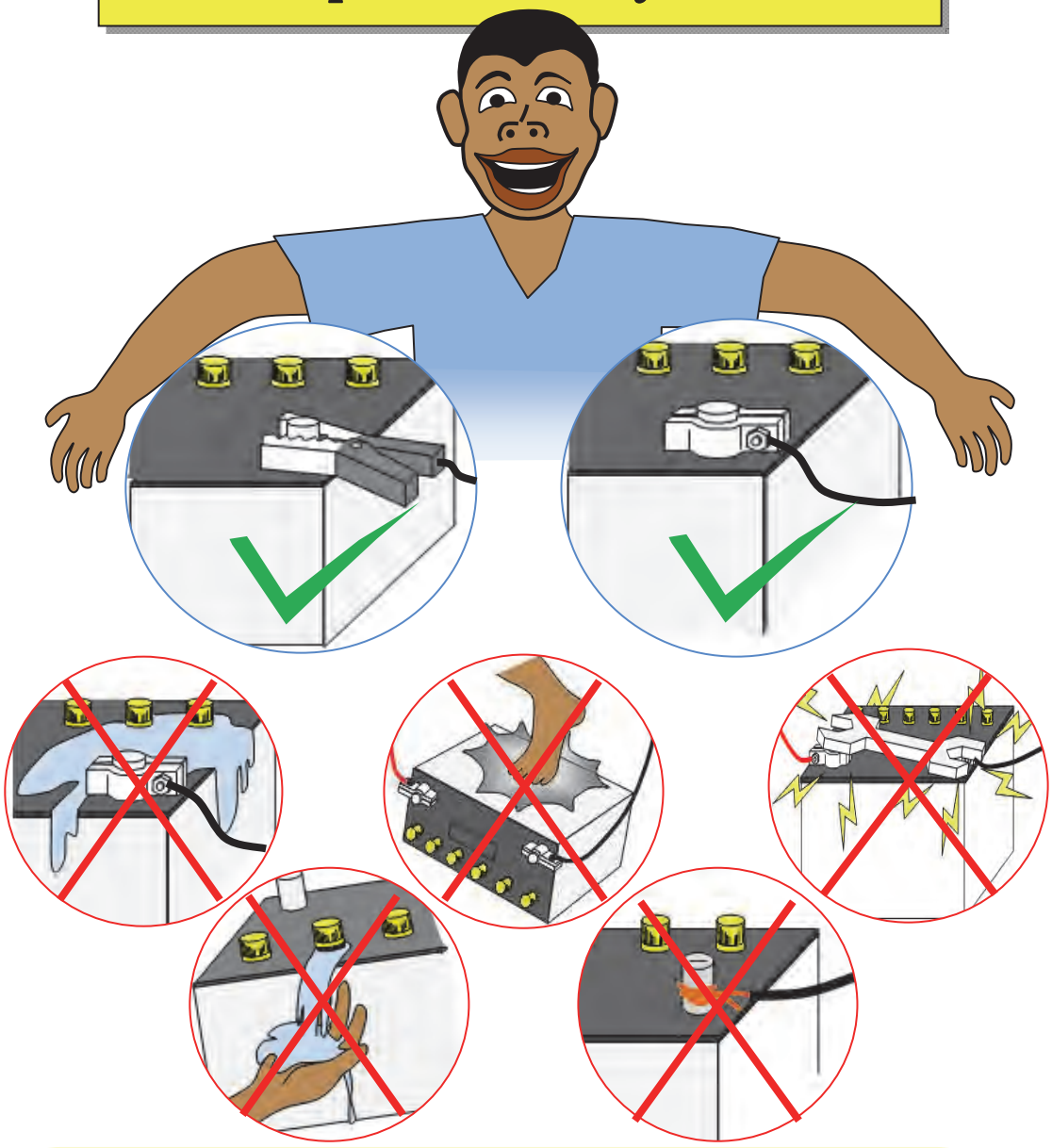
You have to check the water level at least once a month.



CAUTION

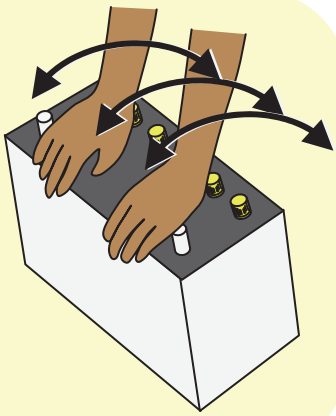
1. Every time you touch battery or battery liquid wash your hands with soap and clean water.
2. Do not touch battery terminals by hand or metallic objects.
3. Do not touch any installed equipment by wet hands, wet clothes or by metallic objects.

Tips on battery use



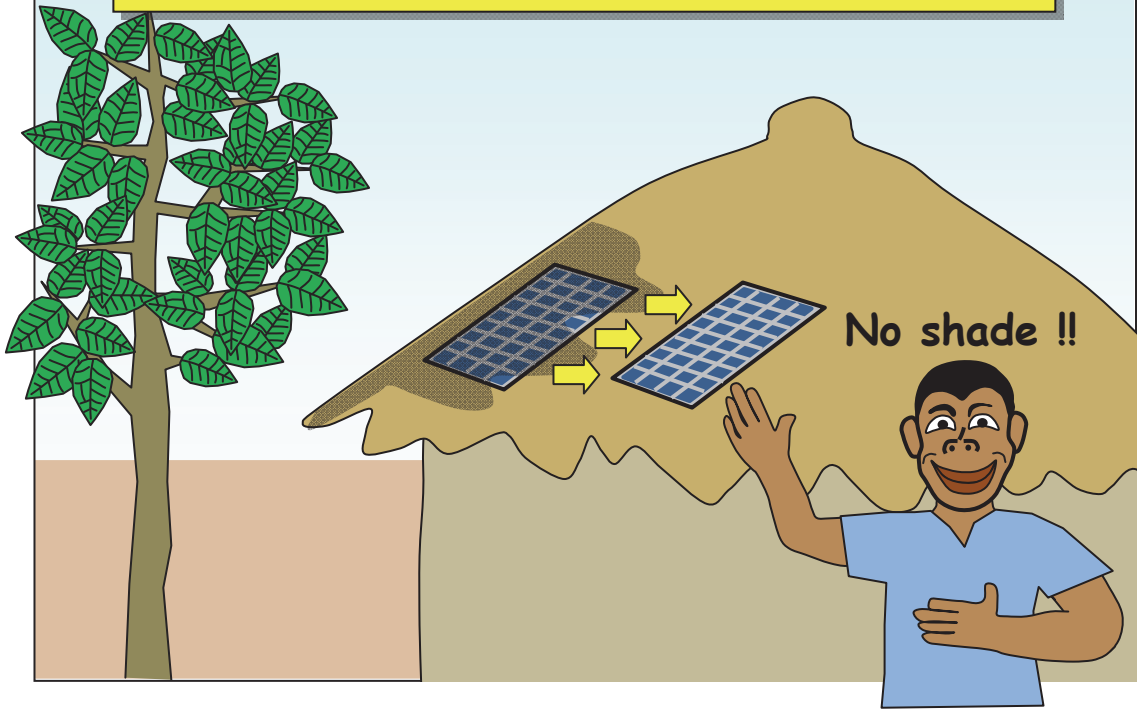
If possible, ...

Shaking prolongs battery life span. Around once a month more than 10 times shaking. **But don't force and should not be unreasonable.**

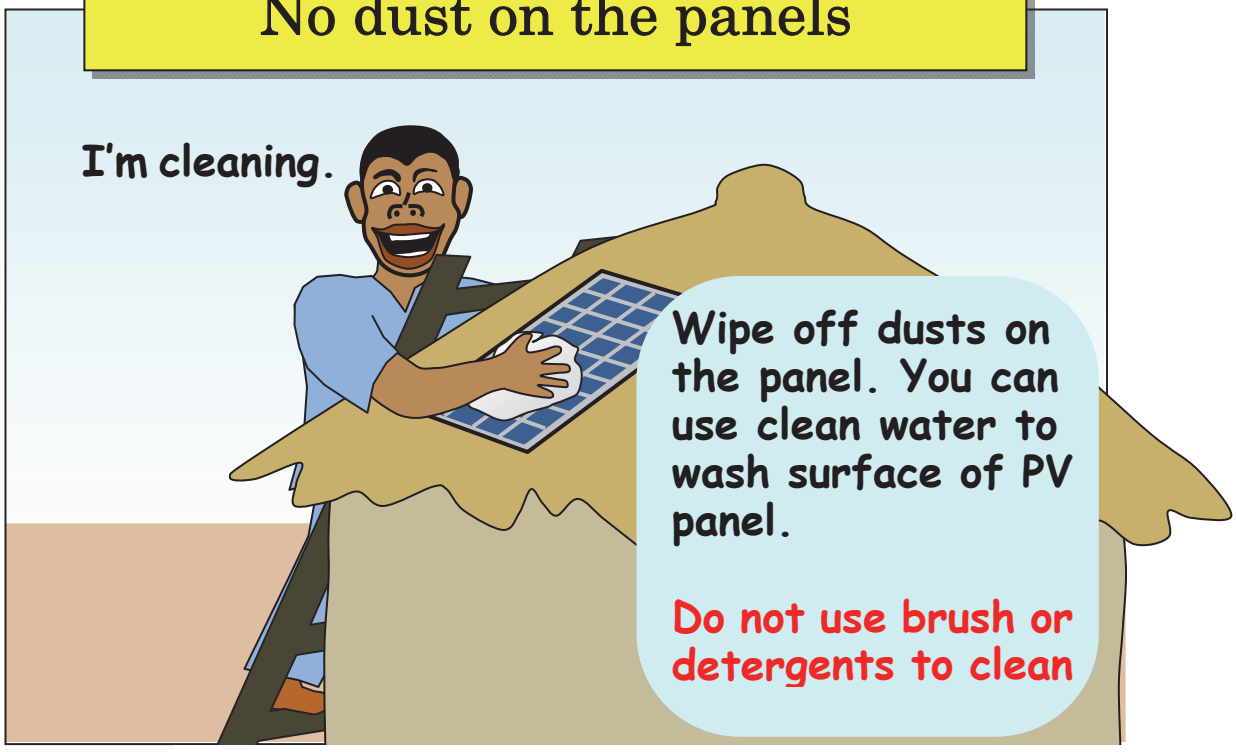


Other maintenance for PV system

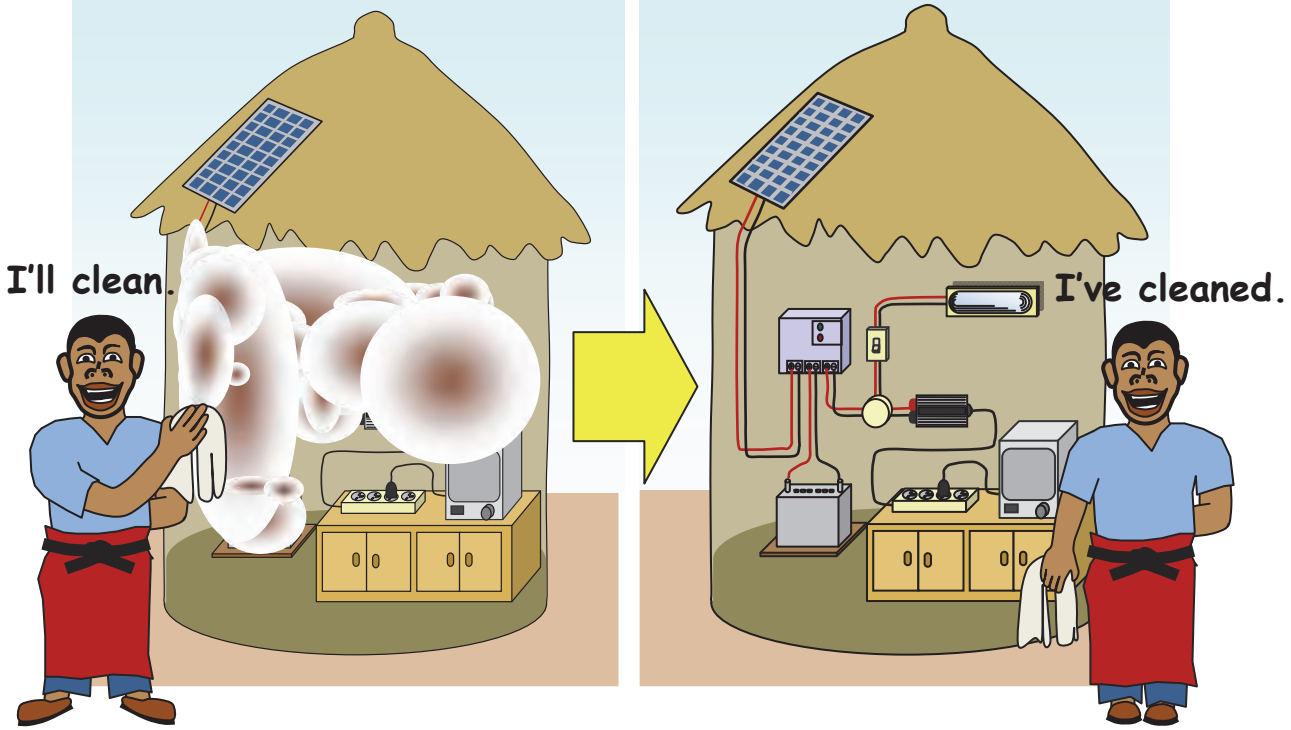
Avoid shade over PV panels



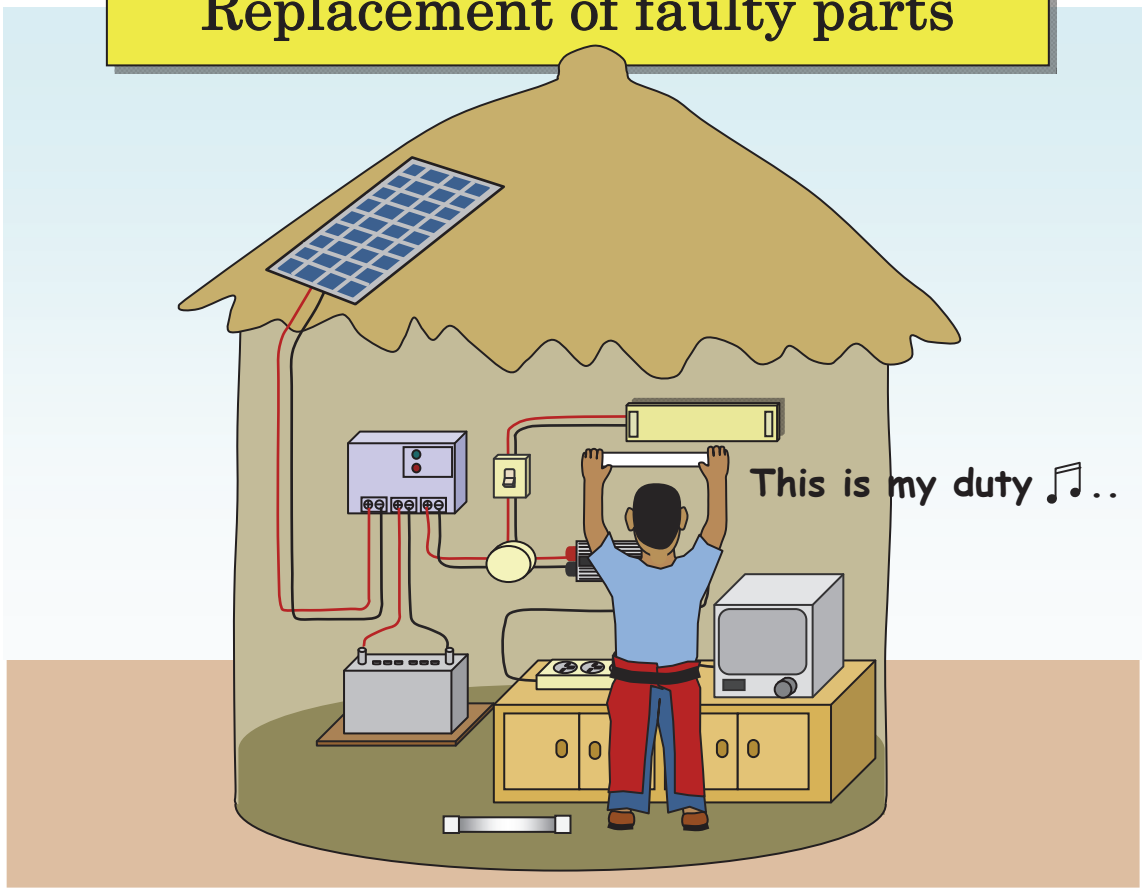
No dust on the panels



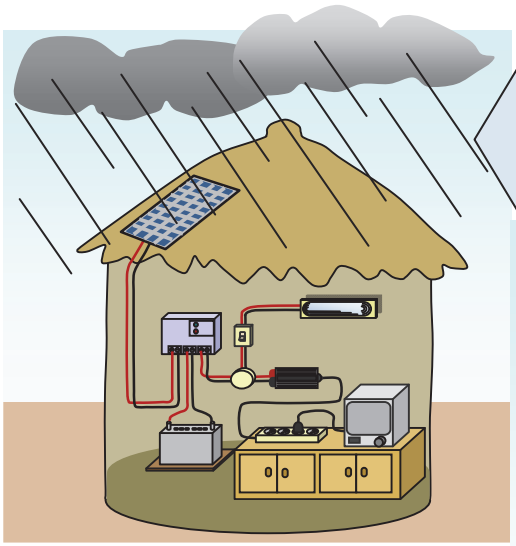
Cleaning of PV system



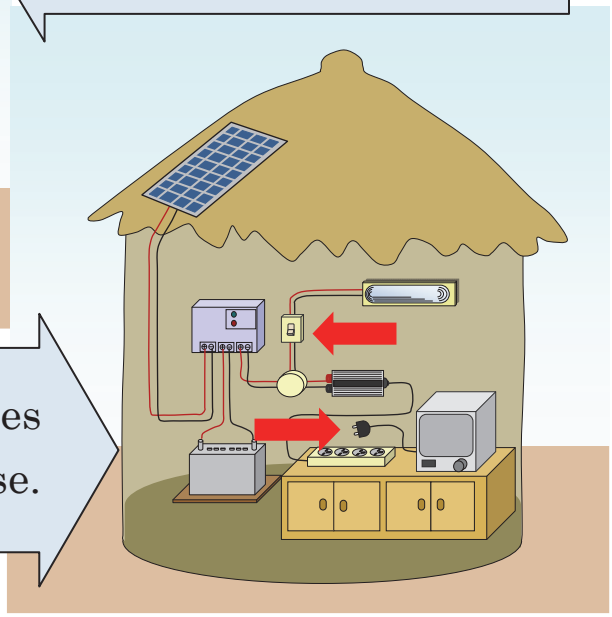
Replacement of faulty parts



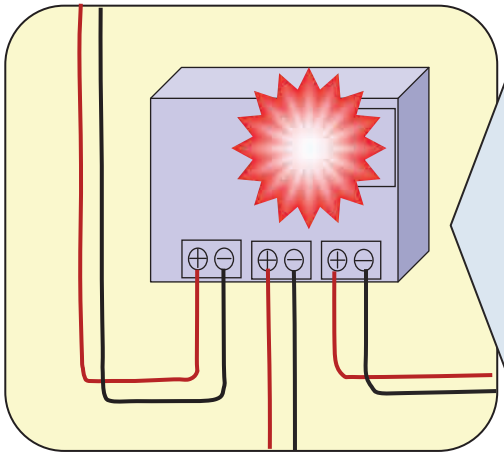
General operation tips



Save energy use on rainy days and cloudy days.

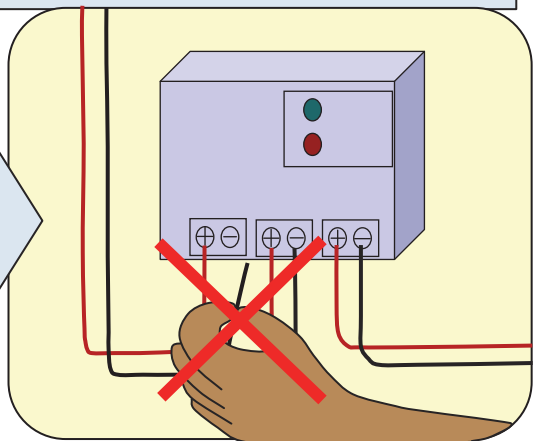


Switch off appliances when they are not in use.



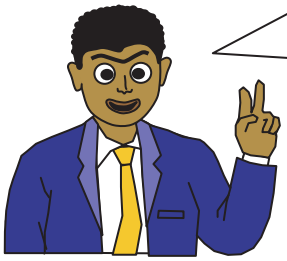
Check the indicator on the controller. If “battery is low”, then switch off appliances and manage the supply until Battery indicates charged.

Don’t change wiring.



PV systems at public institutions

Electrification of public institution is important. Solar PV is often used for electrifying remote rural public institutions. The government is responsible for the electrification, but maintenance is left to each institution's hand.



Two issues for PV maintenance.

- Saving money. **Financial issue**
- Having proper knowledge. **Technical issue**

With charging business,

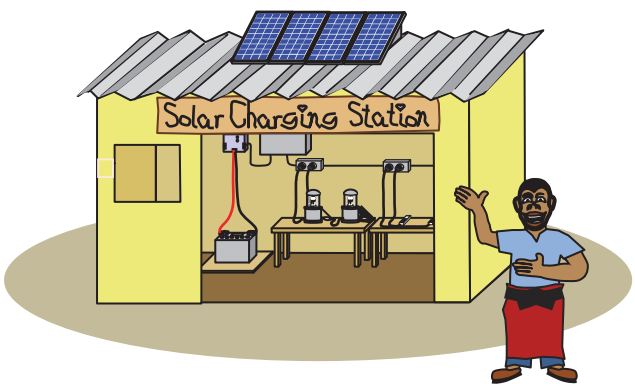
Financial issue

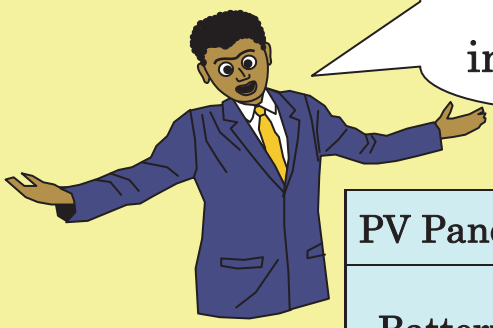
The business can generate money. You can use it for maintenance.

Technical issue

The operator must have proper knowledge on operation and maintenance.

The community people can enjoy rechargeable appliances, in addition.



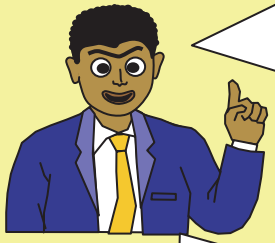


Life of equipment depends on the type and use status. Replacement is an important part of sustainability.

How long they will work?

PV Panel/module		20 - 25 years
Battery	Solar battery	3 - 8 years
	*Car battery	2 - 3 years
Inverter and Controller		5 - 10 years
Lamps	Tube	2 - 4 years
	LED	5 - 10 years

*Generally Car batteries are not recommended for Solar PV systems



Battery should be periodically replaced.
And battery is very expensive.

A lot of money is needed periodically !!

Financial issue

The operator of the charging station should be **trained properly** so that replacement will be possible to carry out properly.

Technical issue

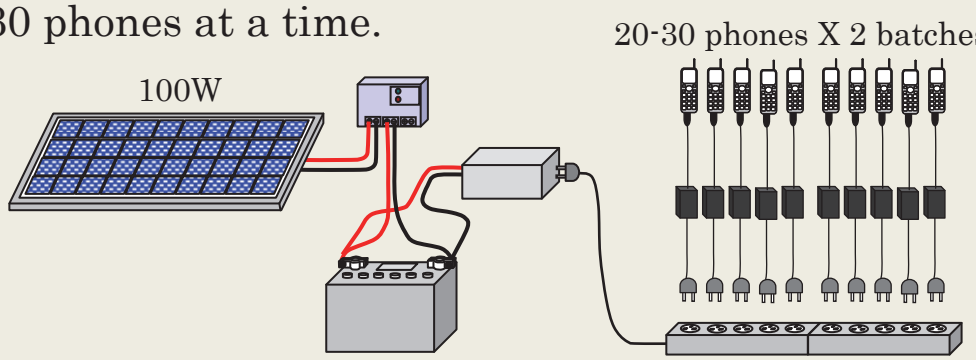
I am trained!!

I can repair the system!!

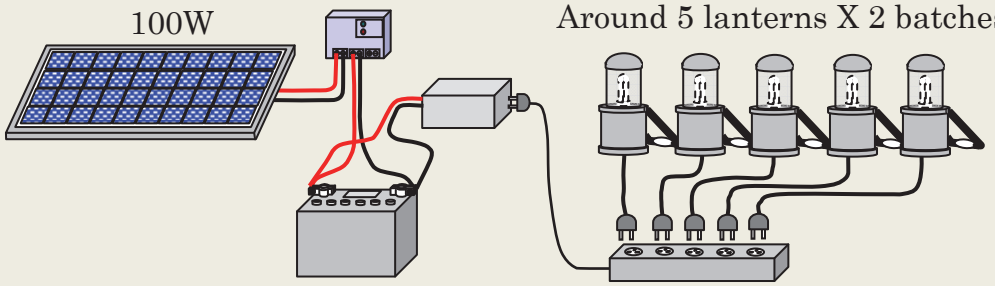
Save energy use and prolong battery life. Then you can save battery replacement cost.

Possible number of charges (Example)

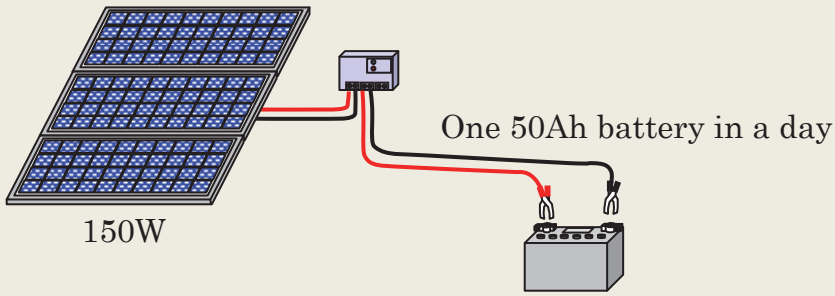
Around 50 Mobile phones can be charged in a day by a 100W panel.
20-30 phones at a time.



10 lanterns can be charged in a day by a 100W panel.
5 lanterns at a time.



One 50Ah battery needs 150W panel to charge in a day.
Battery needs much energy to charge.



Business tips

- **Lanterns shall be recharged at least once a month even it is not used.**

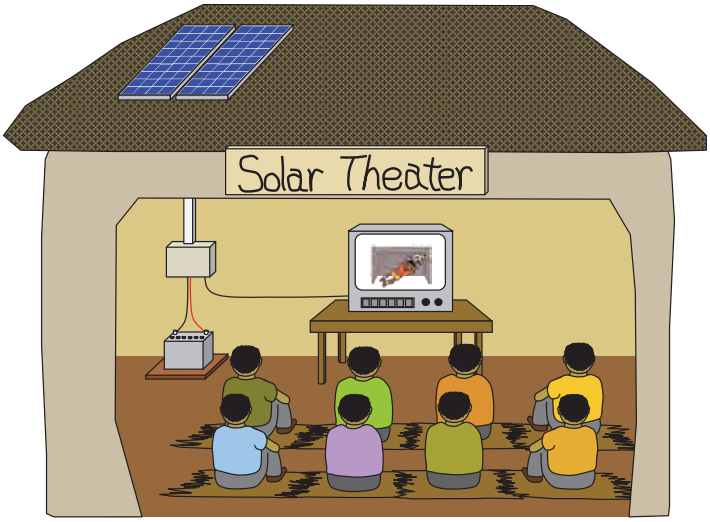
  Most batteries in lanterns are sealed type lead acid. If lanterns are left uncharged for several months, these batteries will be damaged. Even if the lanterns are not used, they have to be charged at least once a month. This should be known to users so that they would not store lanterns for a long time without charging. Less discharge and frequent charge will extend the life of the battery.

- **Maintenance tools**

  Good tools are needed for good maintenance. The charging station has to be equipped with such tools.

Possible PV business

- TV viewing



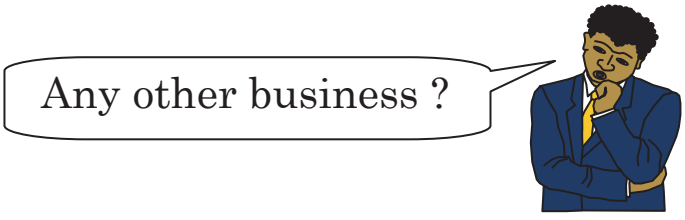
100 – 200W PV system is needed.

DVD player and TV are necessary.

- Hair salon

Minimum 50W PV system is needed.

The barber can use electric hair clippers.



Troubleshooting

Clean and retighten!!

Many Problems are caused by loose connection, rust and dusts.

Before going into troubleshooting,
you should check wirings and retighten connections!

After this,

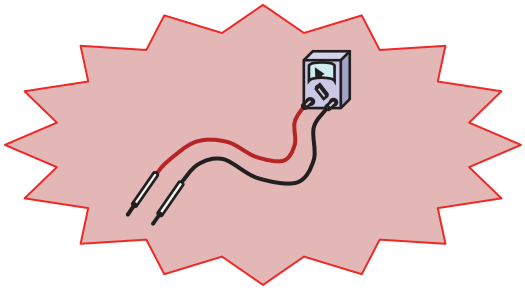
If only one appliance is in trouble, problem is the appliance itself or the wiring to it. Replace the appliance or the wiring.

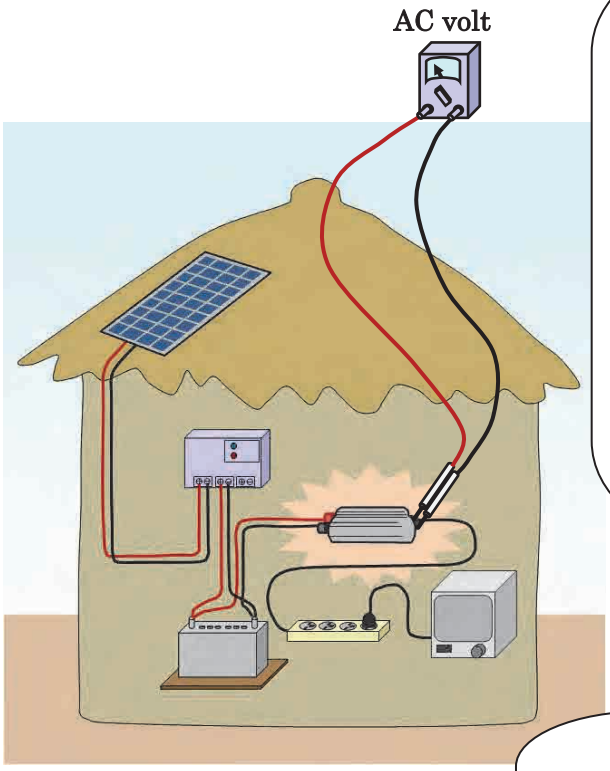
If many appliances are in trouble, then the power supply system is doubtful.

Then, you have to start checking the system.

- - - - - next page

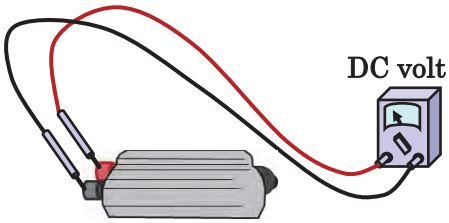
You need a multi-meter!!





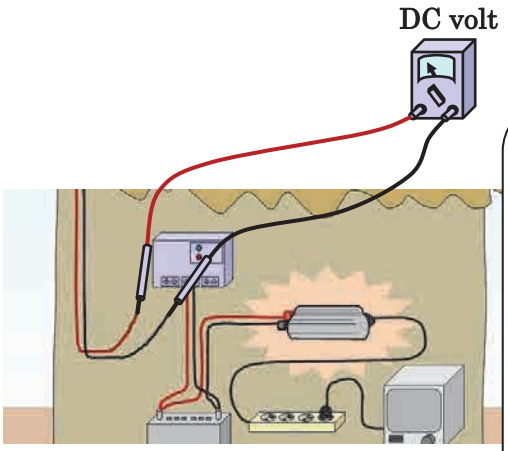
1. Inverter check

Measure the inverter output. If it is around AC220V to 240V, then Inverter is OK, check the AC wiring and connections.
If it is less than AC220V, then check the inverter input. If it is around DC12V for 12V system, DC24V for 24V system and DC48V for the 48V system (laptop system) then the inverter is faulty.



2. Battery check

If Voltage is less than DC12V for a 12V PV system or less than 24V for a 24V PV system, and DC48V for the 48V system (laptop system) in sunny day then the battery is faulty.



Disconnect panel line.
Then, measure voltage.

3a. Panel check

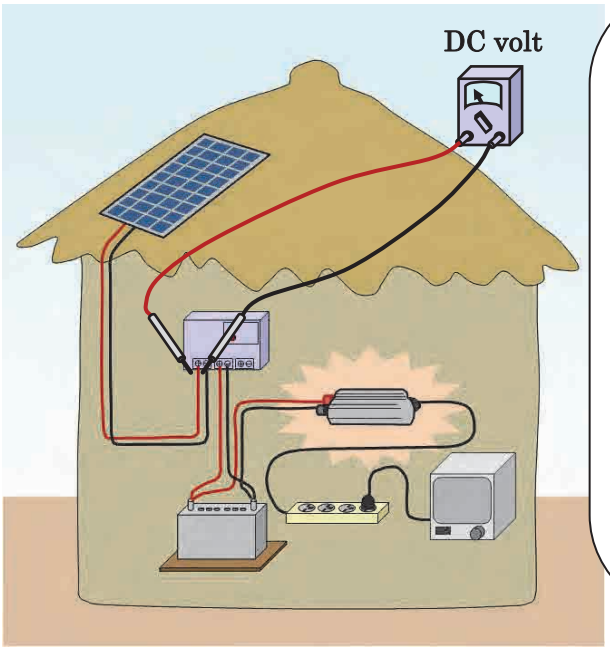
Disconnect panel lines from the controller (turn Isolator to OFF) and measure panel voltage at the isolator. If PV panel voltage is less than DC16V for 12V system or 32V for 24V system on a sunny day then the panel is faulty.
If panel output is more than DC16V or DC32V then panel is OK.

3b. Panel check for laptop system

Disconnect panel lines from the controller (turn off all the breakers at Junction Box) and measure panel voltage at the sub breakers inputs. If PV panel output voltage is more than DC64V then the panel string is OK. If PV panel Voltage is less than DC64V on a sunny day then that panel string is faulty.

Measure all strings one by one and keep record. There will be some difference. It should not be more than ±10%

If PV panel output voltage is more than DC64V for all the strings then turn on the sub breaker one at a time and check the voltage at the input of the main breaker. If the voltage is nearly the same as the one on the input of the sub breaker then the diode is OK, If there is a very big difference between the voltage at the input of the main breaker and the input of the sub breaker (when the other 3 sub breakers are off) then the diode might be faulty.



4. Charge Controller check

Measure DC voltage at battery terminal of the controller. If it is around DC 12V for 12V system or 24V for 24V system, then the battery is OK.

Reconnect the PV panel lines to the controller (turn Isolator to ON) and check the PV panel terminal of the controller. If it is more than DC 16V for 12V system or 32V for 24V system, then the controller is faulty.

If you are using DC output (load terminals) of the controller, check the load terminal of the controller.
If the output is not nearly the same as the battery voltage, then the controller is faulty.

To decide whether the controller is faulty or not, first disconnect the PV panel by turning isolator to OFF position. Then check the fuse installed in between the Charge Controller (CC) and the battery, if the fuse is blown then change the fuse.
To reconnect, follow exactly opposite of disconnection.

CAUTION

Never take out the fuse installed in between the CHARGE CONTROLLER and BATTERY before turning OFF the ISOLATOR, installed between PV panel and Charge Controller (CC)

You have to report the results to the installer or a local PV technician and discuss how to repair it.

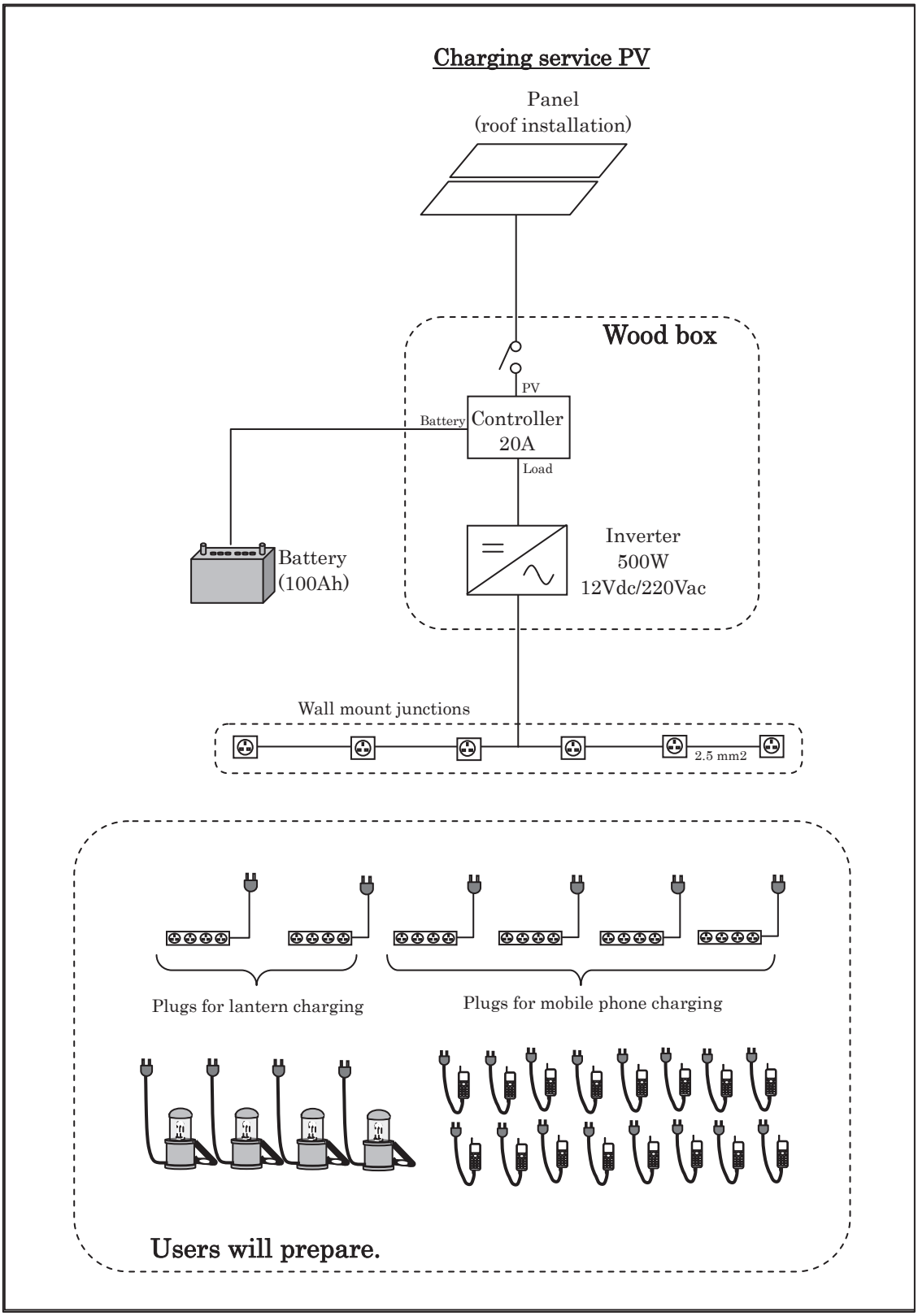
Charging station

Charging station is not so large.

Operating by Technician.

Power outlets on the wall and a shelf are convenient for the operation.

line drawing of PV charging system



Important Tips

Isolator is a switch which can isolate PV panel from connecting to the Charge Controller (CC)

SW off when thunder comes and during O&M when required.

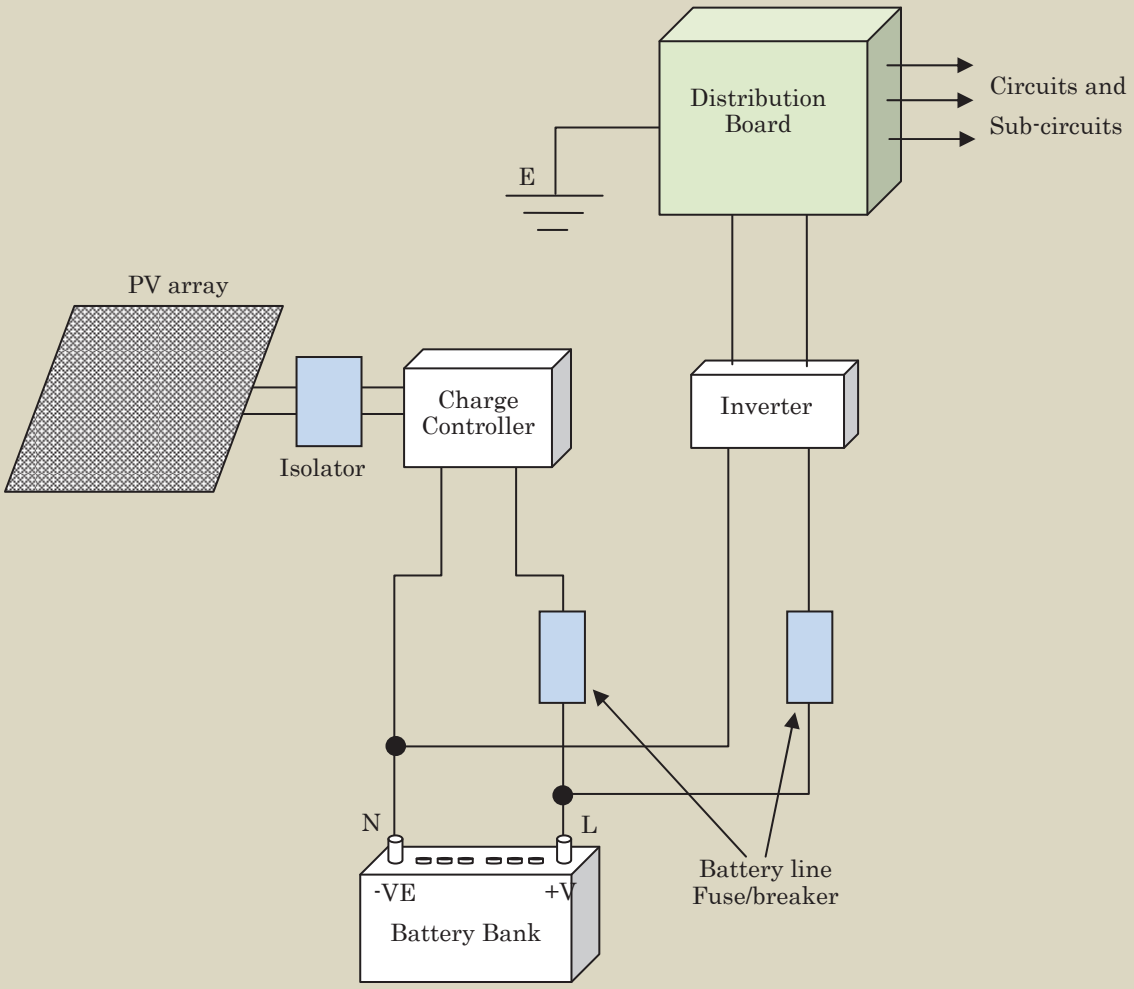
Fuse/Breaker is necessary in between;

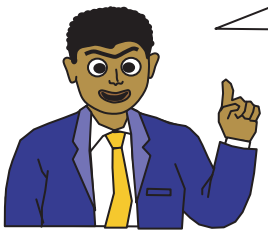
1. Charge controller and Battery
2. Battery and Inverter

The Fuse/breaker protects the circuit from short circuit trouble

General configuration

of PV power supply system

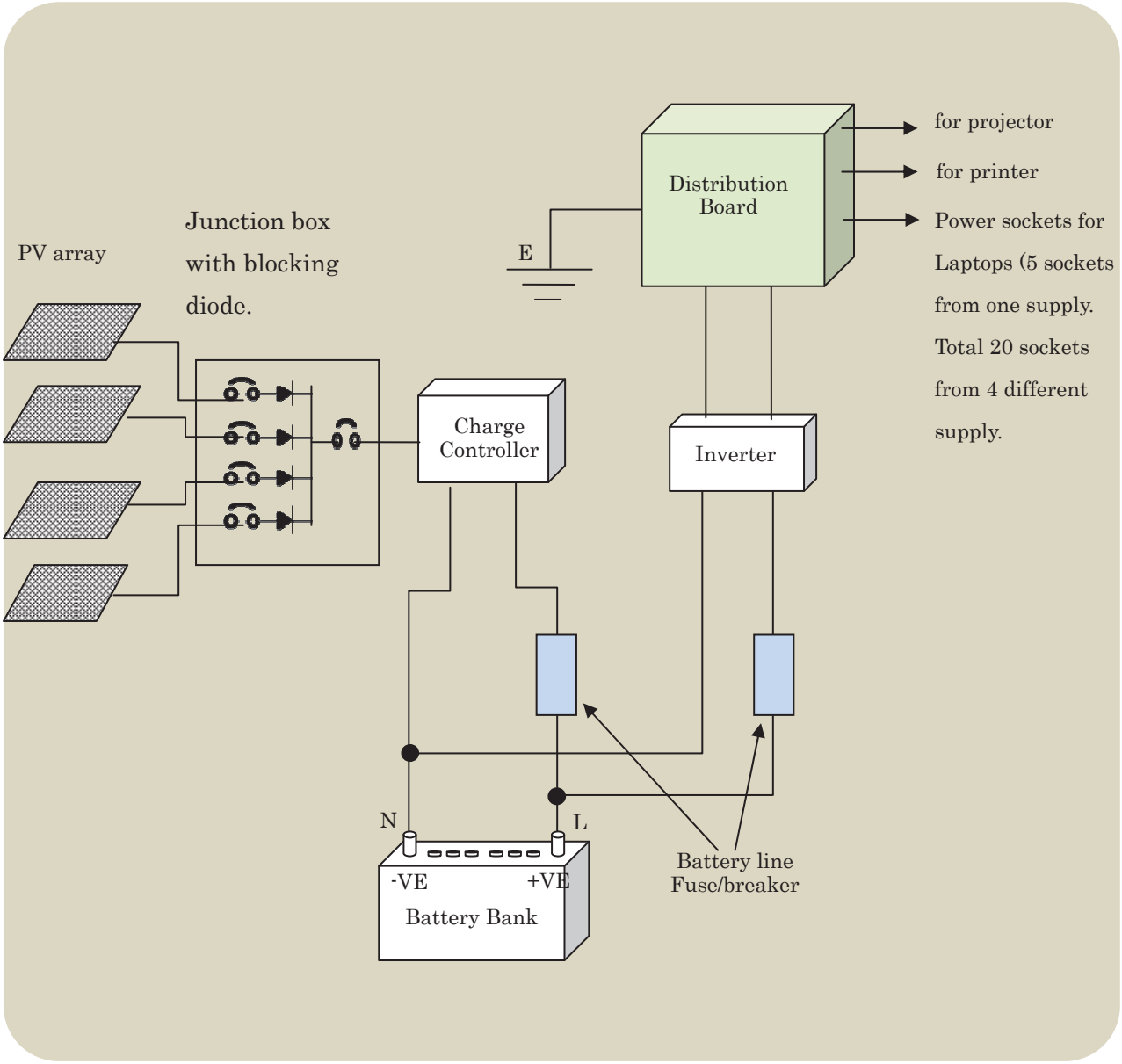




There are some circuit breakers in the Distribution Board. They limit overuse of electricity.

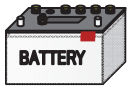
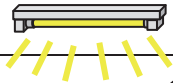
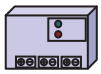
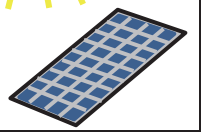
General configuration

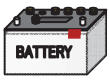
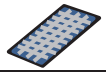
of laptop PV power supply system



Manual for E-waste Disposal

E-Waste is generated after long life span of equipment.

E-waste	Hazardous Element
Used Lead-acid batteries	Lead and Sulfuric Acid 
Used Fluorescent tubes	Mercury 
Used PV panels, Inverters and Other appliances	Other Heavy Metals   

Component	Possible Life Span* (years)	Handling	Remarks
Battery 	3 to 8	・To prevent diffusion of toxic substances in batteries, used ones shall safely be kept without damage (Do not Crash! Do not Take Apart!) until properly dispose them. ・Used batteries can be sold to licensed e-waste handlers and/or battery producing companies in Kenya	・Get latest information from licensed e-waste handlers or NEMA county offices. ・Purchase prices of used batteries are subject to the market trends
Fluorescent Lamp 	2 to 4	・To prevent diffusion of mercury in fluorescent lamps, used ones shall safely be kept without damage (Do not Crash! Do not Take Apart!) until properly dispose them. ・Used Fluorescent Lamps shall be transported to licensed e-waste handlers in Kenya to be disposed.	Get latest information from licensed e-waste handlers or NEMA county offices. 
LED Lamp 	5	・Used LED Lamps shall be transported to registered e-waste handlers in Kenya to be disposed.	
PV Solar Panel 	20 to25	・Used PV Solar Panels shall be transported to registered e-waste handlers in Kenya to be disposed.	
Inventor 	5 to 10	・Used Inventor shall be transported to licensed e-waste handlers in Kenya to be disposed.	

* Note: Vary depending on the intended use as well as status of use

E-wastes such as used-batteries shall be transported to the licensed E-waste handlers and/or battery makers. You can ask for disposal when replace used batteries!!

2. Solar PV Organizational Management Manual

Public facilities, i.e. dispensaries and primary schools and people of their neighbourhood communities benefit from solar PV systems for health care and improvement of education. Solar PV systems will not function well if they not operated and maintained properly.

Public facilities and management committees have responsibility to take care of the PV systems by establishing management system and finance for sustainable system use.

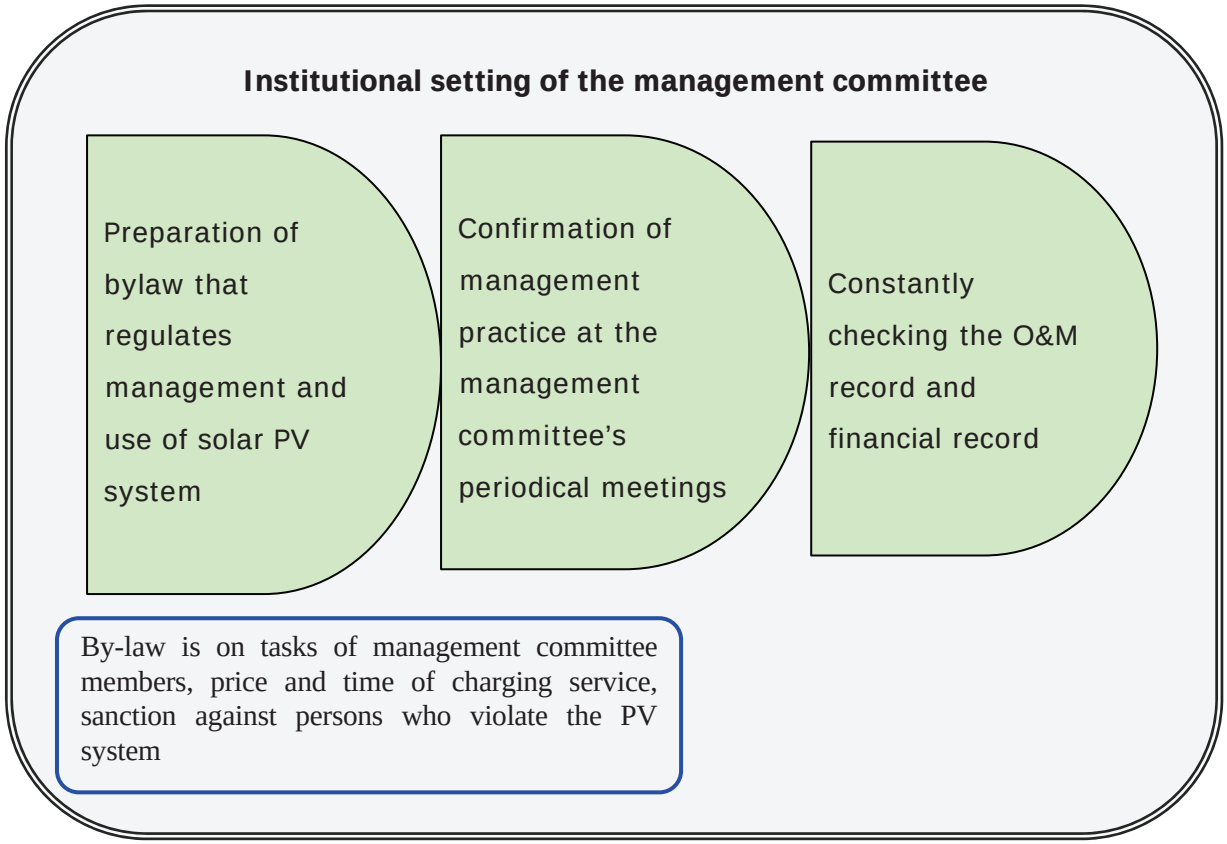
This manual explains to dispensary/school staffs and management committee members how they should manage the solar PV system to get long time use up to the life time of solar panels.

(1) Tasks of management committee members and operator

Organization	Responsibility
Operator	● operation and checking condition of solar PV system daily, ● periodical water topping, ● collecting and recording proceeds from charging service, hair shaving, and other businesses ● informing daily sales to treasurer (or secretary)
Treasurer and/or secretary	● examining the daily record and collecting proceeds ● keeping account book ● reporting the financial state to the chairman and other members ● deposit of proceed at the bank account ● purchase of distilled water and other necessary equipment and tools
Chairperson	● Confirmation of the financial report and O&M report ● Submission of the financial report and O&M report to the county ministry office (monthly) ● Overall supervision about the solar PV system management
Dispensary, school and management committee	● advertizing and implementation of charging service, ● securing the safe condition of solar panels
Users (community people, pupils):	● use of the charging service, ● keeping solar panels safe
County offices of MOH (and MOEST)	● budget preparation for future replacement of batteries, inverters and controllers, ● receiving financial status report (included in the regular report) and

Organization	Responsibility
	O&M report, ● identifying problems of solar PV system mentioned in the reports, ● by-yearly inspection of system condition = MOH

(2) Institutional setting

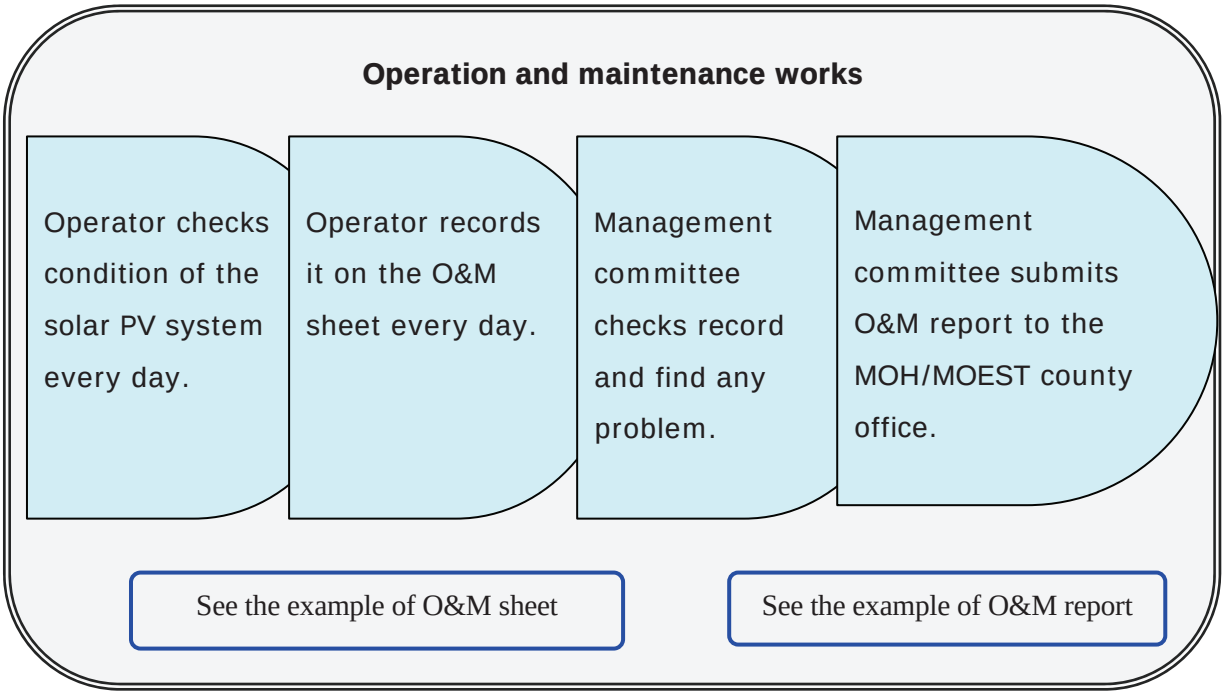


What is important for management committee? Management committee and facility staff members are responsible persons for PV system management. They need to establish institutional framework within the committee to ensure sustainable system use.

What is important for management committee? Management committee and facility staff members are responsible persons for PV system management. They need to establish institutional framework within the committee to ensure sustainable system use.

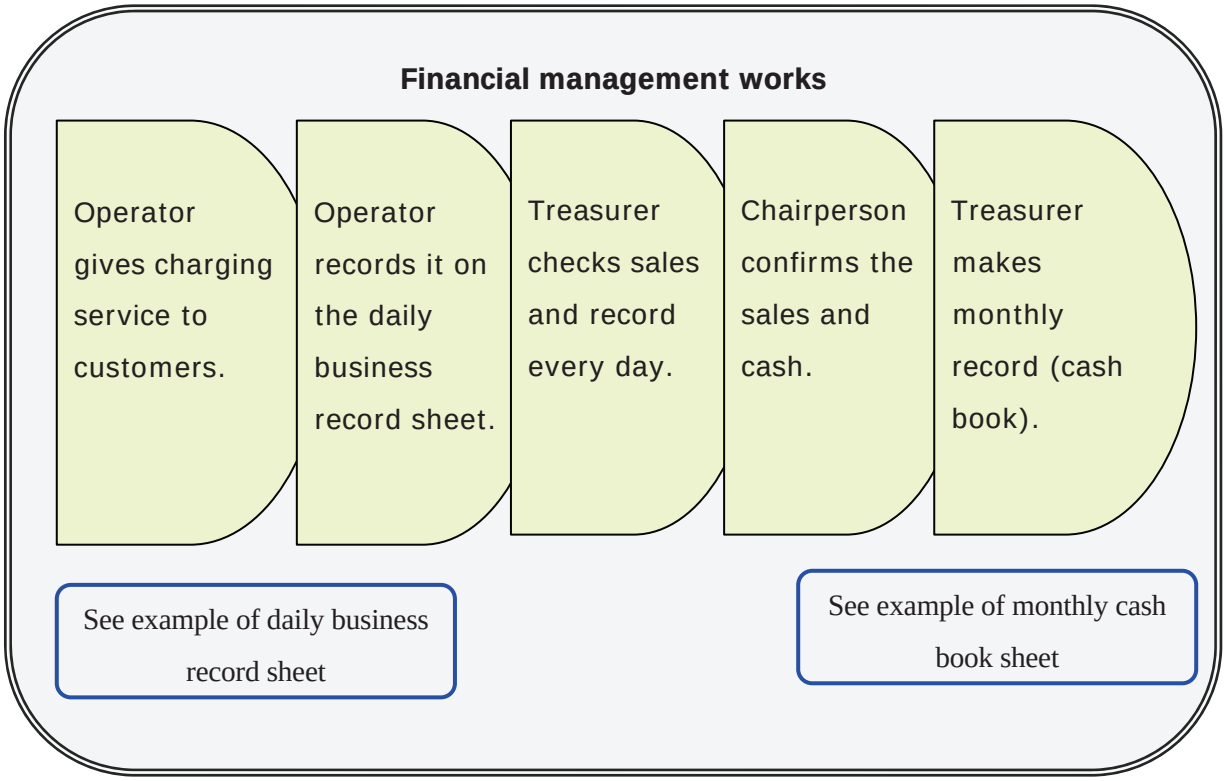
By-law contains works of management committee members and operator, time and price of charging service, sanction against persons who violate the solar PV system and other necessary items.

(3) Operation and Maintenance



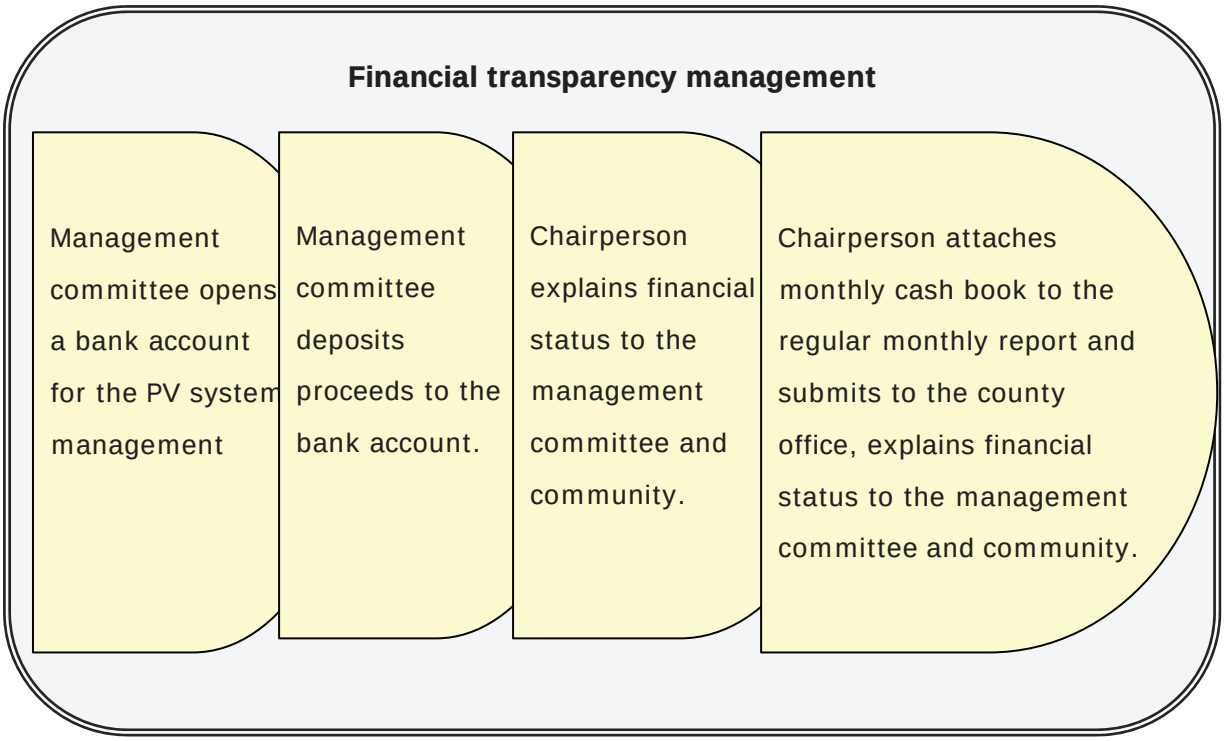
Daily operation is simple but a very important task of the operator as the basis of sustainable system use. If he/she finds water level lows, he/she top up distilled water immediately.

4. Financial management at dispensary/school



Income from charging service sales is a valuable source for the cost of daily solar PV system O&M and management such as purchase of distilled water, replacement of bulbs, transportation and so on.

5. Transparency



Keeping transparency of charging service is indispensable in order that both concerned ministries and community people rely on the performance of management committee.

Reporting of the financial state shall be attached to the facility monthly report and submitted to the county office of the relevant ministries.

6. E-waste management

(i) Request suppliers to take away used ones from each facility when carrying out replacements (this shall be set as a condition for carrying out replacements).

↓

(ii) Earning from the selling of used batteries and other used substances of e-waste shall be remitted using the “m-pesa” system by the suppliers when getting selling money from the licensed E-waste Handlers and/or battery makers.

↓

(iii) The earning money shall be kept in each facility as revenue.

↓

(iv) To make sure the proper transportation and treatment, the **e-waste manifest system** shall be introduced in the e-waste disposal system

Manual for

Financial Management and Accounting for Public Facilities

Public Facilities and surrounding community people benefit by solar PV systems for health care and education. The new responsibility with the stakeholders of the public facilities to take care of the PV systems should be considered as unavoidable for sustainable use. The manual is prepared for "Management Committee" to pursue their new responsibility focusing on the financial aspect for sustainable use and its benefit.

Person in Charge

Chairman
Secretary
Treasurer

Operator

Necessary Books and etc.

Daily Business Record
Cash Book
Monthly Report

Receipt
Bank Account

Members of Management Committee, Chairman/ Secretary/ Treasurer and Operator share the responsibilities for sustainable use of solar PV systems as follows:

Role Sharing

Tools	Purpose & Contents	In Charge	Check & Keep
Daily Business Record	Income record	Operator	Secretary
Cash Book	Income & Expense	Operator	Treasurer
Monthly Report	Cash Balance & Profit	Chairman	Chairman
Receipt	Evidence	Operator	Customers
Bank Account	Official Record	Chairman	Chairman

The cash balance from the result of charging service is transferred to the bank account by Chairman monthly or regularly. Cash and bank books are managed by Management Committee.

EXAMPLE FOR FILLING

Annexes

Delete not applicable

1. Daily Business Record

DAILY BUSINESS RECORD FOR

Iltumtum ~~DISPENSARY~~ / PRIMARY

Name of school or dispensary

Sheet No. : 1

Date: 1 st September 2014 Weather: Sunny

Full name

No.	Name of Customer	Type of appliance *	Amount (KSh.)	Comment/ Remarks/ Complaints e.g. customer misplaced receipt
1.	Mr.Aaaaa Bbbbb	Mobile	20	Normal
2.	Ms.Ccccc Ddddd	Haircut	35	Normal
3.	Mr. Eeee Ffffff	Mobile	20	Did not pay cash, Next day paid
4.	Ms. Oooo Ppppp	Mobile	20	Normal
5.	Ms. Qqqq Rrrrr	Mobile	20	Normal
6.	Mr. Sssss Ttttt	Mobile	20	Pay 50%, Next day paid
7.	Ms. Ttttt Uuuuu	Mobile	20	Normal
8.	Mr. Uuuu Vvvv	Mobile	20	Normal
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
Daily Total		Phone: 140 Lantern: Battery: Clippers: Other (H r cut etc.) : 35	175	

To be checked and signed by Treasurer or Secretary. Finally submit to Chairman together with cash and whole books

Break down of the day income

Total of the day to be checked with the break down

Daily Totals checked by: Mr. Ggggg Hhhhh

signature: *Ggggg Hhhhh*

* Type of appliance: mobile phone, LED lantern, rechargeable battery, hair clippers, other (specify)

The treasurer gives a number to the sheet and issues this sheet to the secretary who issues it to the operator. At the end of the day, the operator returns the sheet to the treasurer who verifies the cash collected against this sheet.

When the number of customers exceeds 25 persons, continue recording on the Sheet 2 and input the daily total at the bottom of Sheet 2.

EXAMPLE FOR FILLING

Fill in name of school or dispensary

2. Copy of Sales Receipt

CASH SALERECEIPT			No. 1
Name of Customer Mr. James Kamweru Mobile: 070-111-222		Iltumtum	~~Dispensary/~~ Primary School
		P.O. BOX XXX	
Mobile phone:		DATE: 1 / 9 / 2014	
No.	**DESCRIPTIONOFMOBILE/LANTERN etc.**		**AMOUNT(Ksh.)**
1	NOKIA Mobile		20
		Total	20
Received by: Mr. Kkkkk LIII		Signature: *Kkkkk Llll*	

Delete not applicable one

Full name, contact number

Signed by operator
Together with cash and other books, Copy of Sales Receipt are transferred to treasure or secretary

EXAMPLE FOR FILLING

3. Cash Book

CASH BOOK FOR

ILTUMTUM DISPENSARY / PRIMARY SCHOOL

Month/Year: September 2014 **Sheet No. :** 1

Date	Revenues		Expenses		Balance (KSh.)
	Item	Amount (KSh.)	Item	Amount (KSh.)	
1.	Charging Income	175			
2.	Charging Income	140			
3.	Charging Income	170	Stationary	100	385
4.					
5.					
6.					
7.					
8.					
9.	Charging Income	180	Transportation for bank	100	465
10.	Charging Income	120	Bank charge	100	485
11.	Charging Income	160	Bank deposit	385	100
12.	Charging Income	175			
13.					
14.					
15.	Charging Income	175			
16.	Charging Income	140			
17.	Charging Income	170			
18.	Charging Income	170			
19.	Charging Income	140			1,230
20.					
21.					
22.	Charging Income	175	Distilled water	500	905
23.	Charging Income	140			
24.	Charging Income	170			
25.	Charging Income	120			
26.	Charging Income				1,495
27.					
28.					
29.	Charging Income	160	Transportation for bank	100	
30.	Charging Income	175	Bank charge	100	
31.			Bank deposit	1,000	630
Monthly Total		3,015	Monthly Total	2,385	630

Monthly Totals
Checked by: Mr.Ggggg Hhhhh
signature: *Ggggg Hhhhh*

A Stationary

B Transportation Bank

C Bank Charge

D Bank Account

E Distilled Water

F Transportation Bank

G Bank Charge

H Bank Account

I Monthly Total

The Cash bo kept by the treasurer who makes entries.

Signed by Treasurer or Secretary
Together with other books and Copy of
Sales Receipt are transferred to Chairman

EXAMPLE FOR FILLING

4. Monthly Record

MONTHLY REPORT OF ILKILNYETI DISPENSARY

Month/Year: September 2014				**Sheet No. :** 1
Income in the month		**(KSh.)**	**Expenditure in the month**	**(KSh.)**
Cash Balance last Month	(a)		1. Operation cost	
1. Revenue from charging service	(b)	3,015	(1) Distilled water	500
2. Other revenues:			(2)	
			(3)	
			(4)	
			(5) Miscellaneous	
Sub-total	(c)	3,015	(e)	500
3. Withdrawals from Bank			[illegible]cost	
Date				
Date				
Date				
Sub-total	(d)	0	Sub-total (f)	0
			3. Administration cost	
			transportation	200
			committee expenses	
			meeting expenses	
			bank charge	200
			others (stationary)	100
			Sub-total (g)	500
			5. Deposit to bank (h)	1,385
Cash Income Total (a)+(b)+(c)+(d)		3,015	**Cash Expenditure Total** (e)+(f)+(g)+(h)	2,385
Balance (Cash income carried forward)				Ksh 630

BANK CONTROL		Unit: Ksh		
Balance in last month			Withdrawals in this month (d)	0
Deposit in this month	(h)	1,385		
Deposit Total		1,385	**Withdrawals Total**	0
Balance (Cash income carried forward)				KSh. 1,385

Cash Book E

Cash Book I

Cash Book B+F

Cash Book C+G

Cash Book A

Cash Book D+H

Available Balance Cash & Bank Deposit

Form

1. Daily Business Record

Daily Business Record of _____Dispensary / Primary School

Sheet No. :_____

Date: _____ Weather:_____

No	Name of Customer	Type of appliance *	Amount (KSh.)	Comment/ Remarks/ Complaints e.g. customer misplaced receipt
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
Daily Total		Phone: Lantern: Battery: Clippers: Other (Hair cut etc.):		

Daily Totals checked by: _____

signature: _____

* Type of appliance: mobile phone, LED lantern, rechargeable battery, hair clippers, other (specify)

The treasurer gives a number to the sheet and issues this sheet to the secretary who issues it to the operator. At the end of the day, the operator returns the sheet to the treasurer who verifies the cash collected against this sheet.

When the number of customers exceeds 25 persons, continue recording on the Sheet 2 and input the daily total at the bottom of Sheet 2.

Form

2. Copy of Sales Receipt

CASH SALERECEIPT			No.
Name of Customer			**Dispensary/ School**
	P.O. BOX		
Mobile phone:	**DATE: / /**		
No.	**DESCRIPTIONOFMOBILE/LANTERN etc.**		**AMOUNT(KSh)**
		Total	
Received by:	**Signature:**		

Form

3. Cash Book

CASH BOOK FOR ILKILNYETI DISPENSARY

Month/Year: _____				Sheet No. : 1	
Date	**Revenues**		**Expenses**		**Balance (KSh.)**
	Item	**Amount (KSh.)**	**Item**	**Amount (KSh.)**	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
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22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
Monthly Total					
Monthly Totals **Checked by:** _____ **signature:** _____					

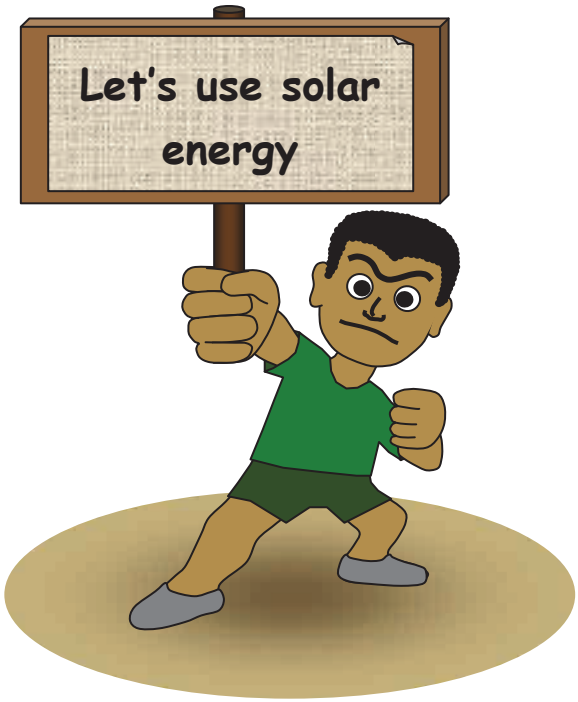
The Cash book is kept by the treasurer who makes entries.

Form

4. Monthly Record

MONTHLY REPORT OF ILKILNYETI DISPENSARY

Month/Year: _____		**Sheet No. :** _1__	
Income in the month	**(KSh.)**	**Expenditure in the month**	**(KSh.)**
Cash Balance last Month (a)		1. Operation cost	
1. Revenue from charging service (b)		(1)	
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)		Sub-total (e)	
3. Withdrawals from Bank		2. Maintenance cost	
Date			
Date			
Date			
Sub-total (d)		Sub-total (f)	
		3. Administration cost	
		- transportation	
		- committee expenses	
		meeting expenses	
		bank charge	
		others	
		Sub-total (g)	
		5. Deposit to bank (h)	
Cash Income Total (a)+(b)+(c)+(d)		**Cash Expenditure Total** (e)+(f)+(g)+(h)	
Balance (Cash income carried forward)			Ksh
BANK CONTROL		Unit: Ksh	
Balance in last month		Withdrawals in this month (d)	
Deposit in this month (h)			
Deposit Total		**Withdrawals Total**	
Balance (Cash income carried forward)		KSh.	



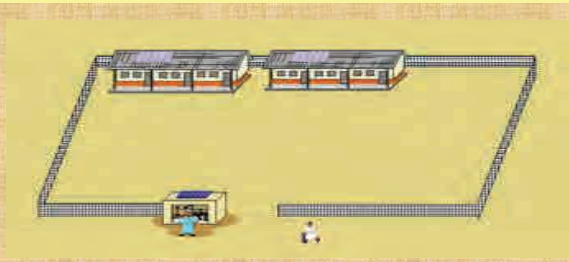
Contact :

Establishment of Rural Electrification model using Renewable Energy

Technical seminar on PV rural electrification

Kunio Asai
PV Technology

1. Background



PV rural electrification

- REA has PV electrification package for rural public facilities
- Sustainability of those systems has not be established yet
- System efficiency can be improved by introducing new technologies

Difficulty in PV rural electrification of public institutions

- Battery replacement

Government can install PV systems. But it is very difficult for the government to maintain all the PV systems it installed.

↓

Maintenance is left to each institution.

↓

Most systems are abandoned when their batteries come to the end of their life span.

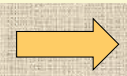
Difficulty in PV rural electrification of public institutions

- Financial difficulty

Batteries are expensive. They have to have a fund source for their replacement.

- Technical difficulty

They don't know when and how to replace batteries. Technicians are very few in rural areas.



PV charging business

Improvement of system efficiency

- Inefficiency causes large system design

Battery bank also becomes large, resulting in increase of battery replacement cost

- Introduction of low power consumption appliances (LED)

With technology development, LED is becoming available and economical now.

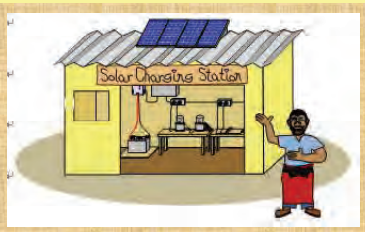
Proper wiring/design

- Many PV systems run with low voltage.
- In low voltage system, voltage loss along cables is not negligible.
- Proper wiring design is very important
- Other techniques are also reviewed.

Summary

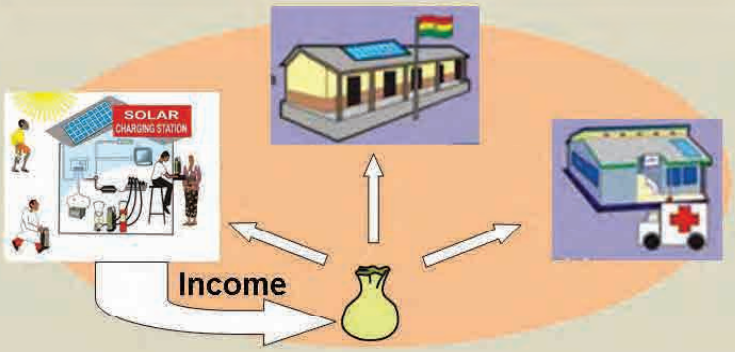
- Current PV rural electrification package is reviewed.
- Charging business is introduced to alleviate battery replacement difficulty.
- LED is introduced to reduce power consumption
- Wiring/design is reviewed

2. PV Charging System



Concept of Community Solar system

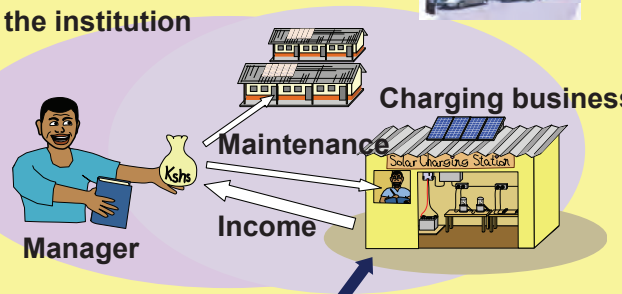
The income from the charging station is used for the operation and maintenance of the whole system



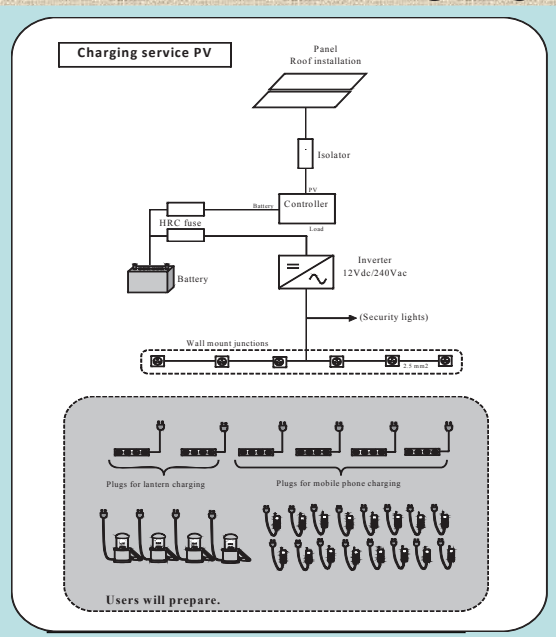
Management of Community Solar system

Installation: by Government

Operation & maintenance: By the institution



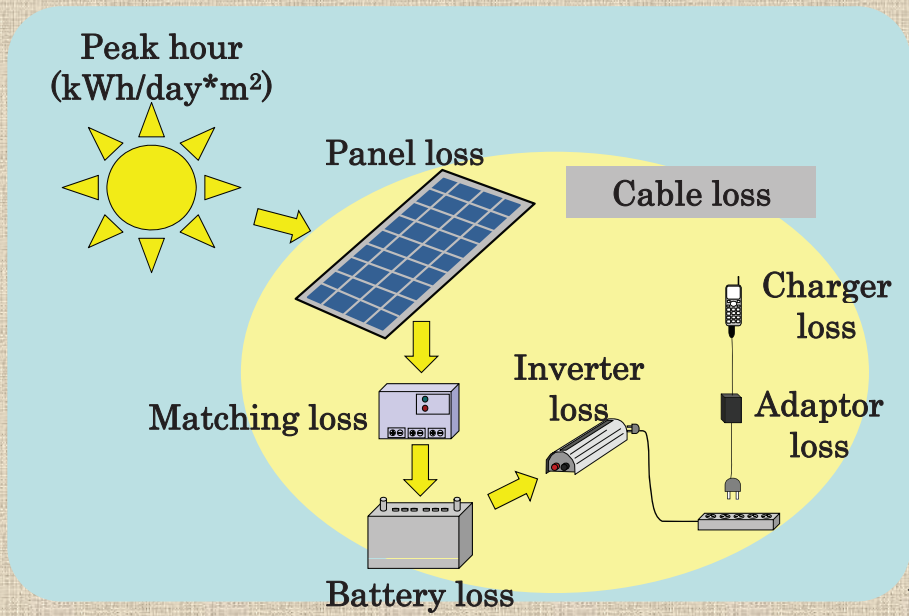
Configuration of charging system



Charging business

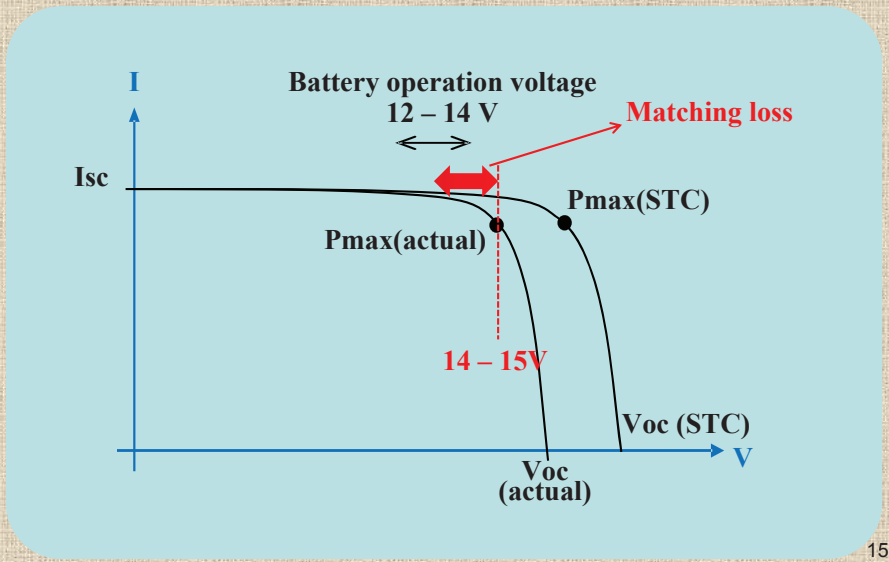
13

How many phones can be charged?



14

Matching loss



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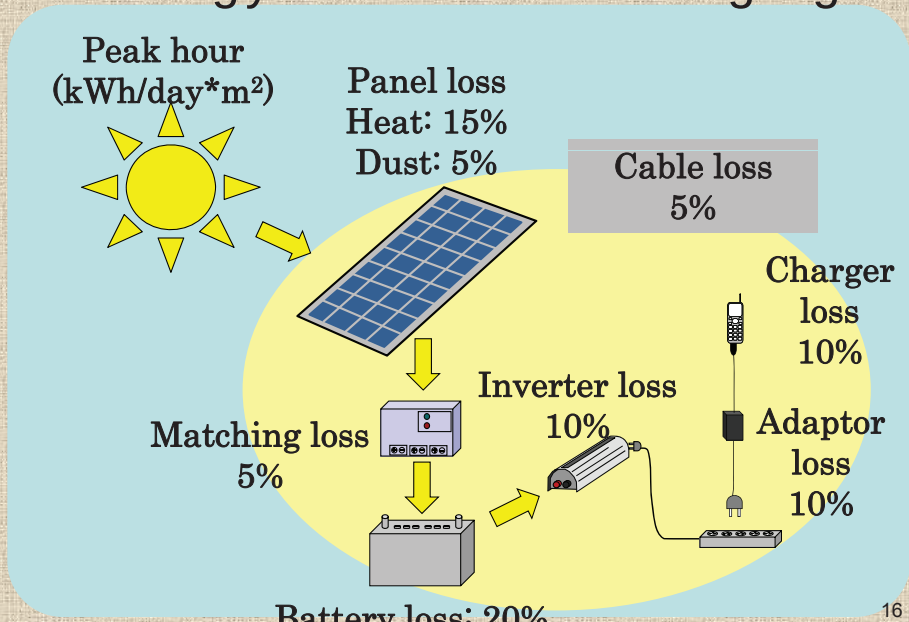
F4-4

Energy balance of charging



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Attachment F-4

Losses

- **Panel loss**
  Heat loss : 15%, Dust loss : 5%
- **Matching loss: 5%**
- **Charge/discharge loss : 20%**
- **Inverter loss : 10%**
- **Cable loss : 5%**
- **Adaptor loss : 10%**
- **Charger loss : 10%**

Overall efficiency : ????

17

Peak hour

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Average Elevation
Average	6.12	6.56	6.30	5.70	5.41	5.11	5.14	5.51	6.15	5.88	5.47	5.73	5.75	819
Minimum	5.15	5.64	5.71	5.13	4.87	4.46	4.62	4.97	5.51	5.26	4.72	5.09	5.09	(m)
Maximum	6.81	7.38	6.87	6.18	5.92	5.61	5.72	6.07	6.70	6.40	5.96	6.32	6.33	

Source : NASA (http://eosweb.larc.nasa.gov/)

Expected one day average panel output =
Panel rating (Wp) * Peak hour (kWh/day*m²)

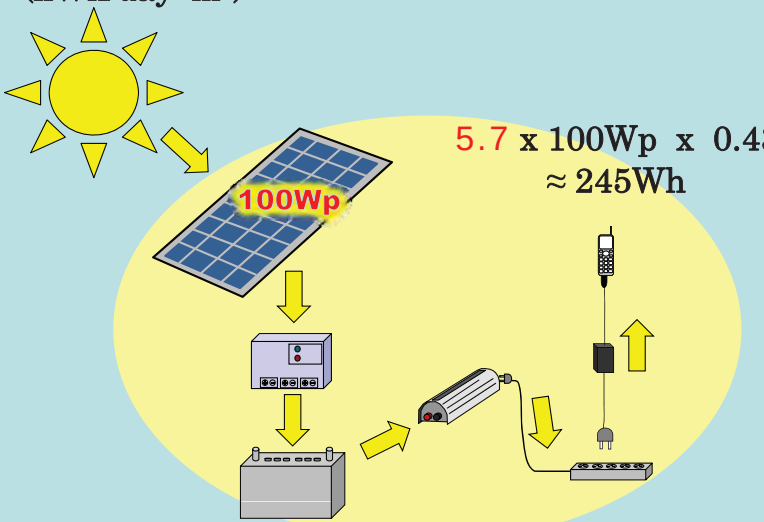
Normal system: use average peak hour
= 5.7 kWh/day*m²

Critical system: use minimum peak hour
= 5.1 kWh/day*m²

18

Available energy

5.7 (kWh/day*m²)



5.7 x 100Wp x 0.43
≈ 245Wh

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F4-5

Expected number of charging

- Batteries in mobile phones
  Voltage : 3 – 3.8 V
  Ampere capacity : 1 – 1.8 Ah
  → **Average battery capacity : 4 Wh**
- Possible number of charging
  (100Wp panel)
  245Wh / 4Wh ≈ 60 phones/day
- Smart phones ????

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Attachment F-4

New Rechargeable Products

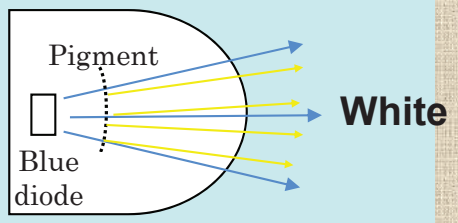
- Lantern, battery pack

  Business has not started yet.

New PV products !

LED

- **Basics on LED**



- **Efficiency**

  LED: 20 – 100 lm/W

  Incandescent bulb: 2 – 20 lm/W

  Fluorescent tube: 60 – 100 lm/W

- **Reliability**

  Life span: Around 20 years

Lantern

There are many types of LED lanterns.

- Rechargeable lanterns

For using at the time of power failure

Most of this type use lead acid batteries ~24Wh

Bright with many LEDs

- Solar lanterns

Used for outdoor leisure (camping . . .)

Some solar lanterns use Li-batteries ~ 5Wh

Long time use with several LEDs

Battery Pack

Small size SHS or large size lantern

- **Small panel**
- **Battery**
- **Controller**

Several LED lamps

Mobile phone charge

Around 100USD

- **Several tens USD – several hundreds USD**

Possible number of charging

- **Mobile phones**
  20 - 30 phones by a 50W panel
- **Lanterns**
  Several – ten lanterns by a 50W panel
- **Battery packs**
  Several packs by a 50W panel
- **Car batteries (50Ah, 12V)**
  One battery by three 50W panels

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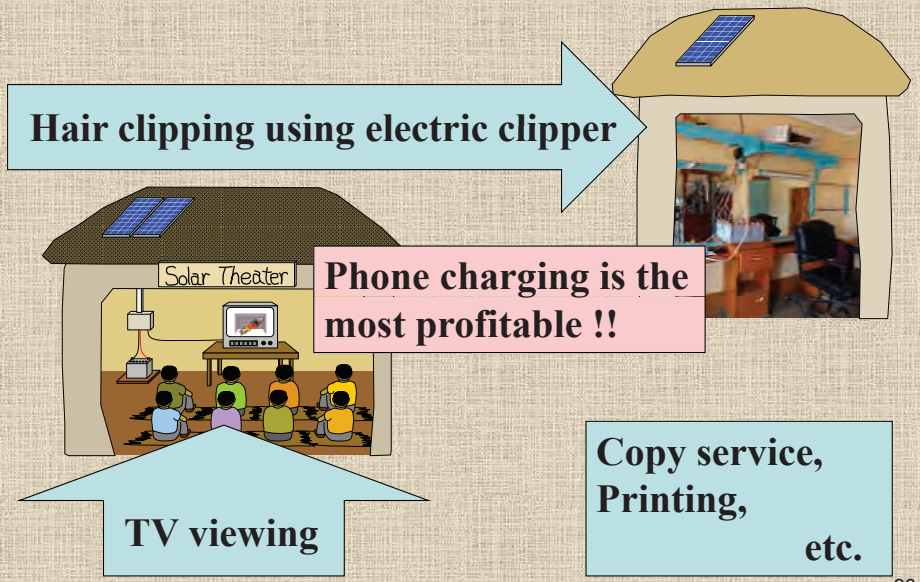
Other possible business



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Charging business
A sample

Phone charge fee	20 Kshs
Number of phone chargeng (daily)	20
Daily turnout	400 Kshs
Annual turnout (300days/year)	120,000 Kshs
Operation cost (wage, maintenance)	50,000 Kshs
Surplus (annual)	70,000 Kshs

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Charging business
A study

Phone charge fee	20 Kshs
Number of phone chargeng (daily)	30
Daily turnout	
Annual turnout (300days/year)	
Operation cost (wage, maintenance)	
Surplus (annual)	

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Maintenance of public PV

- Income from phone charging can cover not only the wage of the operator but also replacement of batteries of public PV systems.
- Replacement of around 10 batteries will be possible by charging business.
- The operator can acquire enough knowledge to maintain PV systems.

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Charging house

- In LOT1, charging houses were prepared by users.
- Construction of the house will affect schedule management.
- Can it be a pat of PV electrification model?

30

Charging system in LOT1

- A 120 – 240W system is attached to a public PV system in LOT1.
- Charging service is conducted by an operator.
- Overall business is managed by the public institution.
- The business is monitored as pilot a project.

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2. PV Rural Electrification in LOT1

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Basic Concept

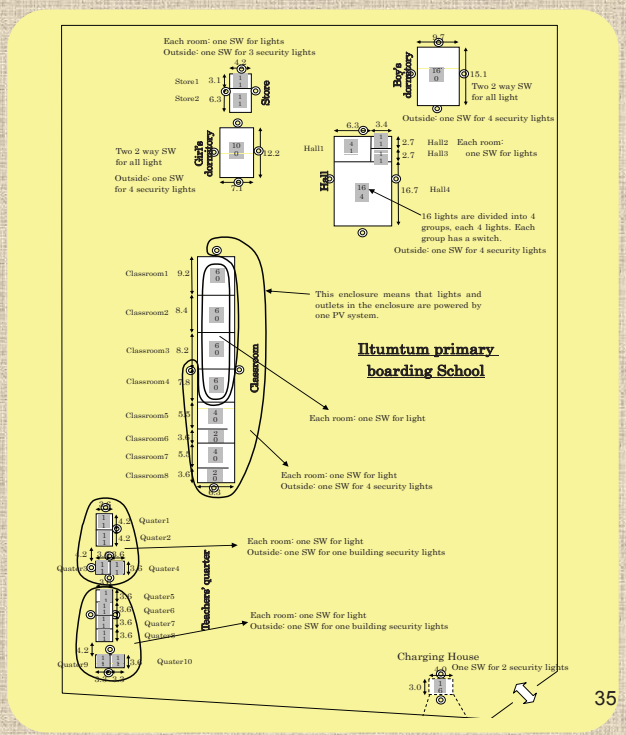
- **The package should be**
  easy to understand and easy to apply to REA.
- **Each system should be**
  easy to maintain and easy to operate by users, and
  reliable and locally available.

Basic Concept

- **Dispersed system**

  One large system ⇨ several small systems
- **Simplified, uniform**
- **Presence of trained personnel is important. User training should be a part of TOR in the procurement**

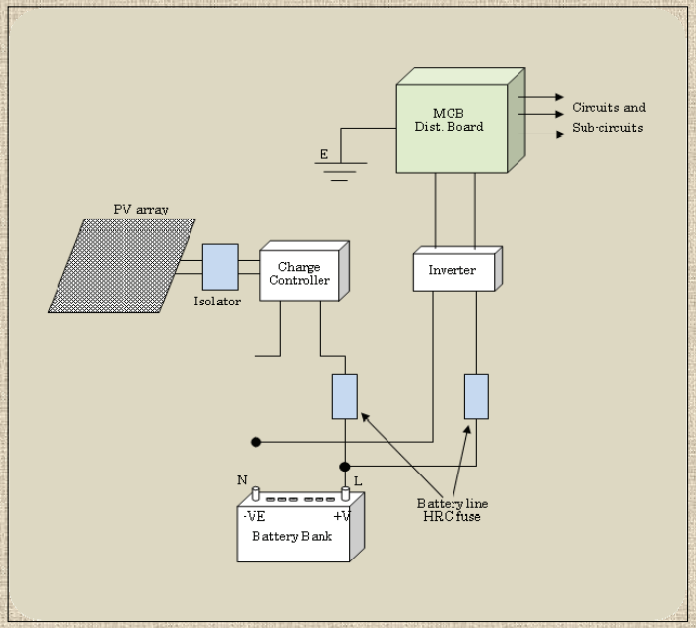
A sample



Electrification Packages In LOT1

- **Systems for school facility**
  New Power Package (NPP1-3)
- **Systems for medical facility**
  New Medical Package (NMP1-4)
- **Systems for staff facilities**
  New Domestic Package (NDP1-2)
- **Systems for charging service**
  New charging Package (NCP1-2)

Basic Configuration



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PV panel

- IEC61215 certificated
- 12V, 120Wp
- Tilt angle around 10 degree

Battery

- Flooded type
- 12V, 200Ah(@20C or 10C)

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Charge Controller

- Current rating

  1.2 * (Isc of the solar array)
  =1.2 * 0.065 * Wp

- Conventional type (PWM) or
  High input voltage type (MPPT)

Inverter

- Pure sine wave

  Pure sine wave type is reliable

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Lamps

- Fluorescent lamps (20W)

  Efficacy: around 40 lumen/W

- Compact fluorescent lamps (9W)

  Efficacy: around 60 lumen/W

- Security lights (10W)

  Efficacy: around 80 lumen/W
  Water proof

40

Efficacy of lamps

	Efficacy (Lumen/W)
Incandescent bulb	2–18
Fluorescent tube	60–80
CFL	40–100
LED	20–100

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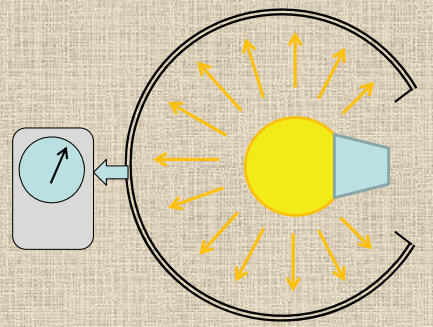
Efficacy

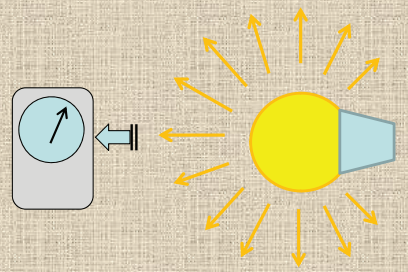
Lumen is a sum of all lights from the lamp

Lamp – lumen/W



Lux is lightness at the spot

Spot – lumen/area



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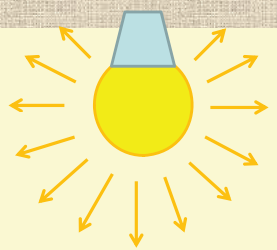
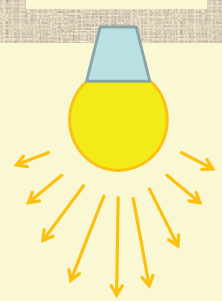
LED - CFL

CFL



LED



LED light is more directional than CFL

LED is brighter than CFL with the same lumen/W

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F4-11

Lamp strategy

Classroom, teacher's room, consultation room	20W FL 2 x 5W LED
Staff quarter, dormitory, store, kitchen	10W CFL 5W LED
Security light	5W LED (10W LED)

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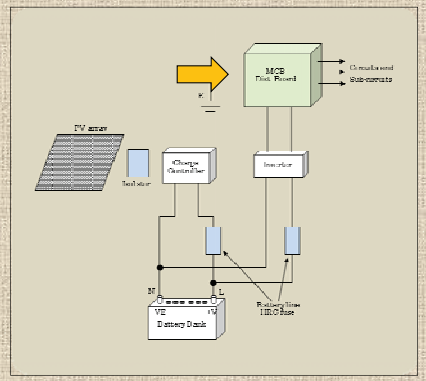
Attachment F-4

Consumer unit

Inverter is connected directly to controller because surge current of inverter sometimes breaks controller. **However,**



Inverter LVD (10.5V)

Controller LVD (11.5V)

Protection from overuse is necessary !!

Consumer unit

Consumer unit

- Function of consumer unit: To avoid overuse of electricity

Important function !!

Load size: 100 – 700 W

Current (240V) : 1 – 3 A

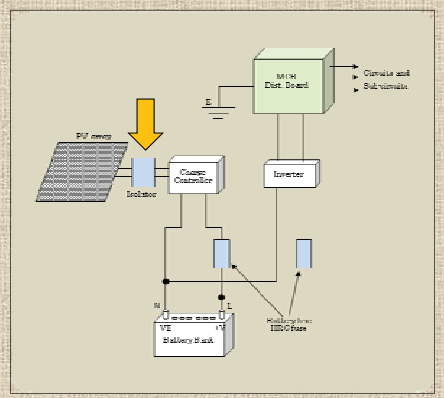
Small MCBs are needed (1A, 2A, 3A)

Still, battery is not protected from over-discharge !!

Other components

- Isolator:

SW for maintenance and lightning isolation

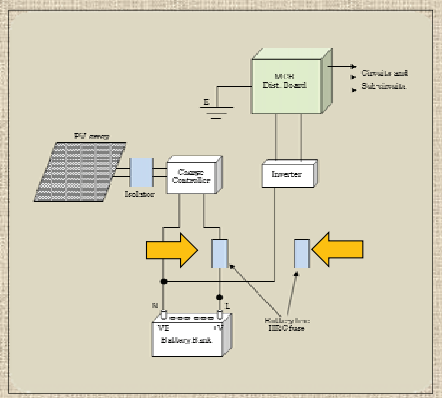


Rating > 1.2 * Isc
= 1.2 * 0.065 * Wp

Other components

- HRC fuse:

Smaller than controller or inverter rating.



New Implementation in LOT1

- **Security light (LED 10W)**
  Operation time is very long (11-12hrs)
  Very energy consuming
  Energy saving effect is very large
- **CFL (9W)**
  Energy saving.
  Available around the country
- **Fridge system**
  Fridge is critical equipment
  Dedicated power source applied

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Systems for schools (New Power Package NPP1-3)

Item	Capacity	Definition	Typical load
NPP1	220Wp	5 – 10 lights 1 – 4 sockets	8 lights (20W 1hrs) 2 security lights (10W 11hrs) 1 socket (50W 1hr)
NPP2	440Wp	10 – 18 lights 3 – 7 sockets	15 lights 3 security lights 3 sockets
NPP3	660Wp	19 – 25 lights 5 – 10 sockets	21 lights 4 security lights 5 sockets

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Systems for Dispensaries (New Medial Package NMP1-3)

Item	Capacity	Definition	Typical load
NMP1	330Wp	5 – 10 lights 1 – 4 sockets	7 lights (20W 2hrs) 3 security lights (10W 11hrs) 1 socket (50W 3hrs)
NMP2	660Wp	10 – 20 lights 2 – 5 sockets	15 lights 5 security lights 3 sockets
NMP4	220Wp		Refrigerator

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Systems for quarters (New Domestic Package NMP1-3)

Item	Capacity	Definition	Typical load
NDP1	75Wp		3 lights (10W 1hr) 1 security lights (10W 12hr) 1 socket (50W 1hr)
NDP2	150Wp		3 lights 2 security lights 1 sockets (50W 3hr)

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Systems for charging (New Charging Package NCP1-3)

Item	Capacity	Definition	Typical load
NCP1	110Wp		30 mobile phones 5 lanterns
NCP2	220Wp		Larger than the above

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Demand study

- **Before designing the systems, demand size have to be studied.**
- **Demands can be calculated by summing up power consumption of all appliances.**
- **Such calculation is very easy once calculation sheet is developed.**
- **Each demand is calculated based on the typical load.**

Demand considerations

- **Several types of appliances are used (20W FL, 10W LED, 9W CFL, power socket). Definition based on the number of lamps is difficult. Demand shall be calculated.**
- **Main use of power socket is PC (50W).**
- **Lamp use in classrooms is very little.**
- **Lamps in supportive facilities can be CFL (10W).**

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Demand estimation practice

- **6 of 20W FL lamps, 4 hours**
- **2 of 10W CFL lamps, 4 hours**
- **1 of PC (50W), 6 hours**

How much is total demand ?

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Demand estimation practice

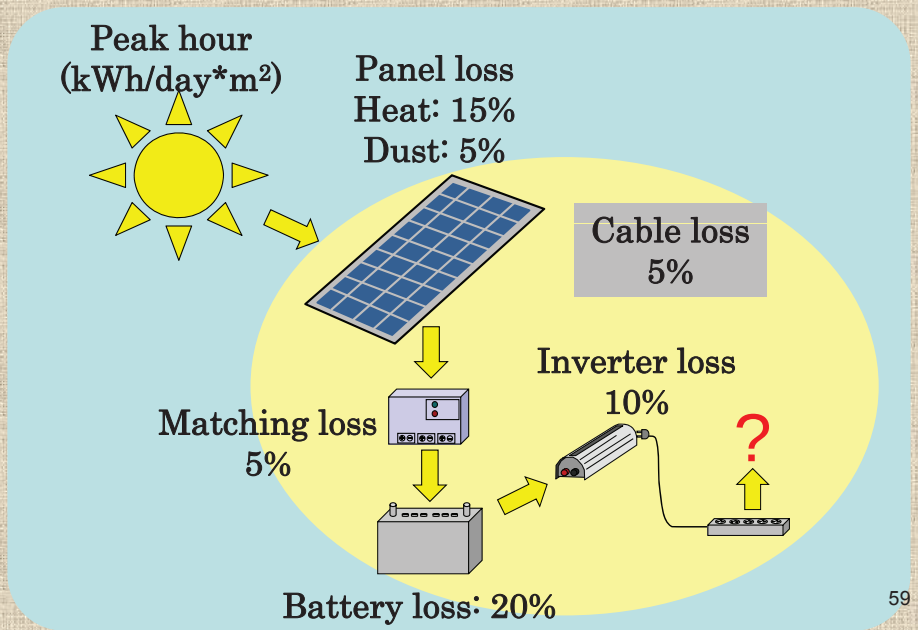
- 6 of 20W FL lamps, 4 hours
  6*20W*4hrs = 480Wh
- 2 of 10W CFL lamps, 4 hours
  2*10W * 4hrs = 80Wh
- 1 of PC (50W), 6 hours
  1*50W* 6 = 300Wh

In total, 480Wh + 80Wh + 300Wh = 860Wh

Demand estimation of the packages

	20FL	Consumption		Wh	Secu	Consumption		Wh	Out	Consumption		Wh	Total
		W	Hr		rity	W	Hr		let	W	Hr		Wh
PP1	8	20	1	160	2	10	11	220	1	50	3	150	530
PP2	15	20	1	300	3	10	11	330	3	50	3	450	1,080
PP3	21	20	1	420	4	10	11	440	5	50	3	750	1,610
MP1	7	20	2	280	3	10	11	330	1	50	3	150	760
MP2	15	20	2	600	5	10	11	550	3	50	3	450	1,600
MP4		20	24	480									480
DP1	3	10	1	30	1	10	11	110	1	50	1	50	190
DP2	3	10	1	30	2	10	11	220	1	50	3	150	400

Available energy



Available energy

- Panel loss
  Heat loss : 15%, Dust loss : 5%
- Matching loss: 5%
- Charge/discharge loss : 20%
- Inverter loss : 10%
- Cable loss : 5%

System efficiency : ???? ← Usually 60-70%

Panel is cheap. It can be over sized !!

Available energy

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Average	Average Elevation
Average	6.12	6.56	6.30	5.70	5.41	5.11	5.14	5.51	6.15	5.88	5.47	5.73	5.75	819
Minimum	5.15	5.64	5.71	5.13	4.87	4.46	4.62	4.97	5.51	5.26	4.72	5.09	5.09	(m)
Maximum	6.81	7.38	6.87	6.18	5.92	5.61	5.72	6.07	6.70	6.40	5.96	6.32	6.33	

Source : NASA (http://eosweb.larc.nasa.gov/)

Better to use minimum value for public facilities especially for dispensaries.

Panel can be over sized !!

Peak hours = 5.1 kWh/m^2

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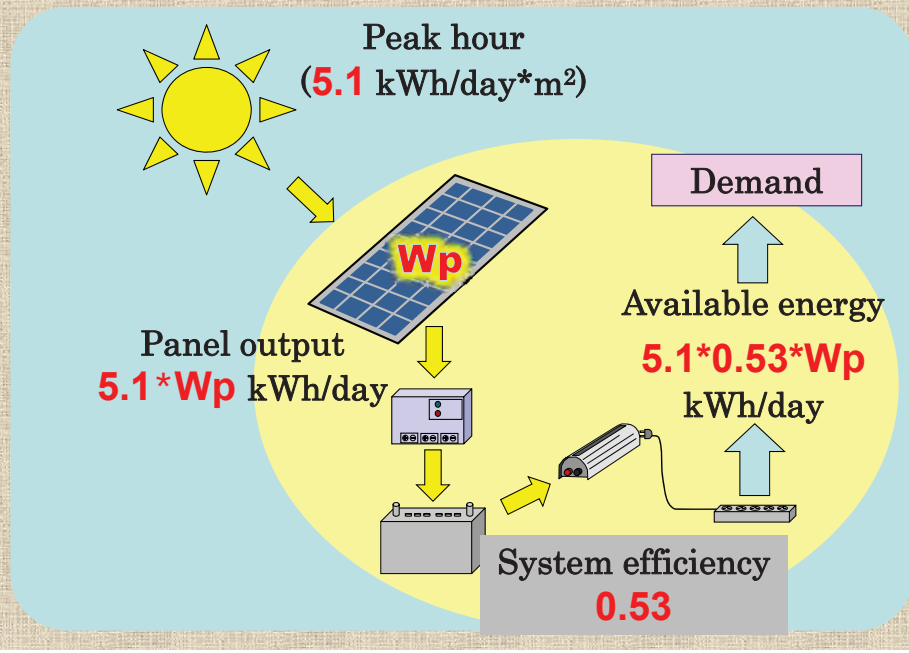
Available energy



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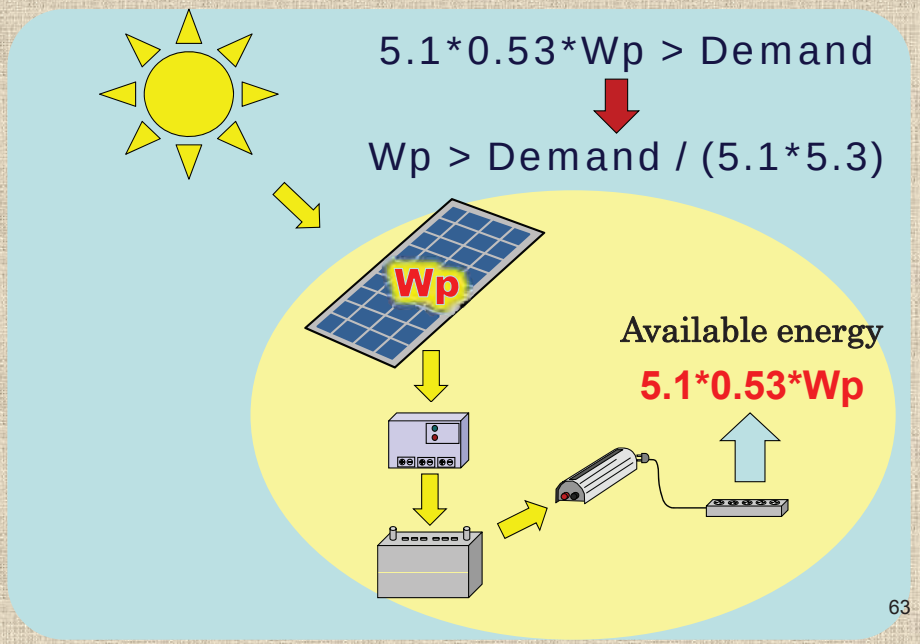
Panel sizing



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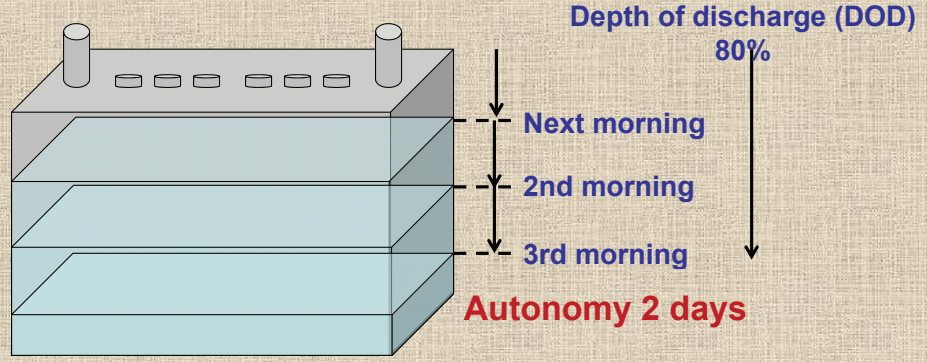
F4-16

Battery sizing

If demand is 1 kWh/day, current consumption @ 12V is 1,000 / 12 = 83 Ah /day.



(Battery capacity * DOD)/(autonomy +1)
= daily current consumption

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Attachment F-4

Battery sizing

$$\text{Daily current consumption} = \frac{(\text{Battery capacity}) * DOD}{\text{autonomy} + 1}$$

$$\text{Battery capacity} = \frac{(\text{daily curremt consumption}) * (\text{autonomy} + 1)}{DOD}$$

Panel/battery sizing analysis of the packages

Total Wh	Peak hours	eff	Panel Wp	One day Ah	Battery Ah	PV size Wp	Battery Ah
530	5.1	0.53	**196**	44	**221**	**220**	**200**
1,080	5.1	0.53	**400**	90	**450**	**440**	**400**
1,610	5.1	0.53	**596**	134	**671**	**660**	**600**
760	5.1	0.53	**281**	63	**317**	**330**	**400**
1,600	5.1	0.53	**592**	133	**667**	**660**	**600**
480	5.1	0.53	**178**	40	**200**	**220**	**200**
190	5.1	0.53	**70**	16	**79**	**75**	**100**
400	5.1	0.53	**148**	33	**167**	**150**	**200**

Inverter sizing analysis of the packages

	20FL	W	Wh	Security	W	Wh	Outlet	W	Wh	Total W	Inv W
PP1	8	20	160	2	10	20	1	50	50	230	300
PP2	15	20	300	3	10	30	3	50	150	480	500
PP3	21	20	420	4	10	40	5	50	250	710	700
MP1	7	20	140	3	10	30	1	50	50	220	300
MP2	15	20	300	5	10	50	3	50	150	500	500
MP4		20	20							20	300
DP1	3	10	30	1	10	10	1	50	50	90	300
DP2	3	10	30	2	10	20	1	50	50	100	300

Results

- **Packages based on the number of lamps are not practical because types of appliances increased.**
- **MOH's fridge consumes much more energy (80W constant) than the Project estimated.**
- **Consumer unit: Too large MCBs were installed. (MCB 1A – 3A available ?)**

New subject

- **The Government is distributing lap-top computers to schools around the country.**
- **What is the size, how many ?**
- **A charging system for lap-top computers necessary ?**
- **How should we respond to it ?**

Fridge

Consumption				Peak hr	eff.	Necessary panel W	Autonomy days	Necessary Battery Wh	Panel Wp	Battery Ah @12V
W	Hrs	Nos	Wh							
80	24	1	1,920	5.1	0.55	684	3	9,600	720	800

Lap-top

Consumption				Peak hr	eff.	Necessary panel W	Autonomy days	Necessary Battery Wh	Panel Wp	Battery Ah @12V
W	Hrs	Nos	Wh							
30	3	30	2,700	5.1	0.55	963	3	13,500	960	1,600

New Package

Demand Wh	Peak hrs	eff.	Necessary W	Package	Panel W	Battery Ah
300	5.1	0.55	107	P0	120	100
400	5.1	0.55	143	P1 Charging	240	200
500	5.1	0.55	178			
600	5.1	0.55	214			
700	5.1	0.55	250	P2	480	400
900	5.1	0.55	321			
1,100	5.1	0.55	392			
1,300	5.1	0.55	463			
1,400	5.1	0.55	499	P3 Fridge	720	600
1,600	5.1	0.55	570			
1,800	5.1	0.55	642			
2,000	5.1	0.55	713			

3. User training

- **Technician is necessary in maintaining PV systems but there are few technicians in rural area.**
- **User training is important to secure a good technicians when installing PV systems in rural areas.**

User's knowledge level

Training is performed with a good manual and hands-on practice.

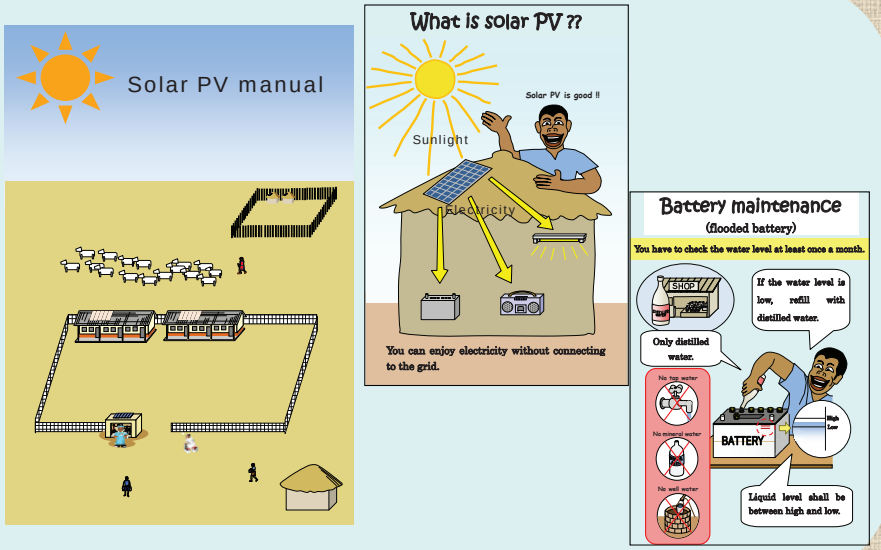
- Pictorial manual

Rural people are not familiar with technical theory and technical expression.

- Hands-on training

With practical training, users can obtain actual skills and knowledge.

Pictorial manual



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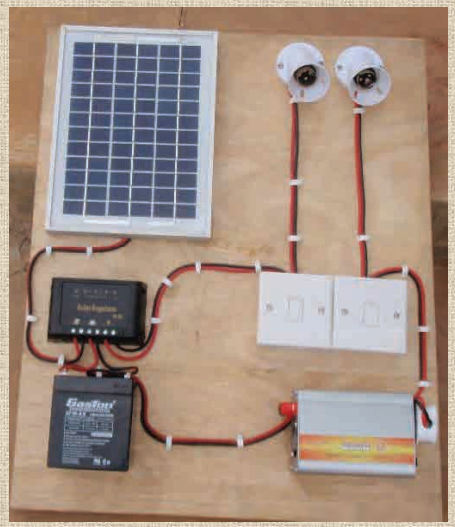
Hands-on training



F4-19

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Maintenance tools

Attachment F-4

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Government's responsibility

- **Government should be responsible for PV installation.**
- **User training shall be conducted at the time of installation. The training will be conducted by installer.**
- **Government should instruct the installer to conduct the user training**

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Experiences in LOT1

- **Training was not conducted sufficiently by the installer. The installer could only concentrate in installation work.**
- **Users did not gather to the training in a timely manner.**
- **Training had better to be controlled separately from installation work.**

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User training in LOT2

- **How we can control the training separately from installation work?**
- **Should it be by the installer or a third company ?**
- **Might it be burden to REA?**

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4. Panel Testing

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IEC panel test requirements

- IEC has PV panel test procedures. IEC61215 is a type approval procedure evaluating panel reliability and performance. Indeed it is a well known procedure, but it is very costly and takes a very long time.
- Industrialized countries have their official organization for IEC61215 test.

Japan: JET, Germany: TÜV, USA: UL

PV panel test

- IEC procedure is too much sophisticated.
- Some test equipment companies supply panel test equipment, which can perform panel I-V test as defined in one of IEC procedures. Still, they are costly.

- For rough evaluation, manual procedure can be applied.

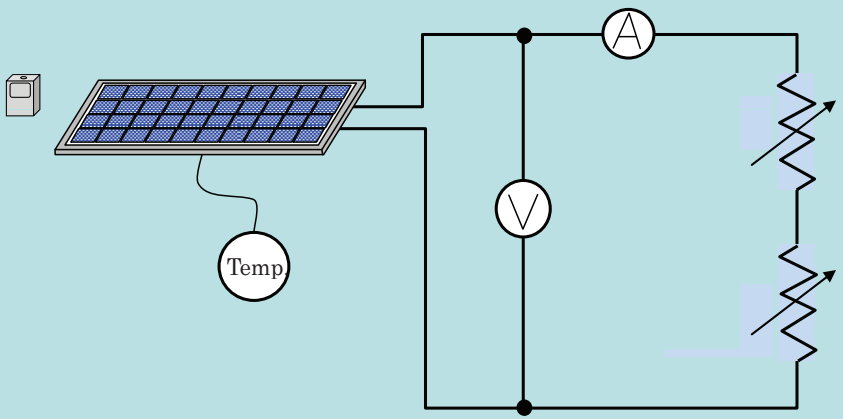
Manual PV panel test

- PV panels can be roughly evaluated manually.
- It can be performed using,

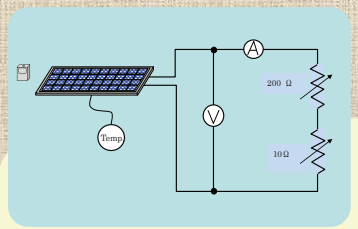
  Digital multi-meter, clamp meter, Thermometer, solar power meter and some rheostats

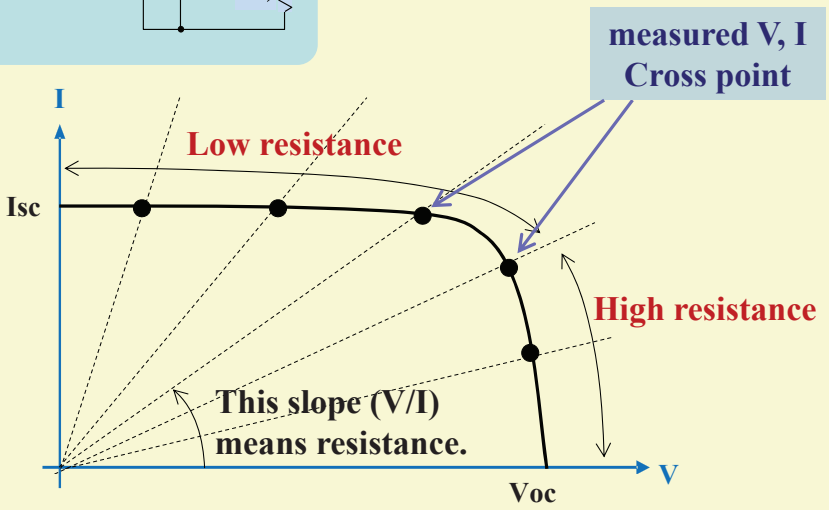
- The test is very useful to understand the concept of I-V characteristic and temperature effect.

Measuring circuit



I-V curve





Calibration to STC

$$I_{stc} = I*(1 + \alpha * (T_{stc}-T))*E_{stc}/E$$
$$V_{stc} = V*(1 + \beta * (T_{stc}-T) + a*\ln(E_{stc}/E))$$

Where
- I : measured current
- V: measured voltage
- T: measured temperature
- E: measured solar power
- suffix **stc** means each value under STC

Tstc=25°C, **Estc**=1kW/m²

Calibration

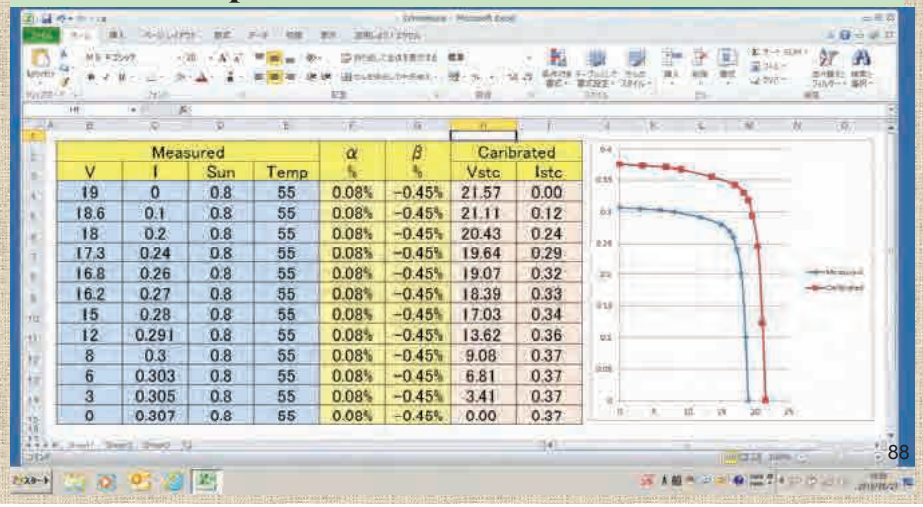
$$I_{stc} = I*(1 + \alpha * (T_{stc}-T))*E_{stc}/E$$
$$V_{stc} = V*(1 + \beta * (T_{stc}-T) + a*\ln(E_{stc}/E))$$

Where
- α : Temperature coefficient of I
- β : Temperature coefficient of V
- a : Irradiation coefficient

For c-Si solar cell
- α is around 0.10%/K
- β is around -0.45%/K
- a is around 0.03

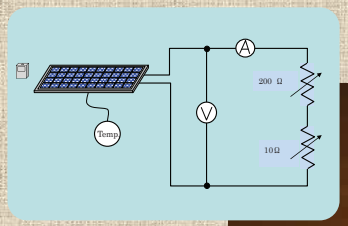
Sample

- Measured data can be easily calibrated by using EXCEL spread sheet.

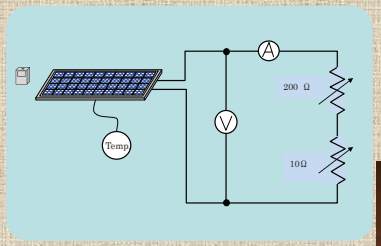


Measured				α	β	Caribrated	
V	I	Sun	Temp	%	%	Vstc	Istc
19	0	0.8	55	0.08%	-0.45%	21.57	0.00
18.6	0.1	0.8	55	0.08%	-0.45%	21.11	0.12
18	0.2	0.8	55	0.08%	-0.45%	20.43	0.24
17.3	0.24	0.8	55	0.08%	-0.45%	19.64	0.29
16.8	0.26	0.8	55	0.08%	-0.45%	19.07	0.32
16.2	0.27	0.8	55	0.08%	-0.45%	18.39	0.33
15	0.28	0.8	55	0.08%	-0.45%	17.03	0.34
12	0.291	0.8	55	0.08%	-0.45%	13.62	0.36
8	0.3	0.8	55	0.08%	-0.45%	9.08	0.37
6	0.303	0.8	55	0.08%	-0.45%	6.81	0.37
3	0.305	0.8	55	0.08%	-0.45%	3.41	0.37
0	0.307	0.8	55	0.08%	-0.45%	0.00	0.37

Tools
Rheostat

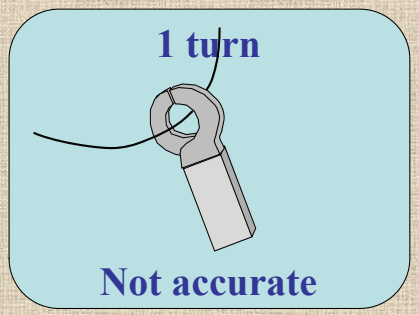


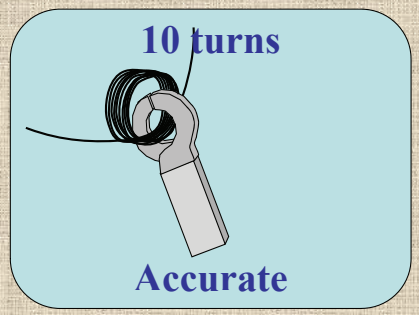
Tools
Measurement



Tip on clamp meter

- **Clamp meter is not good at measuring small current.**
- **By magnifying current, measurement of small current is improved.**





Let's measure

Let's measure V, I, E, T !!

by changing rheostat resistance.

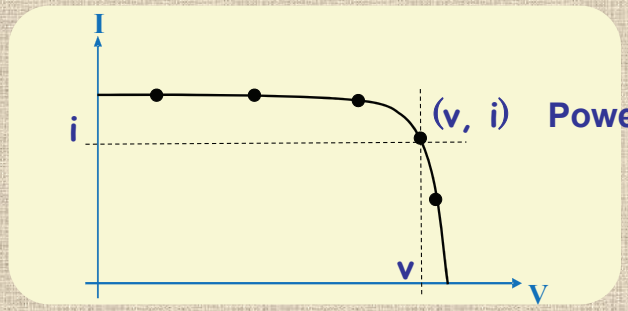
Use

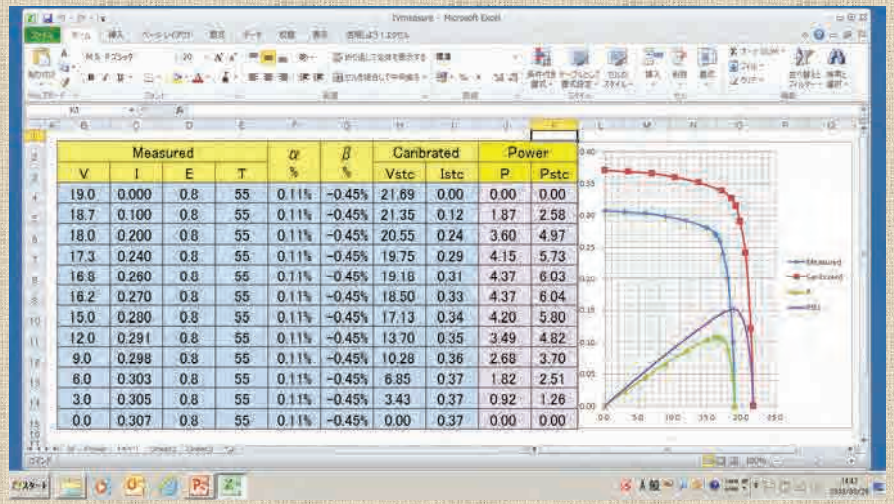
α : 0.1%/K

β : -0.45%/K

Let's complete EXCEL sheet

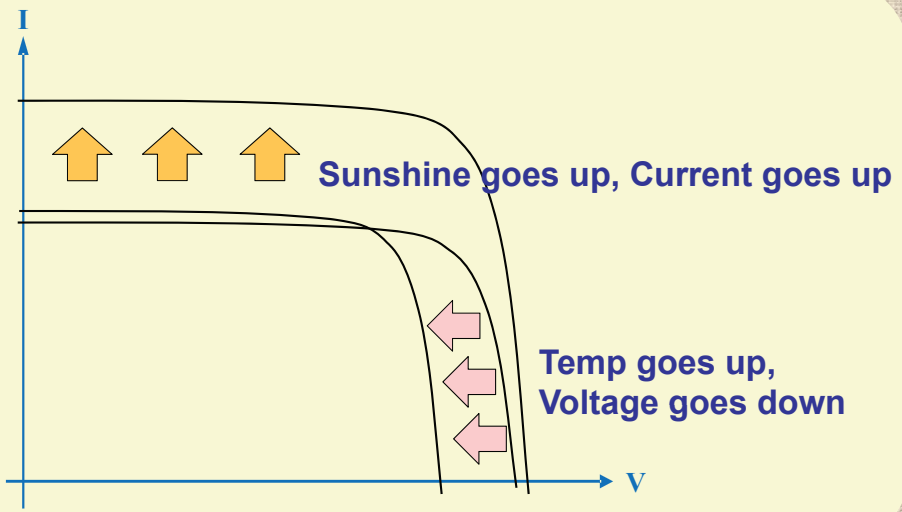
- **Calculate output power at various point**
- **Where is the Maximum Power Point (MPPT) ?**



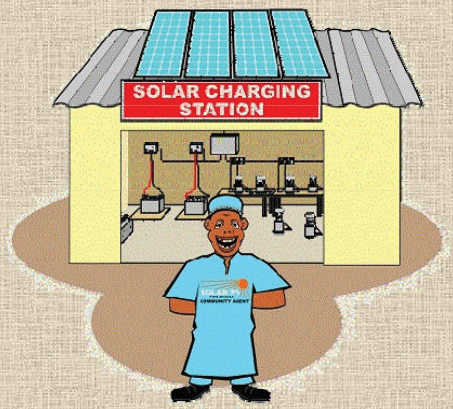


Measured				α	β	Caribrated		Power	
V	I	E	T	%	%	Vstc	Istc	P	Pstc
19.0	0.000	0.8	55	0.11%	-0.45%	21.69	0.00	0.00	0.00
18.7	0.100	0.8	55	0.11%	-0.45%	21.35	0.12	1.87	2.58
18.0	0.200	0.8	55	0.11%	-0.45%	20.55	0.24	3.60	4.97
17.3	0.240	0.8	55	0.11%	-0.45%	19.75	0.29	4.15	5.73
16.8	0.260	0.8	55	0.11%	-0.45%	19.18	0.31	4.37	6.03
16.2	0.270	0.8	55	0.11%	-0.45%	18.50	0.33	4.37	6.04
15.0	0.280	0.8	55	0.11%	-0.45%	17.13	0.34	4.20	5.80
12.0	0.291	0.8	55	0.11%	-0.45%	13.70	0.35	3.49	4.82
9.0	0.298	0.8	55	0.11%	-0.45%	10.28	0.36	2.68	3.70
6.0	0.303	0.8	55	0.11%	-0.45%	6.85	0.37	1.82	2.51
3.0	0.305	0.8	55	0.11%	-0.45%	3.43	0.37	0.92	1.26
0.0	0.307	0.8	55	0.11%	-0.45%	0.00	0.37	0.00	0.00

I-V curve



End of presentation



Attachment G Materials for Solar PV System (O&M Part)

Attachment G-1 Questionnaire of Baseline Survey

Attachment G-2 Result of Baseline Survey

Attachment G-3 O&M and Monitoring Report

Attachment G-4 Result and Analysis of the Charging Service

Attachment G-1 Questionnaire of Baseline Survey

G-1-1 Baseline Survey to the Facilities

1. Interview data

(1) Date of interview _____ Interviewer
(2) Name of the facility
(3) Sub-county _____ Division
Location _____ Sub-Location
(4) Interviewee's name, sex, age
(5) Position/title in the facility

2. Facility structure and function

(6) Number of communities in the service catchment area
(7) How many persons in the facility?
<School>
School: Teachers __ non-teacher workers __ Total
Number of pupils ___ (number of boarders ____)
<Dispensary>
Dispensary: Medical staff __non-medical staff __ Total
Average number of patients/day ____ (average number of night patient/day ____)
(8) 1) Does the facility have any expansion plan? /___/
2) If yes, please explain (area expansion, number of rooms, etc.)
3) Has the facility got the budget already? /___/
4) When the construction starts?

3. Actual energy use

(9) Source of actual energy use. Please add the device names used in your facility.

Purpose of energy use	Type (& fuel type)	Number	Amount consumed in a month (unit)	Amount of money Ksh/month
Lighting 1				
Lighting 2				
Radio and/or TV				
PC				
Vaccine refrigerator				
Security light				

Note: Energy source: Grid, generator, dry cell, kerosene, etc.

4. Experience of power generation

(10) Does the facility have or had power generation system?/

Item	Generator	PV system
Number		
Does it function now or stopped?		
Number of system actually functions		
Year of installation		
Who paid and took initiative for installation?		
Capacity of power generation		

(11) 1) If the facility has/had power generation systems, who operates it?
2) Is/was there any fee for the operator?
3) If yes, how much and who pays?
3) Has that person got training of operation/maintenance technique?
4) Is/was there any trouble or problem concerning generator/PV system operation?
5) If yes, please explain.

5. Management and use of electricity to be installed by the pilot project

(12) If you start phone charging service, how much Ksh do you think is appropriate for the fee of one phone charging?
_____Ksh/phone
(13) Do you have any idea using PV power to get income other than phone charging?

Asante Sana !

END

G-1-2 Baseline Survey to Chief or Assistant Chief

1. Interview data

1) Date of interview /_____/ Interviewer /_____/ Name of facility /_____/
2) Interviewee's name and position /_____/

2. Village profile

(4) Latest Population of
Sub-location ____(Year _) Location ____(Year___)
(5) Number of households of ____ is __HHs in the year of
(6) Ethnic groups living in the community in order of population
1._____ 2._____ 3._____ 4._____ 5.
(7) Public facilities in the sub-location. Please enter the number if it exists.
1. Primary school /__/ 2. Secondary school /__/ 3. Dispensary /__/
4. Office of governmental organization (specify) /_____/

3. **Economic and social condition**

(8) Main income sources of the location (specify products, in order of importance)
1._____ 2._____ 3._____ 4._____ 5.
(9) Is there any project (on- going and planning) for community development in this village?

4. Actual energy use and electricity (general tendency in the community)

(10) Sources of energy in the community

Purpose of energy use	Energy source*	Place of fuel collection/ purchase/charging	Unit price of fuel and unit
Lighting 1			
Lighting 2			
Radio and/or TV (if any)			
Mobile phone charging			

Note: Energy source: Grid, diesel, dry cell, kerosene, etc.

(11) 1) Where is the nearest town where inhabitants go to charge phones?

2) How much is the transportation cost (round trip) to go there? /____/Ksh

3) Where is the nearest town where the facility can buy distilled water?

4) Does anyone in the community do charging service using the power from their generator/PV system?

Power generation type		Diesel generator	PV system
Number in the service providers			
1. Mobile charging	Number of service in the village		
	Fee Ksh/1 time		
	Total sales Ksh/month		
2 Other	Specify the type of service		
	Number of service in the village		
	Fee Ksh/ (unit)		

(12) How many percent of the village inhabitants have mobile phone? /____/
(13) Do inhabitants use LED rechargeable lantern? /____/
(14) 1) Does the community have an electrification plan? /____/
2) If yes, what plan? Please explain.

(15) How much Ksh/time is appropriate for inhabitants to pay to charging mobile phone? Ksh per phone

Asante Sana !

END

G-1-3 Baseline Survey to Household

1. Interview data

(1) Date of interview_____ Interviewer
(2) Name of community
(3) Interviewee's name, sex and age
(4) Interviewee's occupation and position in the community

2. Household profile

(5) 1) Number of household members Male/___/ Female/___/ Total/___/
2) Number of household members who live in the community throughout the year /___/
(6) Ethnic group of the household head
(7) Main income source of your household in order of importance and person who mainly engage in it? (in order of importance)

	Occupation/ work 1	Occupation/ work 2	Occupation/ work 3
Name of work			

(8) Household cash income of **last month** ____Ksh, and l**ast year**____Ksh
(9) Household expenditure of **last month** ____Ksh, and l**ast year**____Ksh

3. Household energy use

(10) Do you have diesel generator(s) and/or PV system?

Power generation type	Diesel generator	PV system
Number		
Generation power (kWh)		
Fuel consumption (liter/month)		-
Fuel expenses (Ksh/month)		-
Purpose of use		

(11) Do your household own following appliances? Please answer the number.
Mobile phone /__/ television /__/ Radio /__/
(12) If you have mobile phone(s),
If no, why?
1) Where do you charge?
2) How many hours does it take to reach the charging place?
3) How many times do you charge it in **a month**?
4) How many Ksh do you pay for one time recharging? _____Ksh/time
5) How much can you pay at maximum for charging in **a month**? ____Ksh/month
(13) If the dispensary or primary school in this community starts charging service, will you use the service? / /
(14) 1) What kind of lighting appliance do you use?
2) If it is kerosene lantern, where do you buy the fuel?
3) How much do you pay for kerosene in a month? _____Ksh/month

Asante Sana !

END

Attachment G-2 Result of Baseline Survey

G-2-1 Lot 1 sites

G-2-1-1 Summary of the interview to target facilities

Item	Ilkilnyeti Dispensary	Iltumtum Primary School	Olkinyei Dispensary	Olemoncho Primary School
Basic information of the facility				
Facility type	dispensary	School	dispensary	School
Sub-Location	Kiboko	Enkorika	Olkinyei	Aitong'
Location	Kenyewa	Oletukat	Olkinyei	Aitong'
District	Mashuru	Narok North	Narok South	Narok South
Service catchment area	About 7 villages	Over 10 villages	9 villages	4 Villages
Facility staff members	2	9	4	10
Nos of pupils (boarding pupils)	-	351 (106)	-	347 (62)
Present power generation system				
Type of generation	No generation	PV system	PV sytem	PV system
Number (devices functioning)	-	1	5	2
Generation capacity	-	40 Watts	600 Watts	80 Watts
Operator of PV system	-	Teachers	Dispensary staff	Teachers and prefects
Problem of existing PV system	-	When it is coo, the amount of elec. accumulated reduces.	Three panels does not fully function.	The students often tamper with it sometimes until it goes off.
Actual energy use				
Lighting 1	Kerosene Lamp	Electricity generated by PV system	Electricity generated by PV system	Electricity generated by PV system
Lighting 2	Torch using dry cell	Hurricane lamp	Kerosene lamp	Torch using dry cell
Radio/TV	Dry cell	Electricity generated by PV system for 1 TV	Dry cell	Electricity generated by PV system for 1 TV
PC	No PC	No PC	No PC	No PC
Vaccine fridge	LPG gas	-	Electricity generated by PV system	-
Use of the electricity generated from the PV system that the Project will install				
Expected use of electricity	Lighting at night, Preserving vaccines	Charging phones, Lighting up classes & teacher's houses	Lighting, Running lab equipment, Phone charging	Evening study, Phone charging centre, ICT centre
Operator	n.a.	Teachers	Subordinate staff of the dispensary	Employed electrician
Financial manager	n.a.	Headteacher of the school	Employee who will be chosen	An elected person of the SMC
Purchase of distilled water	n.a.	School community to pay, SMC	Daily collections from phone/charging	n.a.
Purchase of spare parts	n.a.	School community to pay, SMC	Daily collections from phone/charging	n.a.
Salary of operator	n.a.	To agree based on charging fee collection	Daily collections from phone/charging	Will pay from sales of battery charging.
Expected charging service catchment area	n.a.	They expect customers from school catchment area	n,a.	Olemoncho, Rekero, Oltorotuai, Osero villages

* DMC = Dispensary Management Committee, SMC = School Management Committee,

G-2-1-2 Summary of the interview to local authorities and community elders

Item	Ilkilnyeti Dispensary	Iltumtum Primary School	Olkinyei Dispensary	Olemoncho Primary School
Basic geographical data				
Population estimate (Year)	5,000 (2012)	2,180 (2009)	7300 (2009)	2000 - 3000 (2009)
Ethnic group	Dominant: Maasai ; Others: Kamba, Kikuyu	Maasai	Maasai	Maasai
Economic and social activities				
Occupation of community people in order of importance				
for subsistence	Milk: meat: beans	Milk; meat; beans	Cattle; goat; sheep	Cattle; goat; sheep; milk
for commerce	Cattle: goat; sheep: milk	Cattle; sheep; goat; milk	Cattle; goat; sheep; maize	Cattle; goat; sheep; milk
Social relation				
Comparison with neighbour communities	Poor because meat and milk has no market place.	Poor because illiteracy rate here is higher than neighbouring clusters.	Not defined, because most people have plenty of livestock while neighbouring community gets conservancy pay from Maasai Mara National Park.	Poor because over-reliance on livestock as a source of income generation which is not dependable during the dry season. There's no water in the area.
Inhabitant's group	-	Iltumtum women group: savings and loans Machinet youth group: health and education awareness	Osenetoi Women's Group: buys and sells livestock at a profit. Every village has its own group. Youth groups also exist.	Olemoncho Women's Group: construction of houses Osero Women's Group: Construction of houses Mara North Conservancy
Unity inside community	Good, the community has a positive attitude towards solving problems	Good, because of cluster member cooperation	Good, people live together in harmony and respect each other	Good, Villages co-operate among various activities/projects
Relation with neighbour communities	Good	Good	Good	Good
Community development plan	Borehole-Ilkilnyeti Community Project	Rain water harvesting tank-complete	Constituency Development Fund (CDF) is currently building schools.	None
(3) Present power generation in the community				
Existing diesel generator	1	4	Not clear but around 4	n.d.
Existing PV system	5	1	Not clear but around 4	n.d.
Electrification plan	None	None	None	Yes, but due to financial constraints might not be able to achieve it.
Future system management				
Appropriate PV O&M and management body	Community to come up with management committee	School Management Committee	Community's organization	Community's organization
Reason	It will create a sense of ownership/ responsibility of community towards the project.	Solar panel is located in the school, therefore it's only good that the school management be in charge of it.	I is a project that the government started and left to the community to run and it works well.	Community does things in a very united way.

Item	Ilkilnyeti Dispensary	Iltumtum Primary School	Olkinyei Dispensary	Olemoncho Primary School
Person for O&M	Not specified	Not specified	None-but there is an operator at District Office of Health Office	Electrician in the community
Payment	-	-	negotiable depending on type of service	Negotiable
Person for management	Yes	Not specific	Yes	Yes
Payment	Ksh.10,000	-	Negotiable after holding consultations with villagers	Negotiable

Prepared by JET

G-2-2 Lot 2 sites

G-2-2-1 Summary of the interview to target facilities

Facility	Tuum Primary School	Illaut Primary School	Marti Primary School	South Horr Dispensary	Latakweny Dispensary	Angata Nanyokei Dispensary
Location						
District	Samburu North	Samburu North	Samburu North	Samburu North	Samburu North	Samburu Central
Division	Nyiro	Nyiro	Baragoi	Nyiro	Baragoi	Kirisia
Location	Tuum	Arsim	Marti	South Horr	Latakweny	Angata Nanyokei
Sub-Location	Tuum	Illaut	Kalele	South Horr	Latakweny	Angata Nanyokei
Persons in the facility						
Teachers	9	8	8	-	-	-
Other staff	2	2	5		-	-
Pupils (boarders)	174 (0)	275 (80)	437 (150)	-	-	-
Medical staff	-	-	-	4	2	1
Non-medical staff	-	-	-	3	3	3
Average patients/day (night patient)/ day	-	-	-	40 (2-3)	60-70 (3-4)	20 (2)
Facility expansion plan	Dormitory for Girls	Dormitory for Girls (Approximately 100 Girls)	Classrooms: 7, Dining Hall: 200 Pupils, Teachers' Quarters: 10 and Fencing	Nurse's House, Toilets, Bathrooms and fencing	Staff houses: 3 Single Rooms	Not aware of the exact plans.
Budget	Got budget	No	Yes	Yes	No	-
Time of construction	2008/2009 – 2014	Not known	2014	2013 to date (nurse's house)	Not sure of the date	-
Fund from government	Yes	Yes	2014	Yes	Yes	Yes
From	Free Primary Education Fund from the Government	Free Primary Education Fund from the Government	FPEF Quarterly: Kshs. 360,000 for Boarding, Kshs. 100,000 for Tuition and Kshs. 59,200	1. Government – HSSF Quarterly: Kshs. 64,700; 2. CDF: Kshs.	HSSF Quarterly: Kshs. 75,000	Respondent was not aware of the exact amount
Amount	n.a.	n.a.		1.2M (Once		Ditto

Facility	Tuum Primary School	Illaut Primary School	Marti Primary School	South Horr Dispensary	Latakweny Dispensary	Angata Nanyokei Dispensary
Ksh			for operation	only)		
Purpose	(education)	(education)				
Periodical report	Yes	Yes	Yes	Yes	Yes	Yes
	1 District Education Office – Financial Report (Yearly) 2 Monthly Returns and School Meal's Programme Report (monthly, yearly)	1 Division Education Office – Financial Report (Yearly), 2 Monthly Returns and School Feeding Programme Report (monthly, yearly)	1 Monthly – Monthly returns to the DEO 2 Quarterly – Financial Report to the DEO 3 Yearly – Audited report to the DEO	1 Quarterly – Financial returns to the District Health Office 2 Monthly – Register for patients to the District Health Office	District (Medical Health Services Office) – Monthly Report and HSSF Imprest Surrender Report.	(To District officer) Quarterly
Energy use						
Lighting 1 type	Kerosene	Kerosene	Kerosene	Kerosene	Electric torch	Solar PV
Number	5 lamps	2 lamps	2 pressure lamps	(5 liters)	1 with 4 dry cells	1
Fuel Ksh/month	345 per lamp (= 1,725/month)	540 per lamp (= 1,080/month))	4,800	1,100	240	-
Lighting 2 type	Solar Torch	Torch (Dry cells)	-	2 torches	Kerosene Lantern	Kerosene
Number	1	10 cells		Dry cells	1	?
Fuel Ksh/month	3,500	400		560	500	d. k.
Radio	1		-	-	1	
	4 dry cells	Dry cells			9 dry cells	3 Dry Cells
	140	480			540	240
Refrigerator	-	-	-	-	1	LPG gas (13kgs)
Ksh/month					n.a.	3,700 – 4,000
Security light			Dry cells (2 Torches)		0	
Ksh/month			400			
Energy source						
Generator	0	0	0	0	0	0
PV system	1	0	2	2	2	1
Actually functioning	0 (stopped)	-	1 of 2 is functioning	2/2 but not good	1 of 2 is functioning	1
Year of installation	2008	-	2011	Not sure	Not sure	2013
Who paid installation	Catholic Mission	-	d.k.	MoEST, CDF, CDF	Government	MoE & P
Capacity	40W	-	d.k.	d.k.	75W	d.k.
Operator	Teacher on duty	-	Deputy Head Teacher	Watchman	Nurse in charge	Nurse
Fee to operator	-	-	No	Dispensary pays. Amount not known	No. Only volunteer work	-
Training	No training	-	Self-acquired	No training	No training	Yes, got some training

Facility	Tuum Primary School	Illaut Primary School	Marti Primary School	South Horr Dispensary	Latakweny Dispensary	Angata Nanyokei Dispensary
Who does O&M	SMC	-		Head Nurse, MC	Nurse in charge	(Nurse)
Who pays for O&M and replacement?	n.a. (maybe no fund was used for O&M)	-	From the school account	From the account of the dispensary	From HSSF funds	From the HSSF account of the dispensary
Problem PV system	Battery failure, inverter and cables stolen	-	Technical problem – solved	Battery and bulbs failure	The battery discharges faster and the panels are not good.	The vaccine unit is not functioning on PV
Future PV system						
Management	SMC and teachers	Selection to be done by SMC	Committee will decide later	Committee will decide	Nurse in charge or the CHW	Committee will decide
Phone charging Ksh	20	20	20	20	20	20
Manage of charging service	SMC	Selection to be done by SMC	D/H Teacher	Committee member	CHW	Nurse
Other service	Hair cutting	Hair cutting	Hair cutting Torch charging	Hair cutting, Sale of solar torch and lanterns	Hair Cutting	Hair cutting
Special account	Most appropriate	It is appropriate	Most appropriate but not at the beginning	Most appropriate	Most appropriate	Most appropriate
Alternative fund source for O&M and replacement	Government free primary funds; farming (self-reliant) and community fund raising	Alternative funding from parents is available.	Government fund raising; CDF and; Local Government Funding	Community fund raising	No idea	Community fund raising

Prepared by JET

G-2-2-2 Summary of the interview to local authorities and community elders

Facility	Tuum Primary School	Illaut Primary School	Marti Primary School	South Horr Dispensary	Latakweny Dispensary	Angata Nanyokei Dispensary
Village	Tuum	Illaut	Marti	Parikoo	Latakweny	Angata Nanyokei
Ethnic groups	Samburu	1 Samburu 2 Rendile	1 Turkana 2 Samburu	Samburu	Samburu	Samburu
Village economy						
Subsistence 1	Vegetables	Cows	Livestock	Livestock	Meat	Maize
Subsistence 2	Maize	Sheep	Small scale farming		Milk	Beans
Commercial 1	Vegetables		Livestock	Livestock	Milk	Maize
Commercial 2	Fruits		Livestock products		Honey	Sukuma
Relation with neighbors	Good	Good	Good	n.a.	Good	Good
Energy use						
Lighting 1 source	Kerosene	Dry cells	Kerosene	Kerosene	Torch (dry cells)	Dry cells

Facility	Tuum Primary School	Illaut Primary School	Marti Primary School	South Horr Dispensary	Latakweny Dispensary	Angata Nanyokei Dispensary
Fuel purchase	Tuum	Illaut	Marti/ Maralal	South Horr	Latakweny Market	Maralal
Unit price Ksh	Kshs. 120 per liter	Kshs. 300 per pair	Kshs. 180 per liter	Kshs. 180 per liter	Kshs. 160 per pair	Kshs. 40-100/pair
Lighting 2 source	Dry cells	Kerosene	Dry cells	Dry cells	-	Kerosene
Fuel purchase	Tuum	Korr/ Marsabit	Marti	South Horr	-	Maralal
Unit price Ksh	Kshs. 80 per pair	Kshs. 80 per pair	Kshs. 80 per pair	Kshs. 70 per pair	-	Kshs. 180
Radio/TV source	Dry Cells	Dry Cells	Dry Cells	Dry Cells	Dry cells	Dry Cells
Place of purchase	Tuum	Illaut	Marti	South Horr	Latakweny	Maralal
Unit price Ksh	Kshs. 80 per pair	Kshs. 80 per pair	Kshs. 80 per pair	Kshs. 70 per pair	160/ pair	Kshs. 40-100/pair
Phone charging	Solar PV systems	Solar PV system	Solar PV system	Solar PV System	-	
Place of charging	Homestead	Illaut	Marti	-	-	-
Unit price Ksh	Ksh. 20 per charge	n.a.	Ksh. 20 per charge	-	-	-
Energy source in village						
Generator	10	0	0	0	0	0
PV system	10	0	7	0	0	0
Charging service by Generator	10	0	0	0	0	0
Nos of service	10					
Fee Ksh/1 time	Kshs. 20					
Charging service by PV	10	0	7	0	0	0
Fee Ksh/1 time	20		20			
Hair cutting by Generator	1					
Unit price	Kshs. 30 – 80					
Nos of mobile phone holders in the village	>1000	300	1,000	10	n.a.	100
Appropriate charging fee Ksh/time	20	20	10 – 20	20	20	20

Source: Surveyed and compiled by JET

Attachment G-3 O&M and Monitoring Result

G-3-1 Pilot Project Monitoring Plan

1. Purpose of the monitoring

In response to the request of the Government of Kenya, JICA established the "Project for Establishment of Rural Electrification Model using Renewable Energy in the Republic of Kenya" as a technical cooperation project. The model includes the technical framework of renewable energy appropriate for electrification especially for public facilities located in the non-electrified areas. The project is planned to implement pilot project together with REA to learn lessons for model establishment and to conduct technical transfer to the REA staff.

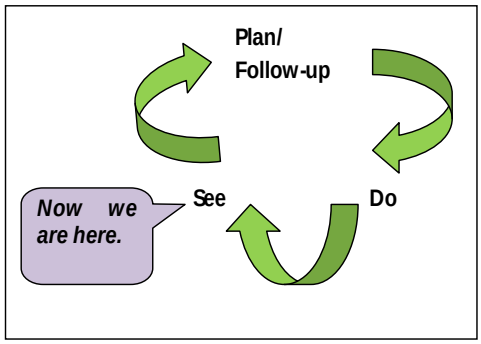
The purpose of the pilot project is that the target public facilities (primary boarding schools and dispensaries) can generate electric power using PV system sustainably. Dispensary nurse can treat patients under the electric light and school children and staff can enjoy the light for night study. The pilot project contains not only construction of PV system to the facilities but also capacity building of facility staff and MC members in technical system operation and maintenance, institutional management and financial management to ensure sustainable system use.

This Plan of monitoring and follow-up on the O&M of PV system aims at facilitating monitoring and follow-up activities in order that the facility management committees do O&M and manage PV system and charging service properly and sustainably after they start to use.

2. Monitoring and follow-up (feed-back)

A project generally has a cycling structure and monitoring is a stage of that cycle. General cycle of a construction project is like:

> Project identification ⇨ Project formation ⇨ Appraisal ⇨ Implementation ⇨ Monitoring ⇨ Revision of plan/ Follow-up



Monitoring is indispensable for sustainable use of the installed/constructed systems because the management bodies are not skilled in O&M and management, and inhabitants in the service catchment area are not aware of the newly constructed facility/system and/or introduced service at the target institutions. It is essential especially during the first few months when both management body and inhabitants are not used to the usage of PV system.

Generally speaking, monitoring is done in accordance with PDM (project design matrix).

The Output 1 of the PDM ver. 2.1 of the Project says that "a practical model for PV electrification of health service institutions in non-electrified areas is developed through pilot projects" and the Output 2 indicates that "a practical model for PV electrification of schools in non-electrified area is developed through pilot projects". The monitoring focuses on whether the PV system installed by the pilot project functions well in terms of technical and financial aspects as well as management.

In more detail, monitoring during the pilot project can determine if: (i) *constructed facilities function well as planned in the project design*, (ii) *management body works appropriately in operation, maintenance and financial and organizational management*, (iii) *charging service obtains market to receive income.* Monitoring team will examine if these outputs are realized and give advices to the management body and feedback to address problems if necessary.

3. Outline of monitoring

1) Time

Basically, monitoring will start after the facility starts to use PV system and continue at every two months till the end of the pilot project in October 2014.

- Two months after the start of system use — Start of monitoring
  (End of August to September 2013 for Lot I and March to April 2014 for Lot II planned)
- During the pilot project period — Monitoring every two months
- Termination of the pilot project — Evaluation workshop (October-November 2014)

2) Person in charge

REA counterpart personnel, JICA expert and Kenyan assistants do monitoring.

4. Contents of the monitoring

1) Organizational management issues: monitor if the facility management committee organization works functionally or not

- Bylaws including role of each member of MC for the PV system management, service time, charging fee, manner of use, prohibition and sanction are drawn up;
- Regular meetings are held as decided by the MC and minutes are taken;
- Committee members and facility staff share information on the charging service and financial status through explanation at the committee's monthly meeting;
- All members of the institution who are in charge of the PV system to be installed by the Project (facility management committee or new group) can explain their tasks and responsibilities clearly;
- MC takes measure when they find problems in technical, financial and management issues.

2) Financial management: whether MC gets enough income as planned and manages income and expenditure

- MC opened a bank account exclusively used for the management of the PV systems;
- Authorized committee members (chairman, secretary, treasurer) regularly deposit money to the bank account;
- Operator constantly works as planned: daily service provision, recording of each sale, checking the daily sale after closing service every evening together with treasurer/secretary, monthly report and annual report, and consultation with the chairman when troubles happen;
- MC members in charge of the charging service constantly work as planned: treasurer/ secretary checks the daily sale after closing service every evening together with operator, makes monthly report and annual report together with operator, explanation to the management committee and community about the sale, auditor checks the financial statement regularly;
- MC regularly discusses the financial state of the charging service;
- MC periodically informs the state of the charging service and promotes its use to the inhabitants living in and outside the facility service catchment area and parents organization;
- MC takes measure when they find the balance is in red by marketing;
- MC submits the financial report to the County (then District) office every month.

3) Technical management: operation and maintenance: monitor if the operator operates and maintains PV system properly or not

- The monitoring team observes, inspects and interviews about the issues:
- Operator records weather daily using the weather sheet prepared by the Expert;
- Battery voltage is at normal level (between X volt and Y volt);
- Inverters and charge controllers by checking the indicator lamps;
- Distilled water is topped up properly by observation of the batteries and daily records;
- Operator operates properly as trained by interviewing his/her daily work;
- Operator writes operation record properly;
- Operator keeps the maintenance tools;
- Operator and management committee members in charge of PV system and O&M have any difficulty or not (by interview);
- When the monitoring team finds any kind of problem, the team gives advices to the management committee concerned to take measures;
- MC submits the O&M report to the county office every month.

4) Behaviour change of electricity users in learning and medical treatment

- Change of expenses for fuel: kerosene for lighting and LPG for vaccine refrigerator,
- Change of life style: studying time, night life, (plus any other responses)
- Quality of night treatment, number of patients coming at night, (plus any other responses)
- Satisfaction of users: school teachers, nurse, students;
- Opinion of users

5) Behaviour of concerned government organizations (responsible organizations)

- Support to the PV system management of primary schools through county and/or sub-county offices of Ministry of Education
- Support to the PV system management of dispensaries through county and/or sub-county offices of Ministry of Health

G-3-2 Monitoring sheet

G-3-2-1 Interview to the facility staff and chairman of the management committee

1. Basic data of the monitoring

1.1 Date _____ 1.2 Site name _____ 1.3 Member of the monitoring team /_____/

1.4 Name and position of interviewees /_____/

2. Organizational management

(1) Bylaw (rule and manner of PV system use and charging service) drawing

1) Existence of a bylaw

Drawn and approved by the committee /___/ Drawn but not approved yet /___/ Not drawn up /___/

2) If not, future plan to make up the bylaw

(2) Do the members of management committee constantly work as planned?

1) Does the treasurer check the daily sale after closing service every evening together with operator? /_____/

2) Does treasurer/secretary make monthly summary report? /_____/

3) Does he/she explain the report at the committee's meeting? /_____/

4) Does the committee submit the monthly financial report to the county health/education office? /_____/

5) Do they explain to the surrounding community about the management of PV system? /_____/

3. Financial management

(1) Has the management committee opened a bank account exclusively used for the PV system? /_____/

(2) Fund raising

1) Does the management committee check the amount of money collected and accumulated for operation and administrative expenses? /_____/

2) Is it sufficient for general expenditure (distilled water, transportation, etc.) till now? /_____/

(3) What measure does the management committee take if the amount is not enough?

(4) If the management committee finds problem in the charging business, what is it?

(5) Does the committee advertise charging service to community people? /_____/

4. Operation and Maintenance of PV system

(1) Does the operator work every day for charging service? /_____/

(2) Does he/she do water topping up? Please observe the condition.

Room/building of the PV system	Water level at the proper level (G/NG)	Record of water topping (yes/ no)	Remarks

(3) Does he/she understand the contents of the Operation and Maintenance record? /_____/

(4) Does he/she fill the Operation and Maintenance record?

Record writing Yes/no	Contents of the O&M record (good/not good)	Remarks

(5) Performance of operator: evaluation of chairman (or head teacher, nurse) : mark <Good / Not Good>

Daily charging service	Recording of "Daily business record"	Recording of "Cash book" every evening	Informing mal function and other troubles to the chairman, if any

5. Change after electrification

(1) What change occurred after the pilot project had started?

<To school>

1) Has the student's studying time changed at night after the pilot project started?

<To dispensary>

2) Number of night patient in this month: total /_____/ and previous month total /_____/

<All sites>

3) Any other change?

(4) Satisfaction of the electrification by PV system (pilot project) /mark one answer /

Satisfied 5 -- 4 -- 3 -- 2 -- 1 Not satisfied

*****If the respondent mentioned question or claim at the previous monitoring, the monitoring team should answer to it.

6. Description

(1) Problems the committee faced and measures taken at this moment

(2) Advice of the monitoring team to the facility and management committee

(3) Observation of the monitoring team, if any

End

ASANTE SANA!

.....

G-3.2.2 Interview to the treasurer and/or secretary

1. Treasurer's work

(1) Do you understand the contents of the daily record sheet? Please explain to the monitoring team.

Result, observation of the monitoring team

(2) Do you check the proceeds of charging service every evening? /_____/

(3) Do you record day's total? /_____/

If not, what is the problem?

(4) Do you make a monthly summary of income & expenditure as trained? /_____/

If not, what is the problem?

(5) What are the administration expense items at this moment? /_____/

(6) Do you inform the income & expenditure to the committee members including chairman and secretary every month?

/ /

(7) If not, what is the reason

(8) Do you advertize charging service to community people? /_____/

2. Report

<To dispensaries>

(1) Does the secretary (or treasurer) add the monthly proceeds from charging service to the monthly report and submit it to the county health director's office? /_____/

(2) If not, what is the reason?

<To schools>

(3) Does the secretary (or treasurer) make a monthly report of the proceeds from charging service? /_____/

(4) If not, what is the reason?

3. Problems and difficulties that the treasurer/secretary has faced concerning PV system financial management

4. Opinion on PV system financial management

End

ASANTE SANA!

.....

G-3-2-3 Interview to operator

1. Working time, Working day in a week and time
2. Do you work every day?
3. Recording

(1) Do you understand the contents of the daily record sheet? Please explain to the monitoring team.

Result, observation of the monitoring team

(2) Do you record day's sale as the JET trained you? /_____/

(3) Do you use the format of daily sale as you were trained? /_____/

If not, what is the reason?

(4) Do you remember the contents of the training? /_____/

(5) Do you want to get training again? /_____/

4. O&M

(1) Do you remember the contents of the technical training? /_____/

(2) Do you keep the "Solar PV Manual"? (if the operator does not have one, please give him/her a copy) /_____/

(3) What is water topping up? Please explain

Result, observation of the monitoring team

(4) Do you check water level? If yes, how often?

(5) Do you check voltage, inverter and controller? /_____/

5. Problems and difficulties that operator has faced

6. Opinion on the operation and maintenance of the PV system

End

ASANTE SANA!

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G-3-2-4 Observation by the facility staff and the expert team

1. Observation of the accounting books

2. Condition of the equipment (set of batteries, inverters and controllers) at each room.

Does the apparatus functions well without bad smell and abnormal sound?

No.	Name of Room/building of the PV system*	2.1 battery voltage (write the voltage)	2.2 inverter (indicator lamp is ON/OFF)	2.3 controller (indicator lamp is ON/OFF)
1				
2				
3				
4				
5				
6				
7				
8				

* Name of rooms

<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hat

<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hat

3. Report

<To dispensaries>

(1) Does the secretary (or treasurer) add the monthly proceeds from charging service to the monthly report and submit it to the county health director's office? /_____/

(2) If not, what is the reason?

<To schools>

(3) Does the secretary (or treasurer) make a monthly report of the proceeds from charging service? /_____/

(4) If not, what is the reason?

3. Problems and difficulties that the treasurer/secretary has faced concerning PV system financial management

4. Opinion on PV system financial management

End

ASANTE SANA!

G-3-3 Summary of the Monitoring Result

G-3-3-1 Lot 1 site (fifth monitoring)

(1) Interview to the facility staff and MC members

Site / Monitoring item	Ilkilnyeti Dispensary	Iltumtum Primary B. School	Olkinyei Dispensary	Olemoncho Primary B. School
County	Kajiado	Narok	Narok	Narok
Date of monitoring	29/08/2014	25/08/2014	26/08/2014	27/08/2014
Interview to	Nurse	Head Teacher	CHW	Noosaron James
1 **Organization setting-up**				

Site	Monitoring item	Ilkilnyeti Dispensary	Iltumtum Primary B. School	Olkinyei Dispensary	Olemoncho Primary B. School
11	By-law (rule of PV system use & charging service)	Drawn and approved by the committee	Drawn and approved by the committee	Not drawn up because the MC lacks commitment.	Drawn and approved by the committee
12	Meeting of the MC on PV system management after installation	Yes-quarterly	Once every term	No meeting	Yes
13	Chairman's performance	Nothing	Advertising services to community	Nothing	Providing oversight
14	Secretary's performance	Maintaining the system and overseeing operations	Policy making to ensure pupils shaved every month at the charging house	Nothing	Makes provision for buying distilled water and supervising the operator
15	Treasurer's performance	Nothing	Making sure records are up to date	Nothing	Providing oversight to the operator
16	Other member	-	Teachers: advertising of the charging business	-	-
17	Does the treasurer check the daily sale in the evening?	No	No	No	Sometimes
	Does the treasurer make monthly report?	Yes	Yes	No	(don't know)
18	Does the committee submit the monthly report to the county officer?	Yes	Yes	Yes	(don't know)
2	**Financial management**				
21	Bank account for the PV system management	No	Yes, go to the bank fortnightly	Yes, go to the bank monthly	Yes, go to bank monthly
22	Check of revenue/expenditure by MC	Yes	Yes	Yes	Yes
23	Are sales sufficient for general expenditure?	Yes	No	No	No
24	Measures for shortage of fund	-	No	Call for fundraising or CDF funds	Wanted to rent out the extra room next to the charging kiosk
25	Committee advertises charging service to community?	Yes	Yes	Yes	Yes
3	O&M				
31	Water topping up	Yes	Yes	Yes	Yes
32	OM				
33	Change of pupil's night time life	-	Now students study up to 9pm or even 10pm without power disruptions leading to improved performance.	-	Yes
	Change in number of night patients	Increase by 5 from previous month: 10 to 15	-	Increased from 3 to 5.	-
34	Change in general	Has increased the work load at night; the patients are now choosing to come for consultations at night while they do business at the market during	Study time up to 9.30pm	Can work at night easily.	More study time at night.

Site	Monitoring item	Ilkilnyeti Dispensary	Iltumtum Primary B. School	Olkinyei Dispensary	Olemoncho Primary B. School
		the day			
4. Satisfaction					
41	Rating (1 – 5)	5	5	5	5
42	Reason of the evaluation	It's a good idea and has increased security because the wild animals are scared away. It has also made working at night easier and safer.	PV system should be expanded to cover other schools.	The project has been helpful in ensuring that patients are attended to at night and also provides good security to the dispensary.	Helpful even to the staff to charge phones and teachers can work even at night.
5. Observation of the accounting books by the monitoring team					
51	Daily business record	Done in an exercise book.	Record up to date	Used occasionally when operator is around	Operator uses an exercise book. No record for August 2014 (School Holiday)
52	Cash book	Not kept. Daily totals are recorded in an exercise book.	Record available in an exercise book	Record available till June 2014	Not used
53	Monthly report	Submitted up to July 2014	Submitted up to July 2014	Record available till June 2014	Not prepared
54	O&M record	No	Yes, well recorded.	No	No
55	Receipt book	Not used	Not used	Not used	Not used
	Problems, obstacles and measures taken by the interviewees	Had a bad battery for the refrigeration unit but it has since been changed by the contractor.	Competition from other charging businesses- the MC has decided to keep the existing tariff of Ksh 20 as opposed to Ksh 30 and strive to give quality services	(Operator's salary: He has not been paid since the project started because he is a dispensary worker but it may reduce his intension.)	1. Operator is still new and needs to be trained. The MC is waiting for JET to do the training 2. Low sales, renting out the extra room hoped to raise revenue 3. The operator needs to be housed at the school as she comes from far, the school plans to build an extra room.
57	Observation by the interviewees	Business is good and can be even better with shaving services.	The operator needs to open the charging kiosk during school holidays to ensure the retention of the existing customers.	Lack of interest and commitment to the project by the management committee is a major impediment to the success of PV system.	It appears that the MC is yet to fully understand the business potential of the charging business. Some private individuals are interested in renting the facility in return for fixed amount to the school every month.
58	Advice from monitoring team	-	1. To continue advertising the charging and shaving services to the community. 2. Formulate a specific opening schedule for holidays to ensure that the existing customers are retained	1. Open up a barber shop. 2. Continue advertising the services	1. Try to carry on the charging business even during school holidays 2. PV system should be turned off when not in use.

Prepared by JET

(2) Condition of PV system (by observation)

No	Name of Room/building	2.1 battery voltage	2.2 inverter	2.3 controller	2.4 Functioning	2.5 Cleanliness & Tidiness by observation
1. Ilkilnyeti						
1	Main Treatment Room	No volt meter	ON - Green	Blinking Green	Functions well though some smell	Good
2	Sub Consultation Room	No volt meter	ON -Green	Blinking Green	Functions well	Good
3	Refrigeration Unit	-	-	Temp. reading 6.3	Functions well	Good
4	Staff Quarters	No volt meter	ON - Green	ON – Green	Functions well	Not Good
5	Charging Room	No volt meter	ON - Green	ON - Green	Functions well	Good
2. Iltumtum						
1	Classes 1 – 3	No Voltmeter	ON - Green	ON - Green	Functions well	Good
2	Classes 4 – 8	No Voltmeter	ON - Green	ON – Blinking Green	Functions well	Good
3	Dining Hall	25.7	ON - Green	ON - Green	Functions well	Good
4	Girls' Dormitory	No Voltmeter	ON - Green	ON - Green	Functions well	Not Good
5	Boys' Dormitory	No Voltmeter	ON – Red	OFF (Some Problem)	Doesn't function well	Good
6	Staff Quarters 1 – 4	No Voltmeter	ON – Green	ON – Blinking Green	Functions well	Good
7	Staff Quarters 5 – 10	No Voltmeter	ON – Green	ON – Blinking Green	Functions well	Good
8	Charging system	No Voltmeter	ON – Green	ON – Green	Functions well	Not Good
3. Olkinyei						
1	Main Treatment Room	13.5	ON	Blinking Green	Functions well	Good
2	Staff Quarter 1	Volt meter battery low	ON	ON - Green	Functions well	Good
3	Staff Quarter 2	Volt meter battery low	ON	ON - Green	Functions well	Good
4	Charging Room	23.3	ON	ON – Green	Functions well	Good
4. Olemoncho						
1	Nursery/class 1-2	15.2	ON – Green	ON –Green	Functions well	Good
2	Classes 3-4 and administration block	28.3	ON – Green	On – Green	Functions well	Good
3	Classes 5-7 now 7-8	29.9	ON – Green	Blinking Green	Functions well	Not Good – Dusty
4	Boys' dormitory – now class 5-6	30.0	ON – Green	Blinking Green	Functions well	Not Good – Dusty
5	Girls' dormitory - now staff quota 2	14.6	On – Green	On – Green	Functions well	Good
6	Staff quarters 1	29.8	ON – Green	Blinking Green	Functions well	Good
7	Charging house	14.03	ON - Green	ON - Green	Functions well	Good

Prepared by JET

G-3-3-2 Lot 2 site (second monitoring)

(1) Interview to the facility staff and MC members

Site / Monitoring item	Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
County	Samburu	Samburu	Samburu	Samburu	Samburu	Samburu
Sub-county	Samburu North	Samburu North	Samburu North	Samburu North	Samburu	Samburu

Site / Monitoring item		Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
						North	South
Date of monitoring		17/10/14	17/10/2014	21/10/14	15/10/14	24/10/14	13/10/14
Interview to		Leriano Ambrose, Rosa Loloku	Antipas Leisido-Chairman & Michael Lenkaak - head nurse	Peter Lengungan Lenuranga - Chairman	Robert Lebulote-chairman and Harrison Lepaliele-head nurse	Phillip Lopusiye and John Ekiru	John Selasi - Head Nurse
1 Organization setting-up							
11	By-law (rule of PV system use & charging service)	Drawn and approved by the committee	Drawn but not approved yet	Drawn and approved by the committee	Drawn and approved by the committee	Drawn and approved by the committee	Drawn and approved by the committee
12	Meeting of the MC on PV system management after installation	Yes	No. MC members too busy and lack of any urgent problems does little to help	Yes, monthly	Yes, quarterly	Yes – once this month	Yes, quarterly
13	Chairman's performance	Called for a community meeting and talked about the PV system management and pupils' study time. Also advertising the charging services	Supervising operator especially in cleaning the panels Receiving any complaints from the operator	Advertising the charging services	Suspension of the operator to ensure compliance with the by-laws Ensuring the safety of the PV system through the watchman	Supervision of the operator	Attending meetings and providing financial oversight
14	Secretary's performance	Instilling discipline on pupils to safeguard the PV system	Oversees the day to day operations of the charging house	Advertising the charging services and overseeing the operator	Has used own resources to pay for minor repairs and also checking water levels every week	Supervision of the operator	Recording and keeping of minutes and liaising with the dispensary
15	Treasurer's performance	Advertising the charging services and financial oversight	Confirming the day's collections and recording it	Advertising the charging services and overseeing the operator He does not check daily record. Also he does not understand at all. The DRS was explained to him by JET during the interview	HE checks the proceeds of charging service sometimes.	Advertising the charging service	
16	Other member						Helping in the management of the PV system
17	Does the treasurer check the daily sale in the evening?	Sometimes	Sometimes	No-weekly	Sometimes	Sometimes	Sometimes
18	Does the treasurer make monthly report?	Yes	Yes	Yes	Yes	Yes	Yes

Site	Monitoring item	Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
19	Does the committee submit the monthly report to the county officer?	Yes	Yes	Yes	Yes	Yes	Yes
2	**Financial management**						
21	Bank account for the PV system management	Yes. One deposit since the last monitoring	No. Monthly deposit to the general dispensary account	No, but MC is planning to open the account soon.	No	No. Planning to open the bank account on 25/10/2014 (In Maralal town)eu	No, not allowed to open an extra account
22	Check of revenue/expenditure by MC	Yes	Yes	Yes	Yes	Yes	Yes
23	Are sales sufficient for general expenditure?	No	No	No	No	Yes	No
24	Measures for shortage of fund	Will ask for community support	Will ask for funding from the County Government and NGOs	Ask for funding from CDF or MOEST	No discussion	-	Hoping the mobile network improvement will solve the problem.
25	Committee advertises charging service to community?	Yes	Yes	Yes	Yes	Yes	Yes
3	O&M						
31	Performance of operator	Not good. Operator is a teacher who is busy with academic work	Yes, she is very committed	Yes, he is present daily to work but has less customers	He does not work every day.	He does not work every day.	Yes
32	Water topping up	Yes	Yes	Yes	Yes	Yes	The operator does not understand. NB: Water topping and demonstration done by the monitoring team during this second monitoring.
33	Daily business record	Yes	Records up to date till 16/10/2014	Daily records are available until September 18, 2014 (Well recorded)	used for phone charging while shaving recorded in an exercise book	Used but mostly in an exercise book.	Record up to date
34	Cash book	No	Up to date till September 2014	not used	Not used	not used	Up to date till October 12/2014
35	Monthly report including proceeds from charging service	Yes	Prepared together, once,, with JET and committee	Prepared together, once,, with JET and committee	Prepared together, once,, with JET and committee	Prepared for September and October but to be submitted later Done once with JET monitoring team. Other reports prepared but	Prepared together, once,, with JET and committee

Site	Monitoring item	Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
						yet to be submitted	
36	O&M record	Yes	No	Yes	Yes	Yes	Up to date though sheets are exhausted
37	Receipt book	Used from 6th May 2014 till 26th September 2014	Not used. The operator says she knows few customers and no need for receipt	Used until 18th September 2014	Not used	All copies used. More copies needed	
38	Bank slips	2(Kshs. 800 and Kshs. 570)are available as evidence of bank deposits.	-	-	-	-	
39	Problem informed by the MC and operator	a. Both technical and financial trainings are not enough to fully understand. (HT missed the first financial training). 2. Shaving machine has failed. No more shaving service)	a. Few customers for shaving. b. The shaving machine has failed. Technician told the operator that it's of poor quality and can't be repaired anymore. c. The O&M of a PV system is an easy task but requires devotion (Some volunteerism)	a. Few customers of charging and shaving b. The charging house is situated too far away from the town. The MC is contemplating moving the kiosk to town, in the area chief's compound. If the kiosk is moved to town, there will be increased income. It will be better supervised by the treasurer in town. c. The community will know that the charging kiosk belongs to the school. d. Shaving machine failed- a new machine should is required urgently.	a. The shaving machine has failed. b. The charging house is too small, so customers don't want to shave from inside: too hot.	a.. Increased competition especially by committee members owning private charging businesses b. Lack of enough chargers c. According to the assistant operator, if PV systems are well maintained, O&M is an easy task to carry out. d. However, according to him, one needs to understand O&M before carrying out the exercise.	a. The first operator misappropriated Ksh. 500. The management committee is following up on this issue b. Customers for charging are few. Some customers want to charge on credit. c. The shaving machine is not working; it has failed. The ope.
4. Effect of electrification and satisfaction							
41	Change of pupil's night time life	Study time is extended to 9pm every night	-	Yes-now having more study time at night	=	Yes – Extended study hours in early morning and early evening	
	Change in number of night patients	-	2 (October), 15 (September)	-	3 (October), 6 (September)	-	0 (October), 2 (September)

Site	Monitoring item	Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
42	Change in general	Students having longer study time	Yes, now able to assist in baby deliveries safely	Evening study up to 10pm	Medical emergencies can be dealt with at night without much huddles	n.a.	Can treat patients at night and can also show video on diseases. In addition, there is good security.
43	Rating (1 – 5i)	3	4	5	3.5	5	5
44	Reason of the evaluation	Very good project but having less customers for charging and shaving services.	-Security is greatly improved at night -Patients can be attended to at night with ease. -The project is good as it can generate some income through the charging system.	Happy about the project because pupils can study at night, can charge phones and shave at the charging house	The system is good	Has served its purpose well.	Very efficient
5. Observation of the accounting books by the monitoring team							
51	Problems, obstacles and measures taken by the interviewees	Low number of customers- caused partly by lack of a dedicated operator. The MC is looking for an alternative operator.	Operator is not fully trained on technical aspects of the system. The chairman hopes that JICA will do this training again.	Few customers - the MC will continue to advertise the business.	a. The radio communicatio n equipment is not able to use the solar system. b. Have some cables dangling which are dangerous. c. Reported to the JET technical team with no solution.	Infrequent management committee meetings – The committee will strive to have more frequent meetings and also invite local leaders to support the project	. -
52	Observation by the interviewees	Lack of operator seriously hampering the operation of the charging kiosk	Lack of regular meetings is impacting negatively on the running of the charging business	The chairman approves the work of the operator very much contrary to the opinion of the head teacher. The deputy head teacher confirmed that there was apparent incoherency in the MC resulting in poor performance by the charging business	a. business is picking up b. Vaccine unit works during the day only c. The operator has been shown the basics of PV O&M by nurse and understands. (the nurse usually helps the operator to learn the basics of O&M)	Some committee members own charging business which undermines the school charging businesss	Business is low but can improve with improved shaving services.
53	Advice from monitoring team	a. Look for a dedicated and reliable operator b. Continue advertising the services to the community	a. O&M can be undertaken by the county health technicians who will be privy to the contents of the monthly	a. The MC can assign times when the operator can collect phones from customers at the market centre in response to	a. ensure that there is financial handover each evening from the operator to the treasurer b. clarify the	a. The operator should be available in all times at the charging house b. Intensify advertising	1. Repair the shaver and explore the possibility of engaging the ambulance driver to shave when not busy, as he is usually

Site	Monitoring item	Tuum Primary School	South Horr Dispensary	Illaut Primary School	Latakweny Dispensary	Marti Primary School	Angata Nanyokei Dispensary
			report submitted to the county b. The MC should explore ways to fund the construction of a bigger charging house for use for shaving	sentiments from customers that the school charging house is too far from the market. b. The MC must then publicize these times to the community. c. Expedite the opening of the bank account	issue of the bank account with the county on the way forward (it is alleged that the county accountant said it is problematic to account for the deposits by the MC into the common bank account)	with possible award of discounts to groups like the policemen c. Institute school policy on shaving of pupils at the charging house	not busy. 2. Continue advertising shaving and phone charging at site

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(2) Condition of PV system (by observation)

No	Name of Room/building	2.1 battery voltage	2.2 inverter	2.3 controller	2.4 Functioning	2.5 Cleanliness & Tidiness by observation
1. Tuum Primary School						
1	Rooms 1-5	26.7	ON – Green	Blinking green	Functions well	Good
2	Staff Room & Room 6-7	26.5	ON – Green	Blinking green	Functions well	Good
3	Room 8-11	27.2	ON – Green	Blinking green	Functions well	Good
4	Office Block	28.5	ON- Green	Blinking green	Functions well	Good
5	Dining Hall & store	28.6	ON- Green	Blinking green	Functions well	Good
6	Girls' dorm	28.8	ON- Green	Blinking green	Functions well	Good
7	Laptop system	53.6	ON- Green	Blinking green	Functions well	Good
8	Charging system	14.6	ON- Green	Blinking green	Functions well	Good
		NB: The charging house leaks when it's raining and drains water through the sockets. It may harm the system				
2. South Horr Dispensary						
1	Staff Quarters	No voltmeter	ON – Green	ON- Solid green	Functions well	Good
2	Charging system	14.0	ON – Green	Blinking green	Functions well	Good
3	Maternity Ward	12.5	ON – Green	Blinking Green &Red (has a problem)	Does not function well	Good
4	Consultation room	13.3	ON- Green	ON- Green	Functions well	Good
5	Vaccine unit	13.4	-	Blinking green	Functions well	Good
		NB: 1. The staff quarter leaks through the solar PV Panels' fasteners when it rains 2. At maternity ward, the system goes off after some time 3. The vaccine unit can't work 24hours on the PV system				
3. Illaut Primary School						
1	Room 1-4	28.4	ON – Green	ON-Solid green	Functions well	Good
2	Room 5-8	28.2	ON – Green	ON-Blinking green	Functions well	Good
3	Office Block	24.5	ON – Green	ON-Solid green	Functions well	Good
4	Staff Quarter	28.1	ON- Green	ON-Blinking green	Functions well	Not Good
5	Boys' Dormitory	26.4	ON- Green	ON-Blinking green	Functions well	Not Good
6	Girls' Dormitory	28.5	ON- Green	ON-Blinking green	Functions well	Good
7	Laptop System	53.6	ON- Green	ON-Blinking green	Functions well	Good
8	Charging System	14.2	ON- Green	ON-Blinking green	Functions well	Good
		NB: Water topping done together with operator and deputy head teacher to some systems				
4. Latakweny Dispensary						

No	Name of Room/building	2.1 battery voltage	2.2 inverter	2.3 controller	2.4 Functioning	2.5 Cleanliness & Tidiness by observation
1	Wards 1-4	26.2	ON – Green	Blinking green	Functions well	Good
2	Wards 1-7	26.0	ON – Green	Blinking green	Functions well	Good
3	Staff Quarters	26.3	ON – Green	Blinking green	Functions well	Good
4	Outpatient Block	26.4	ON- Green	Blinking green	Functions well	Good
5	Charging house	13.1	ON- Green	Blinking green	Functions well	Good
6	Vaccine unit	Working – Green light on. Temperature at 5.8			Functions well	Good
5. Marti Primary School						
1	Nursery	28.6	ON – Green	Blinking green	Functions well	Not Good - Dusty
2	Girls Dormitory 1	28.6	ON – Green	Blinking green	Functions well	Good
3	Girls Dormitory 2	28.7	ON – Green	Blinking green	Functions well	Good
4	Room 1-3 &Office	28.6	ON- Green*	Blinking green	Does not function well	Good
5	Room 4-8	28.6	ON- Green*	Blinking green	Does not function well	Good
6	Room 9-11	28.3	ON- Green*	Blinking green	Does not function well	Good
7	Boys' Dormitory 1	28.7	ON- Green	Blinking green	Functions well	Good
8	Boys' Dormitory 2	28.19	ON- Green	OFF-Not working**	Does not function well	Good
9	Boys' Dormitory 3	28.7	ON- Green	Blinking green	Functions well	Not Good - Dusty
10	Laptop system	53.6	ON- Green	Blinking green	Functions well	Good – System not in use
11	Charging system	13.4	ON- Green	Blinking green	Functions well	Not Good - Dusty
		NB: The charging house leaks when it's raining and drains water through the sockets-May harm the system				
6. Angata Nanyokei Dispensary						
1	Staff Quarters	26.7	ON – Green	ON – Blinking green	Functions well	Good
2	Maternity and Store	26.5	ON – Green	ON – Blinking green	Functions well	Good
3	Charging system	13.4	On – Green	ON – Blinking green	Functions well	Good
4	Vaccine Unit	13.4	DC system- Vaccine temp at 10 (Green light ON)		Functions well	Good
5	Consultation Room	12.8	On - Green	ON – Blinking green	Functions well	Good

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Attachment G-4 Result and Analysis of the Charging Service

G-4-1 Summary of Revenue and Expenditure of the Charging Service

G-4-1-1 Lot 1 Site (after the 5th Monitoring)

Unit: Kshs

Site	Year	Month	Income	Expenditure	Balance	Site	Year	Month	Income	Expenditure	Balance
Ilkilnyeti	2013	Jul/Aug	3,320	4,930	-1,610	Olkinyei	2013	Jul/Aug	200	0	200
		Sep.	2,900	4,400	-1,500			Sep.	1,120	0	1,120
		Oct.	3,580	4,520	-940			Oct.	220	0	220
		Nov.	3,870	4,500	-630			Nov.	830	130	700
		Dec.	3,240	4,460	-1,220			Dec.	160	0	160
	2014	Jan.	2,900	4,000	-1,100		2014	Jan.	0	0	0
		Feb.	0	0	0			Feb.	0	0	0
		Mar.	6,740	3,220	3,520			Mar.	0	0	0
		Apr.	5,980	2,580	3,400			Apr.	0	0	0
		May	5,480	2,300	3,180			May	900	0	900
		Jun.	1,660	3,540	-1,880			Jun.	0	0	0
		Jul.	6,980	2,770	4,210			Jul.	0	0	0
		Aug.	6,320	0	6,320			Aug.	0	0	0
		Sep.	5,860	0	0			Sep.	0	0	0
		Oct.	5,680	0	0			Oct.	0	0	0
	Total		64,510	41,220	11,750		Total		3,430	130	3,300
Iltumtum	2013	JulyAug	9,320	7,310	2,010	Olemoncho	2013	Jul/Aug	2,190	350	1,840
		Sep.	7,930	4,080	3,850			Sep.	2,740	280	2,460
		Oct.	7,570	4,820	2,750			Oct.	1,940	3,350	-1,410
		Nov.	4,540	4,178	362			Nov.	0	0	0
		Dec.	5,550	4,270	1,280			Dec.	0	0	0
	2014	Jan.	7,260	7,580	-320		2014	Jan.	0	0	0
		Feb.	7,850	5,700	2,150			Feb.	0	0	0
		Mar.	10,970	5,420	5,550			Mar.	0	0	0
		Apr.	10,980	4,300	6,680			Apr.	0	0	0
		May	8,430	5,720	2,710			May	0	0	0
		Jun.	0	0	0			Jun.	1,590	400	1,190
		Jul.	8,280	6,030	2,250			Jul.	2,890	1,510	1,380
		Aug.	4,340	0	4,340			Aug.	0	1,910	-1,910
		Sep.	0	0	0			Sep.	0	0	0
		Oct.	0	0	0			Oct.	0	0	0
	Total		93,020	59,408	33,612		Total		11,350	7,800	3,550

Note: Data was not available when the secretary and operator were absent. Olemoncho primary school did not run the charging service from November 2013 to May 2014 due that the head teacher and operator were fired out.

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G-4-1-2 Lot 2 Site (after the 2nd monitoring)

Unit: Kshs

Site	Month in 2014	Income	Expenditure	Balance	Site	Month in 2014	Income	Expenditure	Balance
Tuum	May	180	0	180	Latakweny	May	0	-	
	Jun.	540	0	540		Jun.	775	0	775
	Jul.	900	0	900		Jul.	1,200	0	1,200
	Aug.	n.d.	n.d.			Aug.	n.d.	0	
	Sep.	280	0	0		Sep.	460	0	460
	Oct.	40	0	0		Oct.	830	0	830
	Total	1,940	0	1,620		Total	3,265	0	3,265
South Horr	May	1,690	1,600	90	Marti	May	500	0	500
	Jun.	1,420	1,000	420		Jun.	1,640	0	1,640
	Jul.	1,370	700	670		Jul.	3,380	0	3,380
	Aug.	570	0	570		Aug.	n.d.	0	
	Sep.	1,060	550	480		Sep.	1,930	280	1,650
	Oct.	585	0	585		Oct.	945	40	905
	Total	6,695	3,850	2,815		Total	8,395	320	8,075
Illaut	May	-			Angata	May	500	0	500
	Jun.	330	0	330	Nanyokei	Jun.	n.d.	0	
	Jul.	1,960	0	1,960		Jul.	800	0	800
	Aug.	105	0	105		Aug.	n.d.	0	
	Sep.	255	0	255		Sep.	180	0	180
	Oct.	n.d.	0			Oct.	80	0	80
	Total	2,650	0	2,650		Total	1,560	0	1,560

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G-4-2 Analysis of Charging Service in the Pilot Project

1. Charging service

Charging service is an important tool of sustainable system use at the facility level. It is a component of solar PV system management at facility level and aims at generating income. With this independent financial source, MCs can enhance their experience and skills in fund management and small business, and react more freely to the troubles. Thus, charging service activity gives MCs not only free fund but also an opportunity of strengthening their activities and capacity in social development.

Charging service is carried out using solar PV system installed by REA for this purpose and it is managed by dispensary/school management committee. Income from this service is used by the MC exclusively to pay for immediate needs of system O&M (e.g., repair of clipper, replacement of broken bulbs) and daily administration cost (e.g. distilled water, spirit water, transportation) in order that the management committee can use the solar PV system without dependence on the fixed annual budget such as HSSF and FPEF.

The key issues of charging service are that it is a business activity. Therefore, first of all, it follows demand – supply relationship. If the market is small, the sale is small. Secondly, mobile phone charging has become commodity service and public facility has no advantage. Third, community has no special obligation to pay to it. JET cannot estimate accurately 100% of phone holders come to the service. Also it cannot ask people to change their charging place from private service provider in the community to come to the service being consistent with the JICA environmental and social consideration guideline.

2. Framework of charging service analysis

What factors affect the amount of income from charging service? What size of income is estimated from the results of the pilot project? Does any factor strengthen the stability of the service? What future net value it has? Above all, what is the structure of charging service industry in Kenya? JET examined the factors using a general analytical framework.

JICA expert examined threats and potential opportunity of charging service to find the important factors affecting charging service and ensuring the sustainable income from it. The first basis for analysis of charging

service was that it is a pure business, neither a voluntary work nor welfare; thus, the JICA expert applied Michael Porter's 'five forces analysis,' a well known business analysis tool[1]. She tried to determine competitive intensity and attractiveness of market of the charging service at public facilities in the non-electrified areas by regarding charging service in Kenya as an industry[2].

The five forces include (i) three forces from 'horizontal' competition: the threat of substitute products or services, the threat of established rivals, and the threat of new entrants; and (ii) two forces from 'vertical' competition: the bargaining power of suppliers and the bargaining power of customers (refer to Figure G.1).

Source: Source: Porter, M. E. (1980). Competitive Strategy

Figure G.1 Portesr's Five Force Analysis – Framework

Table G.1 Michael Porter's Five Forces

Force	Explanation	Reality in the charging service	Degree of threats
Threat of substitute produces or service	Existence of products outside of the realm of the common product boundaries increases the propensity of customers to switch to alternatives	There are few specific substitutes for charging service in the non-electrified areas. Recently, M –Kopa, an initiative by Safaricom and other partners to provide lanterns, has enabled numerous households to have access to mobile phone charging devices.	Low-medium
Bargaining power of suppliers	The bargaining power of suppliers is described as the market of inputs. Suppliers of raw materials, components, labor, and services (such as expertise) to the firm can be a source of power over the firm when there are few substitutes.	Charging service does need supply of specific materials except sunshine, distilled water, and spare parts. Most important supplier of the charging service is REA. Thus, bargaining power of suppliers is weak.	Low
Barrier to new entrants	Profitable markets will attract new firms. This results in many new entrants, which eventually will decrease profitability for all firms in the industry. Unless the entry of new firms can be blocked by incumbents, the abnormal	All communities have potential new entrants and new entrants enter the charging service industry especially when the mobile phone network reaches that area. They are small scale business people within the community or in the neighbourhood who use small generator, solar PV system or grid line. Generally saying, the 'first mover advantage' or	Medium

[1] Porter's five forces analysis is a well-known framework to analyze level of competition within an industry and business strategy development. It draws upon industrial organization (IO) economics to derive five forces that determine the competitive intensity and therefore attractiveness of a market. Attractiveness in this context refers to the overall industry profitability. An "unattractive" industry is one in which the combination of these five forces acts to drive down overall profitability. Porter referred to these forces as the micro environment, to contrast it with the more general term macro environment. (Source: http://en.wikipedia.org/wiki/Porter_five_forces_analysis).

[2] 2009 JICA Report did not consider the external condition of the charging service industry in Kenya.

	profit rate will trend towards zero.	starting a new business in the blue ocean is effective for the charging service.	
Bargaining power of customers	The bargaining power of customers is described as the market of outputs: the ability of customers to put the firm under pressure, which also affects the customer's sensitivity to price changes. The buyer power is high if the buyer has many alternatives	Customer's power is very strong for the charging service if there are new entrants and competitors within and near to community. Monitoring results indicate there are two aspects of the customer's power. Demographic factor (population= market size, economic condition), and their preference (wants of purchase). If the number of potential customers is small, the income of charging service is limited to a certain level. Population and income are the most important threats for gaining profitable profit. Customers' preference is more psychological, social and economic matters relating to their daily living life and, therefore, difficult to change.	High
Intensity of competitive rivalry	For most industries the intensity of competitive rivalry is the major determinant of the competitiveness of the industry.	There are competitors, private charging service providers, in many communities where mobile phone network exist. Even service providers in near towns are competitive rivals for charging service at public facilities. Their advantage is not the price but their social and economic relationship with customers that give not only electricity but also social value to customers.	High

Source: Prepared by JET based on "Competitive Strategy"

As mentioned above, such factors as bargaining power of customers and intensity of competitive rivalry highly affect income and attractiveness of the charging service and new entrants affect at medium degree. We should deeply consider these three factors as important. JET examines the actual condition of pilot project sites using these three factors.

3. Bargaining Power of Customers

(1) Demographic factor: population

Market of the charging service (charging of mobile phone, lantern and radio, hair shaving) is firstly defined by the demographic conditions of the surrounding community: market size and income level. Generally market is neighbourhood of facilities, an easy walking distance and estimated a circle within a radius of 5km. Population of the service area of a facility and that of sub-location where a facility is located are bigger than that but the expert supposes that not all of them are potential customers of the charging service because they include towns in terms of administrative boundary and accessibility. As the living space is dispersed in the semi-arid and arid areas in Kenya (the main target of the Model diffusion), population density is very low.

(2) Geographic factor: form of hamlet

The location of facilities is divided into two types: one is that the facility is in or adjacent to a small agglomeration (group of five to twenty houses, where some houses do small scale business) and the other is isolated in the wilderness where near houses are located in the distance of 200m or more each other. Population size of surrounding community depends on this condition. The demographic and geographical data are summarized in Table G.2. Marti and Tuum show planned village form maybe because they are relocated community for refugees.

JICA expert roughly classifies these communities into (A) more than 50 households with house agglomeration, and (B) 50 or less than 50 households without house agglomeration, and (C) others. It is obvious the sales from

charging service increases as the market size increases if other conditions are ignored. Five pilot project sites (Ilkilnyeti, Olkinyei, Marti, South Horr and Tuum) are type (A) and four sites (Iltumtum, Olemoncho, Latakweny, and Illaut) are type (B). Only Angata Nanyokei that is located in the hilly area with relatively high rain fall is classified as type (C).

Table G.2 Types of Demographic and Geographic Variables of the Pilot Project Sites

Lot I Site	Ilkilnyeti	Iltumtum	Olkinyei	Olemoncho
Surrounding community (est.)	80 (25 are in the centre, 1km from the dispensary)	27+	50 (20 are in the centre, 300m from the dispensary)	50
Location	Existence of village centre	Dispersed	Existence of village center	Dispersed 5km from Aitong Town

Lot II Site	Angata Nanyokie	Marti	Latakweny	Illaut	South Horr	Tuum
Surrounding community (est.)	80	100+ (80+ are in the centre, beside the school)	40	40	20 (2.5km from town)	100+ (80 are in the center beside the school)
Location	Moderately dispersed	Existing of village centre relocated village	Dispersed	Dispersed	Dispersed but town is at 2.5km	Existing of village centre relocated village?

Note: number of households is estimate

Source: Results of baseline survey

(3) Economic factor: income

The target of the model defusing is the ten counties where Laptop Project applies solar PV system. As explained in Progress Report II (2.7.1) and IV (2.7.1), these counties are classified as the most vulnerable counties in Kenya with their low income and social development comparing with Narok and Kajiado counties. Government and private investment has been scarcely implemented. Thus, sales from charging service are supposedly relatively low.

(4) Social or human factor: Customer's preference

This is a social, economic and also psychological factor that affects sales of charging service. As American Marketing Association (2013) mentions, "marketing is the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners and the society at large". Marketing, or more widely sales of goods and services, is the activity relating to value. For inhabitants of the non-electrified areas, the value of charging service is charging itself, but also it guarantees, tightens or creates deep relation with the provider. As the charging service itself is a commodity service, customers prefer the service with additional value. This is the reason why many people in Lot I sites choose private charging service providers rather than public facilities. As their providers are relatives, friends, or business partners, they make tight the relationship by charging mobile phone there. This threat links to the intensity of competitive rivalry.

4. Intensity of Competitive Rivalry

Private service provider is one of the competitors where mobile phone network exists. Charging provider largely depends on the existence of mobile phone network, but people who live in the communities without network are also using mobile phones: they use phones in towns at weekly market day or going to the point where they receive the wave. Adding to this, if inhabitants start charging service when the network will be received there in the near future. It is the new entrant force who threatens the charging service of public facility. Also, electric appliances, e.g. rechargeable solar lantern with charging socket, are substitute products because many of them have charging sockets.

Table G.3 Competitive Rivalry in the Pilot Project Sites

Lot I Site	Ilkilnyeti	Iltumtum	Olkinyei	Olemoncho
Competitors inside and within 5km radius	A few number of private providers in surrounding community	No providers in the surrounding community	A few number of private providers in surrounding community	No providers in the surrounding community
Other competitor	Emali Town, most households in Ilkilnyeti go there on the Friday market	Narok city (around 22km)		Aitong town (around 5km)
Competition	Strong	Low	Strong	Low

Lot II Site	Tuum	South Horr	Illaut	Latakweny	Marti	Angata Nanyokei
Competitors inside and within 5km radius	A few people started and plan to start charging service because mobile phone network comes soon.	Number of providers in South Horr town (2.5k)	No providers in the surrounding community	No providers in the surrounding community	A few people started and plan to start charging service because mobile phone network comes soon.	No providers in the surrounding community
Other competitor	South Horr, Baragoi		Baragoi, South Horr	Baragoi	Maralal, Baragoi	Maralal
Competition	Medium	High	Low	Low	Strong	Low

Prepared by JET

Other electric appliances that can charge small electric appliances are other competitors. Solar lanterns (rechargeable lanterns) is regarded as one of the effective income sources of charging service but it is also competitive because its most attractive sales point is “can be used in non-electrified areas.” Also, car batteries have the same kind of risk. There are many solar lantern manufacturers-sellers in Kenya and some of them go into non-electrified rural areas. Power Point, the contractor of Lot 2 PV system installation, is one and has already promoted their solar lantern in some sites. This threat may happen in entire non-electrified areas.

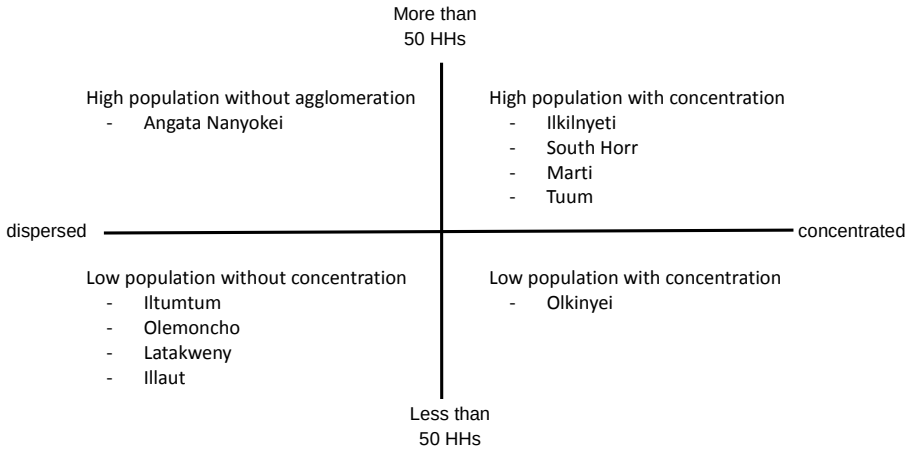
5. Classification and estimate of proceeds

At Step 1, all pilot project sites are classified by estimate number of households (more than 50 or less than 50 estimate) and village form (dispersed and concentrated or having core area). As a result they are mainly divided into two types, relatively large number of households with concentrated village core and smaller number of households without agglomeration.

At step 2, factor of competitive rivalry is added to the step 1 classification.

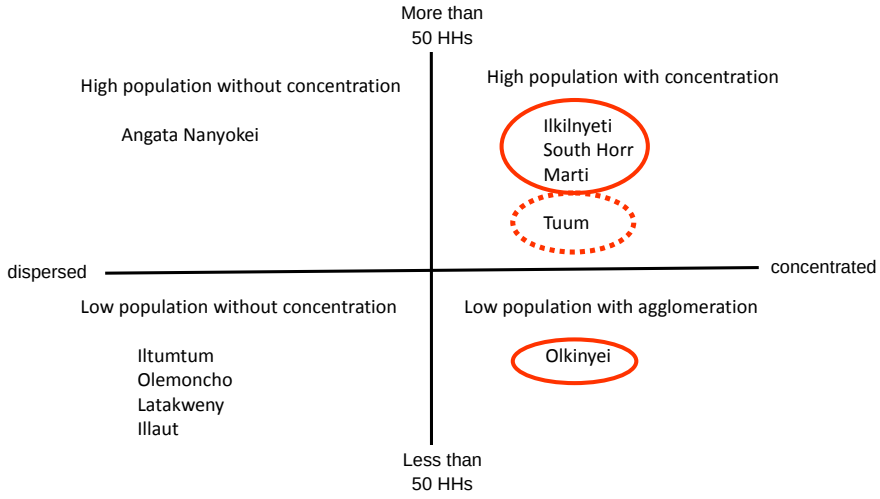
It is obvious that the communities with relatively high number of households with centralization (core) have high potential of competitive rivalry of charging. This figure shows that the strong relation between core and rivalling charging business, which indicates that concentrated areas and commercial activities relate each other (concentrated areas are used for doing activities other than pastoral activities). Also, high rivalry means there is high potential of demand for charging service. If charging service at public facilities starts prior to these rivals, it may have more possibility of earning income as first mover advantage, though social and individual factor intervenes every time. Note that Tuum has no phone network at this moment but inhabitants said that Safaricom would install network tower soon because this community is located at a strategic point for security.

At step 3, sales from charging service is identified for each category based on the result of the pilot project. As electrification of public facilities using solar PV system targets in remote areas, less developed counties, only the data of Lot 2 is appropriate and is applicable here. Some Lot 2 sites started charging service in May 2014 while others in June. Facilities located in or near to concentrated core have potential to earn more than Ksh 1,000 per month in the moderate case (average). If the network comes, even communities located in dispersed areas have potential to earn more than now with the “Blue Ocean” effect. Hair shaving is important source both for dispensary and primary school.



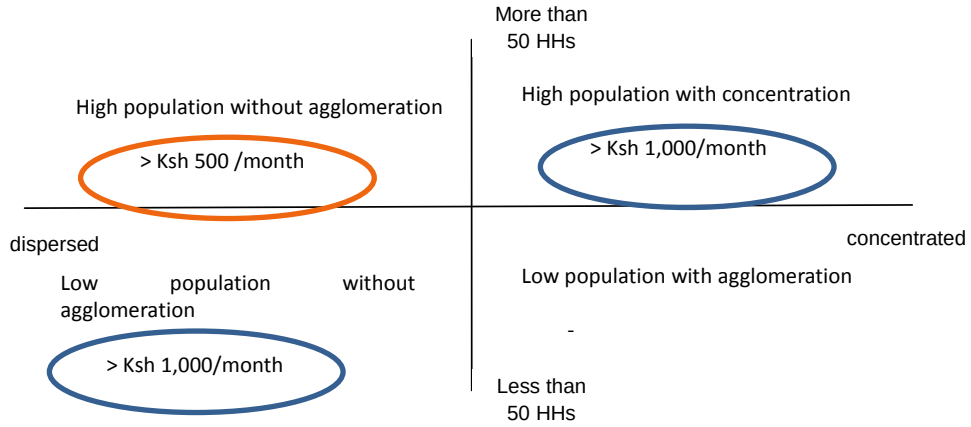
Source: JET based on the result of monitoring and observation

Figure G.2 Classification by Demography and Village Form



Source: JET based on the result of monitoring and observation

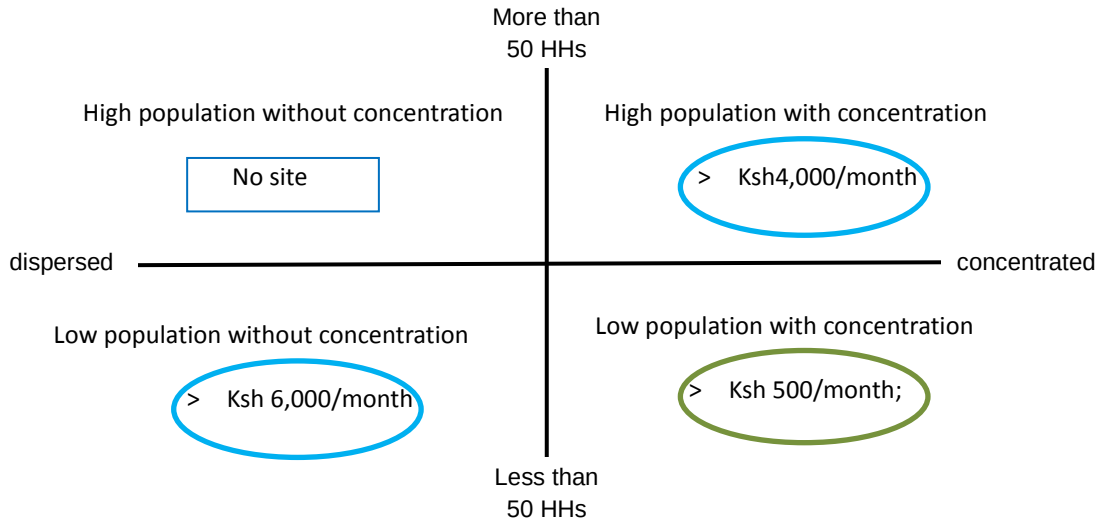
Figure G.3 Factor of Competitive Rivalry Added



Source: JET based on the result of monitoring and observation

Figure G.4 Sales of Charging Service in Lot 2 Sites by Type (Moderate Case)

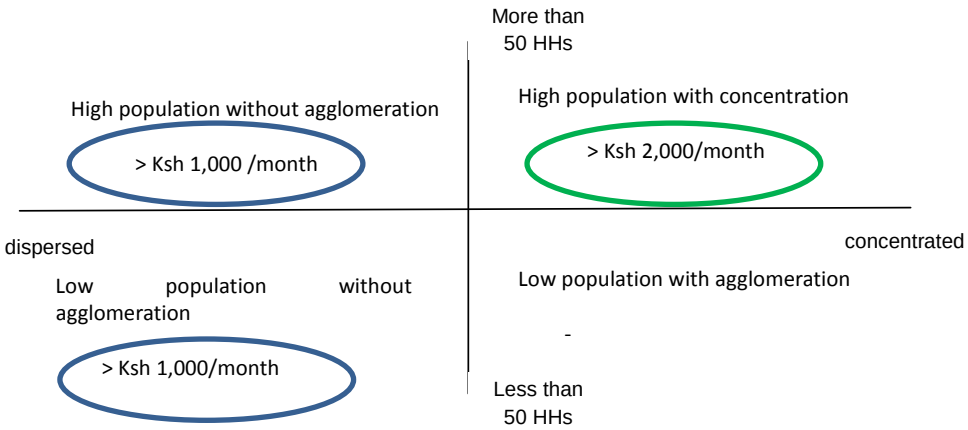
When the sales of Ilkilnyeti, only one Lot 1 site of concentrated form having reliable charging sales data, is considered, the moderate case of high population with concentration increases to Ksh3,000+. Also, if the sales of Iltumtum, only one Lot1 site of dispersed form having reliable charging sales data, are considered, the moderate case of low population with dispersed form increases to Ksh 5,000+. The business at Iltumtum Primary School is remarkably good because it is located near Narok city and its economic condition is relatively high, but as mentioned above, it may not be the situation of entire target area.



Source: JET based on the result of monitoring and observation

Figure G.5 Sales of Charging Service in Lot 1 Sites by Location Type (Moderate Case)

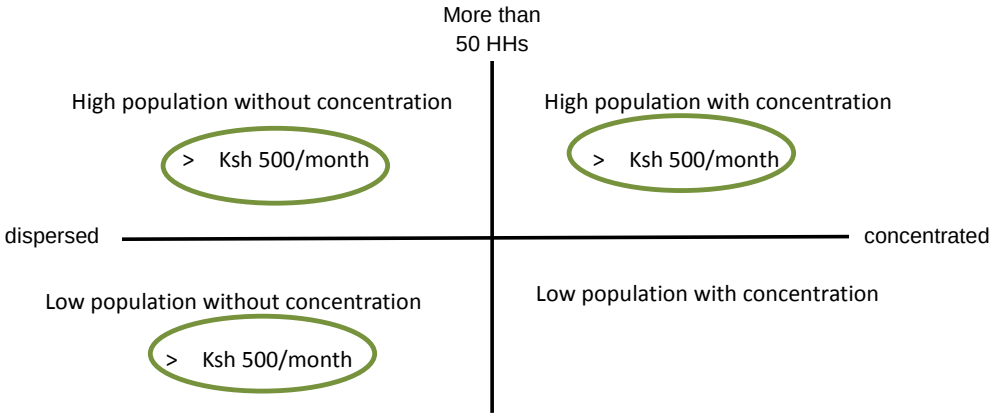
Sales exceed Ksh 1,000 per month for all sites at optimal case (largest monthly income). If MC does promotion of the charging service it is possible to keep this level.



Source: JET based on the result of monitoring and observation

Figure G.6 Sales of Charging Service in Lot 2 Sites by Location Type (Optimal Case)

Following is the pessimistic case (lowest monthly income) but it is not supposed to occur often because this case occurred only the first few months when inhabitants did not know the service.



Source: JET based on the result of monitoring and observation

Figure G.7 Sales of Charging Service in Lot 2 Sites by Location Type (Pessimistic Case)

6. Other Factors Found in the Pilot Project

It must be remarked that all the five forces of Michael Porter are external factors that determine profitability of an industry and that we can observe and measure. Each facility has own conditions, relating to bargaining power of customers and competitive rivalry of the Porter's framework, that affect business profitability inside the facility and in neighbourhood. One is the management, the second is customer's preference and the third is the first mover advantage. Result of monitoring of the pilot project indicates each site has such internal problems as: lack of direction of MC (Olemoncho), lack of motivation or personal limitation of MC and operator (Ilkilnyeti, Olkinyei). An extreme example was embezzlement (Olemoncho). Management control is indispensable for each facility and facility management committee to ensure the income from charging service.

Result of monitoring also indicates that the inhabitants living in neighbourhood of the target facilities go to the charging service providers who are friends or relatives, because they want to strengthen their relationship by frequenting them for charging. Here we must consider two different concepts 'needs' and 'wants' when we think of customer of the charging service. 'Needs' mean a state that is not satisfied and customers take action to solve this problem (i.e. to charge mobile phone). 'Wants' mean a desire to get larger satisfaction than current state of satisfaction. Customers choose the place of charging in order to strengthen social relationship with friends, relatives, and business partners. The monitoring result meets this concept clearly. Thus, new entrant to existing charging service market is not easy for public facilities if the private service providers have been already established. Though public facility cannot relocate itself to increase the revenue from charging business, it seems preferable condition if it is located in the place who has plan of phone network but it has not reached and no rivals started charging service. It is called blue ocean condition of business.

7. Lessons Learnt from the Pilot Project Regarding Charging Service

Applying the five forces framework of M. Porter to the result of monitoring of Lot 2 sites, public facility can get sale more than Ksh 1,000 per month if it is located near to concentrated core and network. It may be possible to earn Ksh 4,000 per month if network is available and only a few private providers are available. Even in case of dispersed condition without network, charging service get income from hair shaving and radio charging. However, managerial responsibility and wants of customer are other factors that determine proceeds of the charging service. Reflecting these discussions, JICA expert recommend the *blue ocean* condition at the place with concentrated population.

G-4-3 Rationales for Charging Service

1. Benefit of the Charging Service

Charging service is an important tool of sustainable system use at the facility level. With this independent financial source, MCs can enhance their experience and skills in fund management and small business, and react more freely to the troubles. Charging service is carried out using solar PV system installed by REA for this purpose and it is managed by dispensary/school MC. Income from this service is used by the MC exclusively to

pay for immediate needs of system O&M (e.g., repair of clipper, replacement of broken bulbs) and daily administration cost (e.g. distilled water, spirit water, transportation) in order that the management committee can use the solar PV system without dependence on the fixed annual budget such as HSSF and FPEF. Thus, from user's point of view, charging service activity gives MCs not only free funds but also an opportunity of strengthening their activities and capacity in social development.

The author of the 2009 JICA Report author estimated that the revenue from the charging service was enough to cover all the necessary expenditure relating to the O&M of solar PV system. He expected that the revenue could cover not only salary of operator and payment to MC members, but also purchase of cables and terminals and replacement of batteries and controllers. However, as mentioned in Progress Reports and Project Completion Report, JET found it was not enough and the Report did not consider the demand (customer) side. On the other hand, as mentioned above, the revenue gives value to MCs to conduct self reliant activities and will strengthen their capacity in management.

2 Minimal Conditions for the Charging Service

(1) Comparison of cost and proceeds

As the target facilities are public, it is under owner's responsibility to replace batteries, inverters and controllers and administration (O&M); however, JET proposes facilities should obtain certain amount of fund to deal with system down and other necessities that suddenly occur, even the amount does not fully cover them, and should raise their capacity of fund management for future social development of rural communities. Also, JICA expert thinks the income from charging service should be above the initial investment, that is, construction cost of charging kit: solar PV system for charging service and charging hut. Then, she tried to find to what extent the revenue can cover and is valuable. Questions are:

Case A: Does the revenue cover the initial investment of the charging service kit?

⇒ If yes, REA has meaning to start charging service and target facility gets benefit.

Case B: Does the revenue cover the initial investment of the charging service kit and daily O&M cost?

⇒ If yes, REA contributes facility, target facility gets benefit for O&M and its MC gets opportunity for their future social development.

JICA expert estimated the initial investment (installation of charging kit) and O&M of the charging service using the data of bidding document and the financial model: the least amount of monthly proceeds is Ksh 1,120 to cover the initial investment. It indicates that charging service of a facility does not generate loss if the proceeds from charging service are moderate case (case of Marti Primary School). These facilities will be the priority ones for dissemination of the Model and charging service in future. However, there are few facilities to cover both initial investment and O&M cost (refer to Table G.4).

Table G.4 Least Amount of Annual Revenue

Ksh/year (Ksh/month)

Estimated amount of money (Ksh/year)					
Item	Construction of charging kit[3] (a)	O&M cost(b)		Initial investment & O&M (a)+(b)	
		Dispensary	Primary school	Dispensary	Primary school
Estimate	13,433	28,800	45,600	42,233	59,033
Least amount of money for cover					
Case A	13,433 (1,120)				
Case B				42,233 (3,600)	59,033 (5,000)

Prepared by JET

Next question is what condition should be met to earn this income? JICA expert classified public facilities using the monitoring result from geographical point of view (households and population concentration). For understanding more concrete conditions from social and business point of view, she reconsidered the five forces that determine profitability of industry to define the social conditions that generate Ksh 1,100 per month in the moderate case. As Table G.1 shows, Bargaining power of customers and Intensity of competitive rivalry both seriously affect the proceeds of the charging service but also risk of substitutes and new entrants should not underestimate. The expert applied Bargaining power to analyze external condition of the charging service by matrix of geographical conditions and she applies intensity of competitive rivalry together with new entrants and substitute for determining target facilities that will cover at least initial investment at this stage. All these factors mean that (i) there are a lot of private service providers as rivalries with public facility, (ii) when mobile phone network comes, new entrants start their business, and (iii) there are a few substitutes for charging service.

It must be noted again that payment for initial cost is NOT required to the facility but the JICA expert applied it to examine if REA invested only for waste or for meaningful social development.

Then, what strategy is feasible and applicable to this situation? As customers go to charge their phone as their wants that meet particular customer's particular needs, which is difficult for public facilities. One strategy is to coexist with these rivals and substitutes and the second is start earlier than rivals to catch the customer's needs and make them customer's wants. Thus, the potential facilities are:

Adding to the abovementioned geographical conditions:

(i) more than fifty households within a radius of five kilo meters:

(ii) concentration of houses near to the facility

More social and business factors should be considered such as:

(iii) where mobile phone network will come soon (Safaricom or other companies announced network extension and started construction of network system);

(iv) M-Kopa and other power generation supported by other donors or NGOs usable for charging service have not or not widely spread yet.

Current situation of Lot 2 sites regarding these conditions are shown Table G.5.

[3] Construction cost of charging kit divided by twenty, price escalation is not included.

Table G.5 Reconsideration of geographical and social condition of the Lot 2 sites

Lot II Site	Tuum	South Horr	Illaut	Latakweny	Marti	Angata Nanyokei
HHs in 5km	50HHs +	50HHs +	50HHs -	- 50HHs -	50HHs + but decreased due to drought	50HHs +
Concentration (core)	Concentrated	Concentrated	dispersed	Dispersed	Concentrated	dispersed
Mobile phone network	no	Yes	No	No	Soon Early 2015	no
Existing competition	A few people started and plan to start charging service because mobile phone network comes soon.	Number of providers in South Horr town (2.5km)	No providers in the surrounding community	No providers in the surrounding community	A few people started and plan to start charging service because mobile phone network will come soon.	No providers in the surrounding community
Substitutes Solar PV, M-Kopa etc.	-	M-Kopa is sold to many households	-	-	PV systems at Marti center and many private service providers	Some households have M-Kopa
Internal problems	Due to no comepetent operator, charging house remains closed.	Security	No reliable operator	No reliable operator	-	-
May-Sep. 2014 sales	Ksh/month 475	Ksh/month 1,385	Ksh/month 848	Ksh/month 691	Ksh/month 1,904	Ksh/month 493

Source: Prepared by JET

By referring to the result of the pilot project in Lot 2 sites, JICA expert extracted lessons for the relation among external/geographical condition, existing of competition and substitutes and sales from charging service. There were some constraints to the charging service in Lot 2 site: monitoring period was six months only, solar PV system of Lot 2 sites was not in good condition due to low capacity of the contractor, and the system was repaired during August to September in 2014. The proceeds identified in the 2nd monitoring were not from full service condition and threats of rivalries and substitutes have increased day by day. Under this condition, South Horr and Marti got sales much enough to cover the initial investment and some amount of daily O&M cost. Based on these facts, the most favourable condition for the charging service that can cover the initial investment cost is:

(i) A facility inside or very near to an agglomeration of houses more,
(ii) More than 50 households in five kilometers radius,
(iii) Mobile phone network will come soon, and
(iv) If a public facility starts charging service before private service providers and M-Kopa come to the neighbourhood, the facility may enjoy the first mover advantage and earn Ksh 1,000 to 2,000 every month.

This is the estimated condition of feasible charging service at public facilities where the facility and MC get a certain amount of O&M cost and REA will not waste their budget for construction of charging service and the budget will enhance the experience of facility staff and MC members in self-reliant financial management.

REA and relevant ministries shall survey these factors when they start planning and before detailed design of electrification by solar PV system with charging service.

Attachment H Materials for Solar PV System (Financial Part)

Attachment H-1 Financial Training

Attachment H-2 Applied Accounting Formats

Attachment H-3 Copy of the Monthly Report Submitted to County Offices

Attachment H-4 Summary of Charging Service Operation and Accounting Activities

Attachment H-5 Sample Calculation by Financial Model

Attachment H-1 Financial Training

H-1-1 Summary of the 1st Financial Training

Item	Description			
a) Objective Persons	Community chief, MC members, operator to be appointed			
b) Contents	i. Orientation of the project · Benefits from the solar PV system and obligations as the beneficiaries · Necessity to organize the MC to manage to use the PV system · Necessity of O&M and replacement cost for sustainable use of the PV system · Necessity of funds for O&M and replacement cost · Charging service and charging fee ii. Explanation of accounting procedure and responsibility of key persons iii. Comprehensive lessons of bookkeeping, cash management and reporting · Presentation and lecture for introduction and guidance · Practice drill training using accounting books			
c) Training Date	Lot 1 Facility	Date	Lot 2 Facility	Date
	Ilkilnyeti Dispensary	13 & 14 May 2013	Tuum Primary School	19 & 20 Apr. 2014
	Iltumtum Primary School	6 & 7 May 2013	South Horr Dispensary	30 Apr. & 1 May 2014
	Olkinyei Dispensary	9 & 10 May 2013	Illaut Primary School	28 & 29 Apr. 2014
	Olemoncho Primary School	2 – 4 May 2013	Latakweny Dispensary	22 & 23 Apr. 2014
	Meto Dispensary	16 – 17 May 2013	Marti Dispensary	17 & 21 Apr. 2014
			Angata Nanyokei Dispensary	5 & 6 May 2014

Note: Meto Dispensary was cancelled in July 2013, just before the installation works, due to decision of grid extension.

Prepared by JET

H-1-2 Summary of the 2nd Financial Training

Item	Description			
a) Objective Persons	Chairman, Treasurer, Secretary (Head nurse/Head teacher), Operator, and others.			
b) Contents	i. Quick review of the comprehensive lessons delivered at the first training before the installation (bookkeeping, cash management and reporting) ii. Question and answer for what are the troubles and difficulties since the starting including the following checking: · Balance of cash/bank account and cash book · Contents of Daily Business Record and Cash Book iii. To focus on the preparation of the monthly report to be submitted to the county offices iv. Special lecture to the personnel change.			
c) Training Date	Lot 1 Facility	Date	Lot 2 Facility	Date
	Ilkilnyeti Dispensary	30 July 2013	Tuum Primary School	26 Sep. 2014
	Iltumtum Primary School	17 July 2013	South Horr Dispensary	29 Sep. 2014
	Olkinyei Dispensary	18 July 2013	Illaut Primary School	30 Sep. 2014
	Olemoncho Primary School	19 July 2013	Latakweny Dispensary	25 Sep. 2014
			Marti Dispensary	24 Sep. 2014
			Angata Nanyokei Dispensary	23 Sep. 2014

Prepared by JET

Attachment H-2 Revised Accounting Formats

H-2-1 Daily Business Record

Daily Business Record of _____ Dispensary / Primary School

Sheet Number				
Date			**Weather**	
No.	**Name of Customer**	**Type of appliance ***	**Amount (KSh.)**	**Comment/ Remarks/ Complaints** e.g. customer misplaced receipt
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				
20.				
21.				
22.				
23.				
24.				
25.				
Daily Total		Phone: Lantern: Battery: Clippers: Other (Hair cut etc.):		
Daily Totals checked by: _____ **signature: _____**				
* Type of appliance: mobile phone, LED lantern, rechargeable battery, hair clippers, other (specify)				

The treasurer gives a number to the sheet and issues this sheet to the secretary who issues it to the operator. At the end of the day, the operator returns the sheet to the treasurer who verifies the cash collected against this sheet.
When the number of customers exceeds 25 persons, continue recording on the Sheet 2 and input the daily total at the bottom of Sheet 2.

H-2-2 Sales Receipt

CASH SALERECEIPT			No.
Name of Customer			**Dispensary/ School**
	P.O. BOX		
Mobile phone:	**DATE: / /**		
No.	**DESCRIPTIONOFMOBILE/LANTERN etc.**		**AMOUNT(Ksh)**
		Total	
Received by:	**Signature:**		

H-2-3 Cash Book

CASH BOOK FOR ILKILNYETI DISPESANRY

Month/Year			**Sheet No.**		
Date	**Revenues**		**Expenses**		**Balance (KSh.)**
	Item	**Amount (KSh.)**	**Item**	**Amount (KSh.)**	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
Monthly Total					
Monthly Totals **Checked by: _____** **signature: _____**					

The Cash book is kept by the treasurer who makes entries.

H-2-4 Monthly Record

MONTHLY REPORT OF ILKILNYETI DISPENSARY

Month/Year		**Sheet No.**	
Income in the month (KSh.)		**Expenditure in the month (KSh.)**	
Cash Balance last Month (a)		1. Operation cost	
1. Revenue from charging service (b)			
2. Other revenues:			
		(5) Miscellaneous	
Sub-total (c)		Sub-total (e)	
3. Withdrawals from Bank		2. Maintenance cost	
Date			
Date			
Date			
Sub-total (d)		Sub-total (f)	
		3. Administration cost	
		- transportation	
		- committee expenses	
		meeting expenses	
		bank charge	
		others	
		Sub-total (g)	
		5. Deposit to bank (h)	
Cash Income Total (a)+(b)+(c)+(d)		**Cash Expenditure Total** (e)+(f)+(g)+(h)	
Balance (Cash income carried forward)		Ksh	

BANK CONTROL	Unit: Ksh		
Balance in last month		Withdrawals in this month (d)	
Deposit in this month (h)			
Deposit Total		**Withdrawals Total**	
Balance (Cash income carried forward)		KSh.	

Attachment H-3 Copy of the Monthly Report Submitted to County Offices

H-3-1 Lot 1 facilities

(1) Ilkilnyeti Dispensary

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: *ILKILNYETI DISPENSARY*

Date of Submission: 25/2/14

To the Director of Medical Services, Kajiado County

Thro':

The MoH, Kajiado Central Sub-County

The management committee of Ilkilnyeti Dispensary, Kajiado Central Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of January 2014

Operator

Chairperson, Management Committee

Head Nurse

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

(Ilkilnyeti Dispensary)

10. **Existence of Daily O&M Record:** ☐ Yes ☐ Sometimes ☐ Not at all

11. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Main Treatment Room	3 hrs	☑Excellent ☐Problem	—
2	Refrigeration Store	12 hrs	☑Excellent ☑Problem	Fridge consuming most of power
3	Sub-consultation Room	Security	☑Excellent ☐Problem	—
4	Staff Quarter	5 hrs	☑Excellent ☐Problem	—
5	Charging System Room	8 hrs	☑Excellent ☐Problem	—
6	Security lights	12 hrs	☑Excellent ☐Problem	—
10				

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights
Note: n.d. = no data

12. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

(1) Refrigerator unit – Current was Fitted Alone for 24hrs

(2) Salary for Operator – not Granted Monthly Kshs. 10 Day

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF *ILKILNYETI DISPENSARY*

Month/Year: January 2014 Sheet No.: ___

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	(5900)	1. Operation cost	
1. Revenue from charging service (b)	2900	(1) Salary	4000
2. Other revenues:	—	(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	—	Sub-total (e)	4000
3. Withdrawals from Bank	—	2. Maintenance cost	—
Date	—		
Date	—		
Date	—		
Sub - total (d)	—	Sub-total (f)	—
		3. Administration cost	
		- transportation	—
		- committee expenses	—
		- meeting expenses	—
		- bank charge	—
		- others	—
		Sub-total (g)	—
		5. Deposit to bank (h)	—
Cash Income Total (a)+(b)+(c)+(d)	(3000)	**Cash Expenditure Total** (e)+(f)+(g)+(h)	4000
Balance (Cash income carried forward)		Ksh	

BANK CONTROL		Unit: Ksh	
Balance in last month	—	Withdrawals in this month	— (d)
Deposit in this month	— (b)		
Deposit Total	—	**Withdrawals Total**	—
Balance (Cash income carried forward)		Ksh	(7000)

(2) Iltumtum Primary School

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya

Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: *ILTUMTUM PRIMARY SCHOOL*

Date of Submission: 7/3/14

To the County Director of Education, Narok County

Thro':

The DEO, Narok North Sub-County

The management committee of Iltumtum Primary School, Narok North Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of FEBRUARY 2014

Operator

Chairperson, Management Committee

Head Teacher

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya

Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF ILTUMTUM PRIMARY SCHOOL

Month/Year: FEBRUARY 2014 Sheet No. : ____

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	450	1. Operation cost	
1. Revenue from charging service (b)		(1) Salary	4,000
2. Other revenues:	7,850	(2) Murray	700
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	11,530	Sub-total (e)	4,700
3. Withdrawals from Bank		2. Maintenance cost	
Date			
Date			
Date			
Sub - total (d)		Sub-total (f)	—
		3. Administration cost	
		- transportation	
		- committee expenses	500
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	500
		5. Deposit to bank (h)	5,430
Cash Income Total (a)+(b)+(c)+(d)	11,530	**Cash Expenditure Total** (e)+(f)+(g)+(h)	10,630
Balance (Cash income carried forward)		Ksh	900
BANK CONTROL		Unit: Ksh	
Balance in last month	6652	Withdrawals in this month	(d)
Deposit in this month	5430		
Deposit Total	12082	**Withdrawals Total**	
Balance (Cash income carried forward)		Ksh	12,082

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya

Operation & Maintenance and Financial Monthly Report

Iltumtum Primary School

1. **Existence of Daily O&M Record:** ✓ **Yes** ☐ **Sometimes** ☐ **Not at all**

2. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Classes 1 – 3	7:00pm – 9:00pm 5:30am – 6:30am	☐Excellent ☐Problem	Technical problem
2	Classes 4 – 8	〃	☑Excellent ☐Problem	
3	Dining Hall	7:00pm – 7:30pm Sat 7:00pm – 9:00pm	☐Excellent ☑Problem	two security lights not working.
4	Girls' Dormitory	9:00pm – 9:00pm 4:30am – 6:30am	☑Excellent ☐Problem	
5	Boys' Dormitory	〃	☐Excellent ☐Problem	
6	Staff Quarter 1 – 4	7:00pm – 10:00pm	☑Excellent ☐Problem	
7	Staff quarter 5 – 10	〃	☐Excellent ☐Problem	
8	Charging system	8:00am – 6:00pm	☑Excellent ☐Problem	
9	Security lights	7:00pm – 6:00am	☐Excellent ☑Problem	two security lights – Dining Hall
10				

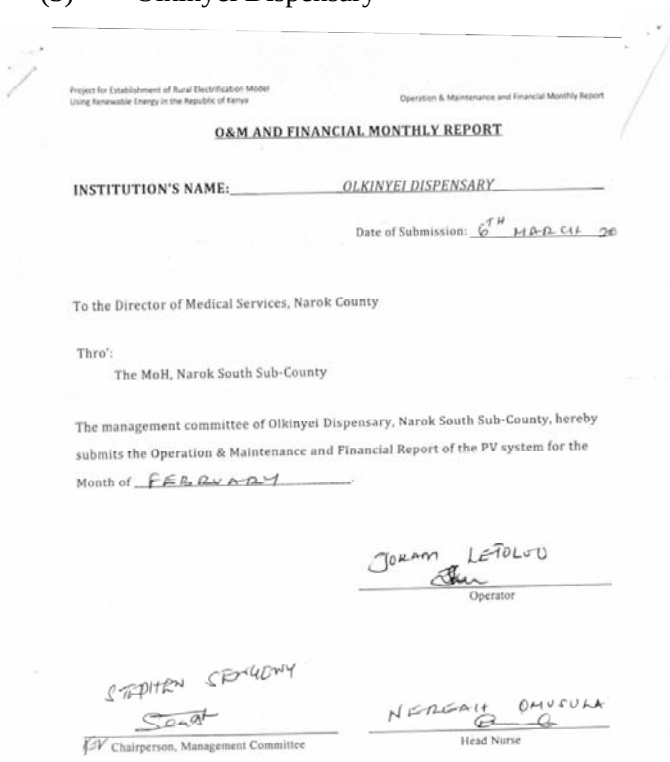
*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights

Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

(3) Olkinyei Dispensary



Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: OLKINYEI DISPENSARY

Date of Submission: 6TH MARCH 20

To the Director of Medical Services, Narok County

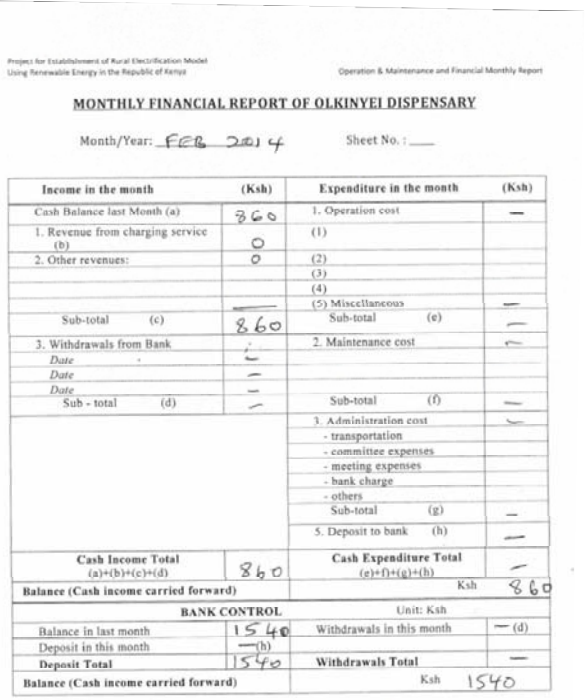
Thro':
The MoH, Narok South Sub-County

The management committee of Olkinyei Dispensary, Narok South Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of FEBRUARY.

JORAM LETOLOO
Operator

STEPHEN SEMENY SOMAT
Chairperson, Management Committee

NEREGAIT OMUSULA
Head Nurse



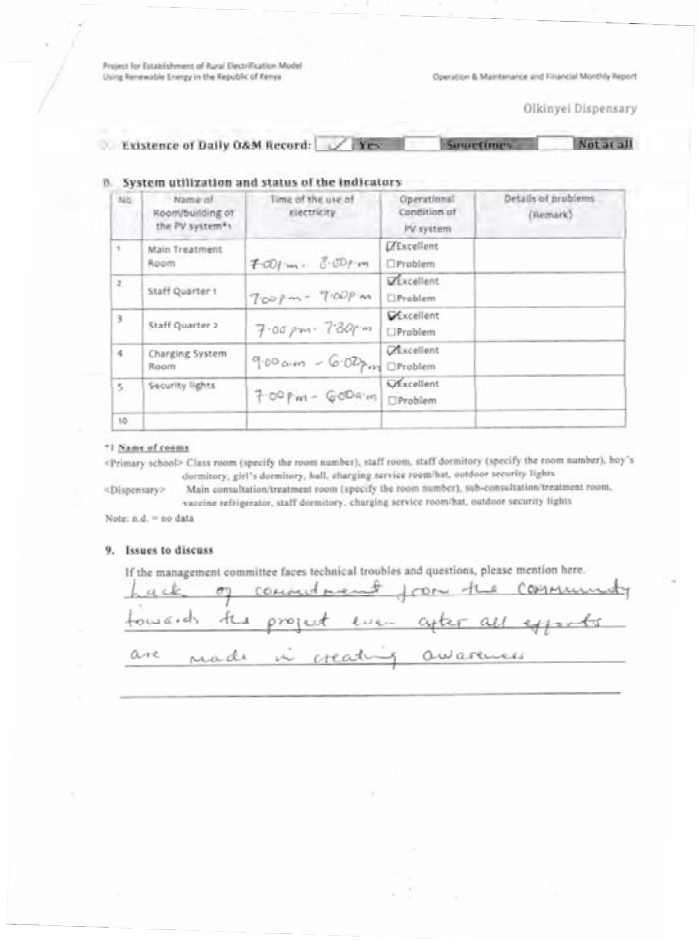
Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF OLKINYEI DISPENSARY

Month/Year: FEB 2014 Sheet No. :

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	860	1. Operation cost	—
1. Revenue from charging service (b)	0	(1)	
2. Other revenues:	0	(2)	
		(3)	
		(4)	
		(5) Miscellaneous	—
Sub-total (c)	860	Sub-total (e)	—
3. Withdrawals from Bank		2. Maintenance cost	—
Date	—		
Date	—		
Date	—		
Sub - total (d)	—	Sub-total (f)	—
		3. Administration cost	—
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	—
		5. Deposit to bank (h)	—
Cash Income Total (a)+(b)+(c)+(d)	860	**Cash Expenditure Total** (e)+(f)+(g)+(h)	—
Balance (Cash income carried forward)		Ksh	860

BANK CONTROL		Unit: Ksh	
Balance in last month	1540	Withdrawals in this month	— (d)
Deposit in this month	—(h)		
Deposit Total	1540	**Withdrawals Total**	—
Balance (Cash income carried forward)		Ksh	1540



Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

Olkinyei Dispensary

8. **Existence of Daily O&M Record:** ☑ Yes ☐ Sometimes ☐ Not at all

9. **System utilization and status of the indicators**

NO.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Main Treatment Room	7:00pm - 8:00pm	☑Excellent ☐Problem	
2	Staff Quarter 1	7:00pm - 9:00pm	☑Excellent ☐Problem	
3	Staff Quarter 3	7:00pm - 7:30pm	☑Excellent ☐Problem	
4	Charging System Room	9:00am - 6:00pm	☑Excellent ☐Problem	
5	Security lights	7:00pm - 6:00am	☑Excellent ☐Problem	
10				

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hat, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hat, outdoor security lights
Note: n.d. = no data

9. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.
Lack of commitment from the community towards the project even after all efforts are made in creating awareness

(4) Olemoncho Primary School

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: OLEMONCHO PRIMARY SCHOOL

Date of Submission: 28/1/2015

To the County Director of EDUCATION NAROK County

Thro':
The DEO NAROK SOUTH Sub-County

The management committee of OLEMONCHO PRI-SCH Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of JANUARY

JANE NKOITOI
Operator

KENNEDY NKOITOI
Chairperson, Management Committee

JOSEPH MARIRU
Head of Institution

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF OLEMONCHO PRI-SCH

Month/Year: January 2015 — Sheet No.: ___

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	6040	1. Operation cost (Electricity bill)	3440
1. Revenue from charging service (b)	1120	(1) Spirit	200
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	7210	Sub-total (e)	
3. Withdrawals from Bank		2. Maintenance cost	
Date	0	Head Cutty machine repair	1370
Date	0		
Date			
Sub - total (d)	0	Sub-total (f)	
		3. Administration cost	
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	
		5. Deposit to bank (b)	500
Cash Income Total (a)+(b)+(c)+(d)		**Cash Expenditure Total** (e)+f)+(g)+(h)	5810
Balance (Cash income carried forward)		Ksh	1400

BANK CONTROL	Unit: Ksh (illegible)		
Balance in last month	500	Withdrawals in this month (d)	0
Deposit in this month (b)	0		
Deposit Total	500	**Withdrawals Total**	0
Balance (Cash income carried forward)		Ksh	500

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☐ Yes ☐ Sometimes ☑ Not at All

2. **System utilization and status of the indicators**

No.	Name of Room/Building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Staff Quarters	7:00-9:00 PM	☐Excellent ☑Problem	Inverter problem
2	Charging room	7:00AM-7:00PM	☑Excellent ☐Problem	Nil
3	Nursery-1st	7:00-9:00 AM	☑Excellent ☐Problem	Nil
4	Staff Quarters	7:00-9:00PM	☑Excellent ☐Problem	Nil
5	Staff room/ 2-4 class	7:00PM-9:00PM	☑Excellent ☐Problem	Nil
6	Class 5-7	7:00PM-9:00PM	☑Excellent ☐Problem	Nil
7	class (6-8)	7:00PM-9:00PM	☑Excellent ☐Problem	Nil
8			☐Excellent ☐Problem	
9			☐Excellent ☐Problem	

*1 **Name of rooms**
<Primary school> Class room (specify the room numbers), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights
Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

Lack Qualified personnel is required
Check the System and operation

H-3-2 Lot 2 facilities

(1) Tuum Primary School

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: TUUM PRIMARY SCHOOL

Date of Submission: 1ST-10-2014

RECEIVED 13 OCT 1914 ... SAMBURU County

To the County Director of EDUCATION SAMBURU County

Thro':

The D E O SAMBURU NORTH Sub-County 01/10/2014

The management committee of TUUM PRY SAMBURU N Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of AUGUST 2014.

ERITH TUUMA
Operator

LEPAIKUNAS RAPHAEL
Chairperson, Management Committee

LELAONO SAMUEL
Head of Institution

HEADTEACHER TUUM PRIMARY SCHOOL P. O. Box 10-20801 BARAGOI Date 26-09-2014

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF TUUM PRIMARY

Month/Year: AUGUST 2014 Sheet No. 01

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	1570	1. Operation cost	
1. Revenue from charging service (b)	180	(1) demonstration allowance	200
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	1750	Sub-total (e)	200
3. Withdrawals from Bank	—	2. Maintenance cost	
Date	—	Shaving machine repair	500
Date	—		
Sub - total (d)	—	Sub-total (f)	700
		3. Administration cost	
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	0
		Deposit to bank (h)	800
Cash Income Total (a)+(b)+(c)+(d)	1750	**Cash Expenditure Total** (e)+(f)+(g)+(h)	1500
Balance (Cash income carried forward)		Ksh	250

BANK CONTROL		Unit: Ksh	
Balance in last month	0	Withdrawals in this month (d)	0
Deposit in this month (h)	800		0
Deposit Total	800	**Withdrawals Total**	0
Balance (Cash income carried forward)		Ksh 800	

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☐ Yes ☐ Sometimes ☑ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/Building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Room 1 To 5	NIGHT	☑Excellent ☐Problem	
2	STAFFROOM AND BT27	DAY AND NIGHT	☑Excellent ☐Problem	
3	ROOM BTU11	NIGHT	☑Excellent ☐Problem	
4	OFFICE BLOCK	DAY & NIGHT	☑Excellent ☐Problem	
5	DINING HALL AND STORE	NIGHT	☑Excellent ☐Problem	
6	GIRLS DORM	NIGHT	☑Excellent ☐Problem	
7	LAPTOPS SYSTEM	NOT IN USE	☑Excellent ☐Problem	
8	CHARGING ROOM	DAY & NIGHT	☑Excellent ☐Problem	
9			☐Excellent ☐Problem	

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights
Note: n.a. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

The cost of replacement is a challenge to School management Committee.

(2) South Horr Dispensary

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: SOUTH HORR DISPENSARY

Date of Submission: 1ST OCTOBER 2014

To the County Director of HEALTH SAMBURU County

Thro':
The MOH SAMBURU NORTH Sub-County

The management committee of SOUTH HORR GIRL DISPENSARY Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of AUGUST 2014

GRACE LEKAKOL
Operator

Chairperson, Management Committee

Michael Lenkoale
Head of Institution

29 SEP 2014

Received
P. Wanyoki

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF SOUTH HORR DISPENSARY

Month/Year: AUGUST 2014 Sheet No.: 1

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	4485	1. Operation cost	
1. Revenue from charging service (b)	1240	(1) ACCESORIES	225
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	5725	Sub-total (e)	—
3. Withdrawals from Bank		2. Maintenance cost	—
Date	—		
Date	—		
Date	—		
Sub - total (d)	0	Sub-total (f)	—
		3. Administration cost	—
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	—
		Deposit to bank (h)	—
Cash Income Total (a)+(b)+(c)+(d)	5725	**Cash Expenditure Total** (e)+(f)+(g)+(h)	225
Balance (Cash income carried forward)		Ksh	3600

BANK CONTROL		Unit: Ksh	
Balance in last month	—	Withdrawals in this month (d)	—
Deposit in this month (h)	—		
Deposit Total	—	**Withdrawals Total**	—
Balance (Cash income carried forward)		Ksh	0

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☐ Yes ☐ Sometimes ☑ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	STAFF QUARTERS	DAY/NIGHT	☑Excellent ☐Problem	—
2	MATERNITY WARD	NIGHT	☑Excellent ☐Problem	—
3	VACCINE UNIT	DAY/NIGHT	☐Excellent ☑Problem	Can't run with system
4	CHARGING SYSTEM	DAY/NIGHT	☑Excellent ☐Problem	—
5			☐Excellent ☐Problem	
6			☐Excellent ☐Problem	
7			☐Excellent ☐Problem	
8			☐Excellent ☐Problem	
9			☐Excellent ☐Problem	

* Problems with lights

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room hut, outdoor security lights
Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

1) VACCINE UNIT CANNOT RUN ON THE SOLAR P.V SYSTEM - TECHNICAL ASSISTANCE IS REQUIRED
2) MANAGEMENT IS NOT ABLE TO PAY OPERATOR SALARY - COUNTY SHOULD ASSIST.

(3) Illaut Primary School

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: ILLAUT PRIMARY SCHOOL

Date of Submission: 1/10/2014

RECEIVED
C.D. COUNTY
P.O. BOX 327-20600 MARALAL

To the County Director of EDUCATION SAMBURU County

Thro':
The D.E.O SAMBURU NORTH Sub-County

ref 01/10/2014

The management committee of ILLAUT PRIMARY SCHOOL S.NORTH Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of SEPTEMBER 2014

Samwel Lopir
Operator

LOITUPUNY LEPARSANTI
For Chairperson, Management Committee

Holia Leparmachal P.
Head of Institution

ILLAUT PRIMARY SCHOOL
P.O.BOX 20317-MOMBASA
DATE. 30/9/2014

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF ILLAUT PRIMARY SCHOOL

Month/Year: SEPT. 2014 Sheet No. : 1

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	2760	1. Operation cost	
1. Revenue from charging service (b)	255	(1) Accessories	200
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)		Sub-total (c)	200
3. Withdrawals from Bank	—	2. Maintenance cost	—
Date	—		
Date	—		
Date	—		
Sub - total (d)	—	Sub-total (f)	—
		3. Administration cost	—
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	—
		4. Deposit to bank (h)	—
Cash Income Total (a)+(b)+(c)+(d)	3015	**Cash Expenditure Total** (e)+f)+(g)+(h)	200
Balance (Cash income carried forward)		Ksh	2815
BANK CONTROL		Unit: Ksh	
Balance in last month	—	Withdrawals in this month (d)	—
Deposit in this month (h)	—		
Deposit Total	—	**Withdrawals Total**	—
Balance (Cash income carried forward)		Ksh	—

Project for Establishment of Rural Electrification Model
Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☑ Yes ☐ Sometimes ☐ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	1-4	NIGHT	☑Excellent ☐Problem	
2	5-8	〃	☑Excellent ☐Problem	
3	OFFICE Block	〃	☐Excellent ☑Problem	see light (1)
4	STAFF HOUSES	〃	☑Excellent ☐Problem	
5	BOYS DORM	〃	☑Excellent ☐Problem	
6	GIRLS DORM	〃	☑Excellent ☐Problem	
7	LAPTOP system	NOT IN USE	☑Excellent ☐Problem	
8	CHARGING ROOM	DAY & NIGHT	☑Excellent ☐Problem	
9			☑Excellent ☐Problem	

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights.
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights.
Note: n.d. = no data

3. **Issues to discuss**
If the management committee faces technical troubles and questions, please mention here.

(1) Financial support to buy LC Batteries and Inverters in future.

(4) Latakweny Dispensary

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: LATAKWENY DISPENSARY

Date of Submission: 01/10/2014

To the County Director of HEALTH SAMBURU County

Thro':

The M.O.H. SAMBURU NORTH Sub-County

The management committee of LATAKWENY DIS. S. NORTH Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of AUGUST 2014

Julius LEPIS
Operator

ROBERT LEPUKOTE
Chairperson, Management Committee

ROBERT LEPUKOTE
Head of Institution

Received P. Wanjohi

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF LATAKWENY DISPENSARY

Month/Year: AUGUST 2014 Sheet No.: 1

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	2255	1. Operation cost	500
1. Revenue from charging service (b)	1940	(1) Chargers	
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	4195	Sub-total (e)	500
3. Withdrawals from Bank		2. Maintenance cost	-
Date	-		
Date	-		
Date	-		
Sub - total (d)	-	Sub-total (f)	-
		3. Administration cost	-
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	-
		4. Deposit to bank (h)	2750
Cash Income Total (a)+(b)+(c)+(d)	4195	**Cash Expenditure Total** (e)+f)+(g)+(h)	3250
Balance (Cash income carried forward)		Ksh	945

BANK CONTROL		Unit: Ksh	
Balance in last month	0	Withdrawals in this month (d)	0
Deposit in this month (h)	2750		
Deposit Total	2750	**Withdrawals Total**	-
Balance (Cash income carried forward)		Ksh 2750	

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☐ Yes ☑ Sometimes ☐ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/Building of the PV system*)	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	WARD 1-4	NIGHT	☑Excellent ☐Problem	
2	WARD 5-8	NIGHT	☑Excellent ☐Problem	
3	STAFF QUARTERS	DAY/NIGHT	☑Excellent ☐Problem	
4	OUT PATIENT	DAY/NIGHT	☐Excellent ☑Problem	SECURITY LIGHT
5	VACCINE ROOM	DAY/NIGHT	☐Excellent ☐Problem	
6	CHARGING POINT	DAY/NIGHT	☑Excellent ☐Problem	
7			☐Excellent ☐Problem	
8			☐Excellent ☐Problem	
9			☐Excellent ☐Problem	

*) **Name of rooms** X problem solved

- Primary school: Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
- Dispensary: Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights

Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

NO ISSUE AT THIS MOMENT

(5) Marti Primary School

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: MARTI PRIMARY SCHOOL

Date of Submission: 1/10/2014

RECEIVED 23 OCT 2014 C.D. COUNTY P.O. BOX 127-20600 MARALAL

To the County Director of EDUCATION SAMBURU County

Thro':

The D.E.O SAMBURU NORTH Sub-County 01/10/2014

The management committee of MARTI PRIMARY SAMBURU NORTH Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of AUGUST 2014

LUCY LOLOME

Operator

JOHN EKIRU

Chairperson, Management Committee

PHILIP LEPUSIYE

Head of Institution

MARTI PRIMARY SCHOOL 1/10/2014 P.O. BOX 22 BARAGOI

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF MARTI PRIMARY

Month/Year: AUGUST 2014 Sheet No. : 2

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	6525	1. Operation cost	
1. Revenue from charging service (b)	3890	(1) Petrol	185
2. Other revenues:		(2) Machine Oil	80
		(3)	
		(4)	
		(5) Miscellaneous	100
Sub-total (c)	10415	Sub-total (e)	
3. Withdrawals from Bank	—	2. Maintenance cost	
Date			
Date			
Date			
Sub - total (d)	—	Sub-total (f)	
		3. Administration cost	
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	90
		Sub-total (g)	
		4. Deposit to bank (h)	
Cash Income Total (a)+(b)+(c)+(d)	10,415	**Cash Expenditure Total** (e)+(f)+(g)+(h)	450
Balance (Cash income carried forward)			Ksh 9,965

BANK CONTROL		Unit: Ksh	
Balance in last month	—	Withdrawals in this month (d)	
Deposit in this month (h)	—		
Deposit Total		**Withdrawals Total**	
Balance (Cash income carried forward)		Ksh	9965

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya — Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☑ Yes ☐ Sometimes ☐ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*1	Time of the use of electricity	Operational condition of PV system	Details of problems (Remark)
1	Charging room	During the day and Night Periods	☑Excellent ☐Problem	
2	Class 9-11	During the Night	☐Excellent ☑Problem	Inverter problem
3	class 1-3 and office	During the Night	☑Excellent ☐Problem	
4	Room 4-8	During the Night	☐Excellent ☑Problem	Inverter Problem
5	Nursery	During the day and Night	☑Excellent ☐Problem	
6	Girls Dorm 1 and 2	During the Night	☑Excellent ☐Problem	
7	Boys Dorm 1, 2, and 3	During the Night	☑Excellent ☐Problem	
8	Laptop Sytem	Not in use	☑Excellent ☐Problem	
9			☐Excellent ☐Problem	

*1 **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hat, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hat, outdoor security lights

Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.

1. Inverter Problem — Need to be checked.
2. Giving customer Motivation to enhance good income

(6) Angata Nanyokei Dispensary

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

O&M AND FINANCIAL MONTHLY REPORT

INSTITUTION'S NAME: ANGATA NANYOKEI COK DISPENSARY

Date of Submission: 2ND OCTOBER 2014

To the County Director of HEALTH SAMBURU County

Thru':
The MOH SAMBURU CENTRAL Sub-County

The management committee of ANGATA NANYOKEI SAMBURU CENTRAL Sub-County, hereby submits the Operation & Maintenance and Financial Report of the PV system for the Month of AUGUST 2014

JULIET NASIEKU
Operator

LONGIRO LOLKUMENI
Chairperson, Management Committee

JOHN SAMBURI LEKOLKUTAR
Head of Institution

02 OCT 2014

ANGATA NANYOKEI DISPENSARY
23 SEP 2014
P.O. BOX 13, MARALAL

Received
P. Wangoli

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

MONTHLY FINANCIAL REPORT OF

Month/Year: August 2014 Sheet No.: 4

Income in the month	(Ksh)	Expenditure in the month	(Ksh)
Cash Balance last Month (a)	800	1. Operation cost	
1. Revenue from charging service (b)	210	(1)	
2. Other revenues:		(2)	
		(3)	
		(4)	
		(5) Miscellaneous	
Sub-total (c)	1010	Sub-total (e)	
3. Withdrawals from Bank		2. Maintenance cost	
Date		Shaving Machine Repair	200-
Date			
Date			
Sub - total (d)	0	Sub-total (f)	200-
		3. Administration cost	
		- transportation	
		- committee expenses	
		- meeting expenses	
		- bank charge	
		- others	
		Sub-total (g)	
		4. Deposit to bank (h)	0
Cash Income Total (a)+(b)+(c)+(d)	1010	**Cash Expenditure Total** (e)+(f)+(g)+(h)	200
Balance (Cash income carried forward)		Ksh	810

BANK CONTROL		Unit: Ksh	
Balance in last month	–	Withdrawals in this month (d)	–
Deposit in this month (h)	–		
Deposit Total	–	**Withdrawals Total**	–
Balance (Cash income carried forward)		Ksh	810

Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya
Operation & Maintenance and Financial Monthly Report

1. **Existence of Daily O&M Record:** ☐ Yes ☐ Sometimes ☐ Not at all

2. **System utilization and status of the indicators**

No.	Name of Room/building of the PV system*)	Time of the use of electricity	Operational Condition of PV system	Details of problems (Remark)
1	Staff Quarters	Night	☑Excellent ☐Problem	
2	Maternity Ward	Day & Night	☑Excellent ☐Problem	
3	Charging house	DAY & Night	☑Excellent ☐Problem	Shaving machine not functioning
4	Consultation Room	Day	☑Excellent ☐Problem	
5	Vaccine Unit	Day & Night	☑Excellent ☐Problem	Temperatures too low
6			☐Excellent ☐Problem	
7			☐Excellent ☐Problem	
8			☐Excellent ☐Problem	
9			☐Excellent ☐Problem	

*) **Name of rooms**
<Primary school> Class room (specify the room number), staff room, staff dormitory (specify the room number), boy's dormitory, girl's dormitory, hall, charging service room/hut, outdoor security lights
<Dispensary> Main consultation/treatment room (specify the room number), sub-consultation/treatment room, vaccine refrigerator, staff dormitory, charging service room/hut, outdoor security lights
Note: n.d. = no data

3. **Issues to discuss**

If the management committee faces technical troubles and questions, please mention here.
① Bank Account for Charging house.
② Responsible Person for Shaving Service

Attachment H-4 Summary of Charging Service Operation and Accounting Activities

(1) Lot 1

Table H4.1 Charging Service Accounting in Ilkilnyeti Dispensary

Ilkilnyeti Dispensary							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	July 2013			0		0	
2	Aug. 2013	3,320	4,930	-1,610	0	-1,610	The negative balance is as a result
3	Sep. 2013	2,900	4,400	-1,500	0	-3,110	of salary for the operator
4	Oct. 2013	3,580	4,520	-940	0	-4,050	
5	Nov. 2013	3,870	4,500	-630	0	-4,680	
6	Dec. 2013	3,240	4,460	-1,220	0	-5,900	
7	Jan. 2014	2,900	4,000	-1,100	0	-7,000	Total balance to be paid to the
8	Feb. 2014	No charging service due to replacement of operator					operator
9	Mar. 2014	6,740	3,220	3,520	3,350	170	The operator is changed and her
10	Apr. 2014	5,980	2,580	3,400	3,200	370	salary is paid by the dispensary
11	May 2014	5,480	2,300	3,180	3,000	550	(The outstanding balance for the
12	Jun. 2014	5,060	3,530	1,530	1,500	580	former operator is paid in
13	Jul. 2014	6,980	2,770	4,210	4,200	590	monthly instalments) Cash balance
14	Aug. 2014	6,320	0	6,320	0	6,910	is accummulated from Mar. 2014
Total		**56,370**	**41,210**	**22,160**	**15,250**	**6,910**	

Table H4.2 Charging Service Accounting in Iltumtum Primary School

Iltumtum Primary School							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	July 2013			0		0	
2	Aug. 2013	9,320	7,310	2,010	0	2,010	The charging house is fully operational.
3	Sep. 2013	7,930	4,080	3,850	0	5,860	
4	Oct. 2013	7,570	4,820	2,750	0	8,610	
5	Nov. 2013	4,540	4,178	362	0	8,972	
6	Dec. 2013	5,550	4,270	1,280	0	10,252	Cash balance is accummulated.
7	Jan. 2014	7,260	7,580	-320	0	9,932	
8	Feb. 2014	7,850	5,700	2,150	0	12,082	
9	Mar. 2014	9,610	5,420	4,190	5,550	10,722	
10	Apr. 2014	10,980	4,300	6,680	6,680	10,722	
11	May 2014	8,430	5,720	2,710	2,000	11,432	
12	Jun. 2014	8,850	5,970	2,880	3,130	11,182	
13	Jul. 2014	8,280	6,030	2,250	2,210	11,222	
14	Aug. 2014	4,340	0	4,340	0	15,562	
Total		**100,510**	**65,378**	**35,132**	**19,570**	**15,562**	

Table H4.3 Charging Service Accounting in Olkinyei Dispensary

Olkinyei Dispensary							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	July 2013			0		0	
2	Aug. 2013	200	0	200	0	200	
3	Sep. 2013	1,120	0	1,120	0	1,320	
4	Oct. 2013	220	0	220	0	1,540	
5	Nov. 2013	830	130	700	0	2,240	
6	Dec. 2013	160	0	160	0	2,400	
7	Jan. 2014	0	0	0	0	2,400	The charging house is not fully operartional. The operator is absent on most days of the month.
8	Feb. 2014	0	0	0	0	2,400	
9	Mar. 2014	300	0	300	0	2,700	
10	Apr. 2014	300	0	300	0	3,000	
11	May 2014	300	0	300	800	2,500	
12	Jun. 2014	200	0	200	0	2,700	
13	Jul. 2014	N.A.	N.A.	N.A.	N.A.	N.A.	
14	Aug. 2014	0		0	2,400	300	
Total		**3,630**	**130**	**3,500**	**3,200**	**300**	

Table H4.4 Charging Service Accounting in Olemoncho Primary School

Olemoncho Primary School							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	July 2013	2,190	350	1,840	0	1,840	
2	Aug. 2013	2,740	280	2,460	0	4,300	
3	Sep. 2013	1,940	3,350	-1,410	0	2,890	
4	Oct. 2013						Management problems:The cahrging house was not fully operatinal and data was not available during this period
5	Nov. 2013						
6	Dec. 2013						
7	Jan. 2014						
8	Feb. 2014						
9	Mar. 2014						
10	Apr. 2014						
11	May 2014	600	0	600	0	3,490	Cash balance is accummulated.
12	Jun. 2014	1,300	180	1,120	0	4,610	
13	Jul. 2014	1,590	1,510	80	0	4,690	
14	Aug. 2014	0	0	0	0	4,690	
Total		**10,360**	**5,670**	**4,690**	**0**	**4,690**	

(2) Lot 2

Table H4.5 Charging Service Accounting in Latakweny Dispensary

Latakweny Dispensary							
No.	Month	Revenue	O&M Cost	Balance	Bank Deposit	Cash Balance	Remarks
1	May 2014	0	0	0		0	
2	Jun. 2014	775	0	775		775	
3	Jul. 2014	1,200	0	1,200		1,975	
4	Aug. 2014			0		1,975	Operator not available.
5	Sep. 2014	460	0	460		2,435	
6	Oct. 2014	830	0	830		3,265	
Total		3,265	0	3,265	0		

Table H4.6 Charging Service Accounting in Marti Primary School

Marti Promary School							
No.	Month	Revenue	O&M Cost	Balance	Bank Deposit	Cash Balance	Remarks
1	May 2014	500	0	500		500	
2	Jun. 2014	1,640	0	1,640		2,140	
3	Jul. 2014	3,380	0	3,380		5,520	
4	Aug. 2014			0		5,520	Record not available.
5	Sep. 2014	1,930	280	1,650		7,170	
6	Oct. 2014	945	40	905		8,075	
Total		8,395	320	8,075	0		

Table H4.7 Charging Service Accounting in Tuum Primary School

Tuum Primary School							
No.	Month	Revenue	O&M Cost	Balance	Bank Deposit	Cash Balance	Remarks
1	May 2014	180	0	180		180	
2	Jun. 2014	540	0	540		720	
3	Jul. 2014	900	0	900		1,620	
4	Aug. 2014	0	0	0		1,620	Operator not available.
5	Sep. 2014	280	0	280		1,900	
6	Oct. 2014	40	0	40		1,940	
Total		1,940	0	1,940	0		

Table H4.8 Charging Service Accounting in Illaut Primary School

Illaut Primary School							
No.	Month	Revenue	O&M Cost	Balance	Bank Deposit	Cash Balance	Remarks
1	May 2014	0	0	0		0	Charging business delayed.
2	Jun. 2014	330	0	330		330	
3	Jul. 2014	1,960	0	1,960		2,290	
4	Aug. 2014	105	0	105		2,395	
5	Sep. 2014	225	0	225		2,620	
6	Oct. 2014	0	0	0		2,620	Operator not available.
Total		2,620	0	2,620	0		

Table H4.9 Charging Service Accounting in South Horr Dispensary

South Horr Dispensary							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	May 2014	1,690	1,600	90		90	
2	Jun. 2014	1,420	1,000	420		510	
3	Jul. 2014	1,370	700	670		1,180	
4	Aug. 2014	570	0	570		1,750	
5	Sep. 2014	1,060	550	510		2,260	
6	Oct. 2014	585	0	585		2,845	
Total		6,695	3,850	2,845	0		

Table H4.10 Charging Service Accounting in Angata Nanyukei Dispensary

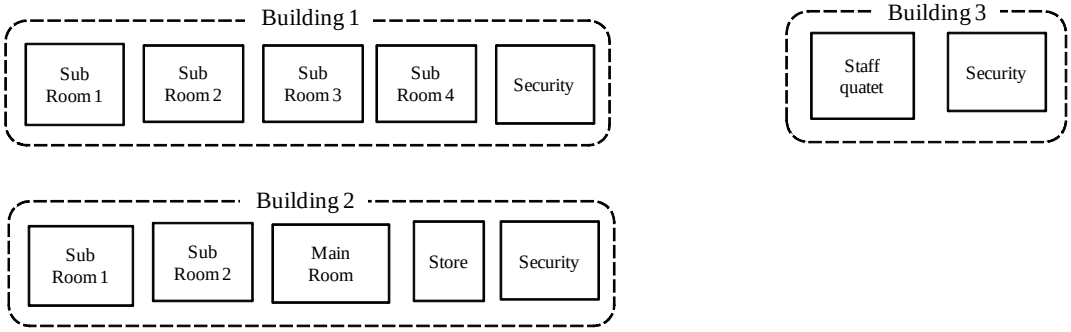
Angata Nanyukie Dispensary							
No.	**Month**	**Revenue**	**O&M Cost**	**Balance**	**Bank Deposit**	**Cash Balance**	**Remarks**
1	May 2014	500	0	500		500	
2	Jun. 2014	0	0	0		500	Operator went out for 1 month.
3	Jul. 2014	800	0	800		1,300	
4	Aug. 2014			0		1,300	Record not available
5	Sep. 2014	180	0	180		1,480	
6	Oct. 2014	80	0	80		1,560	
Total		1,560	0	1,560	0		

Attachment H-5 Sample Calculation of the Financial Model

H-5-1 Sample Calculation of Dispensary

This sample case describes financial model of a typical solar PV system for dispensary. It is assumed that this dispensary has three buildings in layout shown in figure below.

Information of Target Facility



a) Size of Buildings and Power Demand:

Building 1: Sub-building (1,200Wh/day) + Security (110Wh/day) = 1,310 Wh/day
Building 2: Main building (650Wh/day) + Sub-building (600Wh/day) + Security (110Wh/day) = 1,410 Wh/day
Building 3: Staff quarter + TV (600 Wh/day) + Security (110Wh/day) = 710 Wh/day

b) Power Packages & Initial Cost

PP0: Khs.89,400 x 1	= KSh. 89,400
PP2: Khs.177,600 x 3	= KSh. 532,800
Charging Model:	= KSh. 105,100
P1: Initial Cost (Total)	= KSh. 727,300

P2: Cables and etc.	= 25% of Initial Cost	= KSh. 181,125
P3: Cost of charging house		= KSh. 130,000
P4: Commission charge = (P1+P2+P3) x 30%		= KSh. 311,738
PIC = P1+P2+P3+P4 = KSh. 1,350,863		= KSh. 1,360,000

c) O&M Cost

Regular Operation (Daily operation)

$$P_{OM} = 1{,}000 + 100 \times N_{BT}$$

Where, P_{OM}: daily operation expenses (KSh./month)
N_{BT}: number of battery (nos.)

Estimation of O&M Cost

Number of Battery

	PP2	PP1	PP0	Charge	Total
Number of Power Package	3	0	1	1	
Unit number per power package	4	2	1	1	
	12	0	1	1	14

POM	2,400 (Ksh./month)	= 1,000 +	100 x	14
	28,800 (Ksh./year)			

Replacement Cost

Estimation of Replacement Cost

	PP2	PP1	PP0	Charging	Total	
1 Number of Equipment						
Battery	3	0	1	1	5	
Charging Controller	3	0	1	1	5	
Inverter	3	0	1	1	5	
2 Unit Price of Equipment						
Battery	54,000	38,000	19,000	19,000		
Charging Controller	11,000	9,000	9,000	11,000		
Inverter	35,000	25,000	25,000	25,000		
3 Amount of Equipment						
Battery	162,000	0	19,000	19,000	200,000	
Charging Controller	33,000	0	9,000	11,000	53,000	
Inverter	105,000	0	25,000	25,000	155,000	
					408,000	(Ksh.)

$$P_{RP} = P_1 + P_2$$

Where, P_{RP}: Replacement cost of major equipment
P_1: Cost of procurement and installation of major equipment
P_2: Commission charges (40% of above)

Replacement Cost of Battery

PRP1 = 200,000 + 200,000 x 40% = 280,000 (Ksh.) **280,000** (Ksh.)

Replacement Cost of Charging Controller and Inverter

PRP2 = 53,000 + 53,000 x 40% = 74,200 (Ksh.) **75,000** (Ksh.)

PRP3 = 155,000 + 155,000 x 40% = 217,000 (Ksh.) **217,000** (Ksh.)

d) Existing Budget for Regular Operation

It is assumed that there is no existing budget available with the dispensary for regular operation.

e) Revenue from Charging Service

Demand for charging service is subject to the location and type of neighborhood community. It is assumed that the surrounding households are less than 50 and the village is dispersed. In the case the monthly revenue is estimated at only KSh. 1,000 per month.

f) Cash Flow Projection

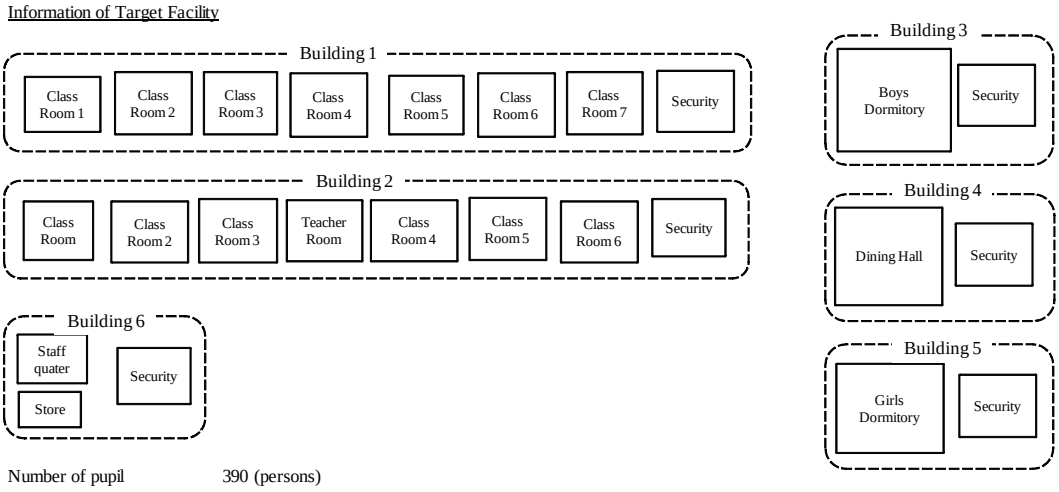
The cash flow projection based on the assumptions of the sample case of dispensary is shown in next page. The projection is expressed in 2014 constant price. The annual deficit from regular operation (difference of charging service revenue and regular operation expenses) amounts at KSh. 16,800 which will be borne by the dispensary. During the system lifetime of 20 years, County Health Office must allocate KSh. 1,424,000 in total for the budget for major replacements.

Cash Flow Projection (Dispensary)

Year	Initial Cost	O&M Cost (KSh)					Revenue (KSh)			Balance (KSh)		**Required Budget Allocation (KSh)**		
		Regular Operation (Local Cost)	Major Replacement: Battery (Foreign	Major Replacement: Inverter (Foreign	Major Replacement: CC (Foreign	Sub-total (1)	Existing Budget (Local)	Charging Service (Local)	Sub-total (2)	Per Year	Accumlation	Initial Cost **REA**	Reguar Operation **Dispensary**	Major Maintennace **County**
		(a)	(b)	(c)	(d)	(e) = (a)+(b)+(c)+(d)	(f)	(g)	(h) = (f)+(g)	(i) = (h)-(e)	(j) = Σ (i)	(k)	(l) = (a) - (h)	(m) = (b)+(c)+(d)
0	1,360,000											1,360,000		
1		28,800				28,800	0	12,000	12,000	-16,800	-16,800	0	16,800	0
2		28,800				28,800	0	12,000	12,000	-16,800	-33,600	0	16,800	0
3		28,800				28,800	0	12,000	12,000	-16,800	-50,400	0	16,800	0
4		28,800				28,800	0	12,000	12,000	-16,800	-67,200	0	16,800	0
5		28,800	280,000			308,800	0	12,000	12,000	-296,800	-364,000	0	16,800	280,000
6		28,800				28,800	0	12,000	12,000	-16,800	-380,800	0	16,800	0
7		28,800		75,000	217,000	320,800	0	12,000	12,000	-308,800	-689,600	0	16,800	292,000
8		28,800				28,800	0	12,000	12,000	-16,800	-706,400	0	16,800	0
9		28,800				28,800	0	12,000	12,000	-16,800	-723,200	0	16,800	0
10		28,800	280,000			308,800	0	12,000	12,000	-296,800	-1,020,000	0	16,800	280,000
11		28,800				28,800	0	12,000	12,000	-16,800	-1,036,800	0	16,800	0
12		28,800				28,800	0	12,000	12,000	-16,800	-1,053,600	0	16,800	0
13		28,800				28,800	0	12,000	12,000	-16,800	-1,070,400	0	16,800	0
14		28,800		75,000	217,000	320,800	0	12,000	12,000	-308,800	-1,379,200	0	16,800	292,000
15		28,800	280,000			308,800	0	12,000	12,000	-296,800	-1,676,000	0	16,800	280,000
16		28,800				28,800	0	12,000	12,000	-16,800	-1,692,800	0	16,800	0
17		28,800				28,800	0	12,000	12,000	-16,800	-1,709,600	0	16,800	0
18		28,800				28,800	0	12,000	12,000	-16,800	-1,726,400	0	16,800	0
19		28,800				28,800	0	12,000	12,000	-16,800	-1,743,200	0	16,800	0
20		28,800				28,800	0	12,000	12,000	-16,800	-1,760,000	0	16,800	0
Total	1,360,000	576,000	840,000	150,000	434,000	2,000,000	0	240,000	240,000	1,760,000	-	1,360,000	336,000	1,424,000
Annual	-	28,800	42,000	7,500	21,700	100,000	0	12,000	12,000	88,000	-	-	16,800	71,200

H-5-2 Sample Calculation of Primary School

This sample case describes financial model of a typical solar PV system for primary school. It is assumed that this school has three buildings in layout shown in figure below.



a) Size of Buildings and Power Demand

Building 1: Class Room (160 Wh/day) x 7 + Security (440 Wh/day) = 1,560 Wh/day
Building 2: Class Room (160 Wh/day) x 6 + Teacher room (450 Wh/day) + Security (440 Wh/day)
= 1,850 Wh/day
Building 3: Boys Dormitory (320 Wh/day) + Security (440 Wh/day) = 760 Wh/day
Building 4: Dining Hall (800 Wh/day) + Security (440 Wh/day) = 1,240 Wh/day
Building 5: Girls Dormitory (320 Wh/day) + Security (440 Wh/day) = 760 Wh/day
Building 6: Staff quarter (600 Wh/day) + Store (50Wh/day) + Security (440 Wh/day)
= 1,090 Wh/day

b) Power Packages & Initial Cost

PP0: KSh. 89,400 x 1	= KSh. 89,400
PP1: KSh.122,100 x 2	= KSh. 244,200
PP2: KSh.177,600 x 5	= KSh.888,000
Charging Model	= KSh.105,100
P1: Initial Cost (Total)	= KSh. 1,326,700
P2: Cables and etc. = 25% of Initial Cost	= KSh. 331,675
P3: Cost of charging house	= KSh. 130,000
P4: Commission charge = (P1+P2+P3) x 10%	= KSh. 178,838
PIC= P1+P2+P3+P4 = KSh. 1,967,213	= KSh. 1,970,000

c) O&M Cost

Regular Operation (Daily operation)

$$P_{OM} = 1{,}000 + 100 \times N_{BT}$$

Where, P_{OM}: daily operation expenses (KSh./month)
N_{BT}: number of battery (nos.)

Estimation of O&M Cost

Number of Battery

	PP2	PP1	PP0	Charge	Total
Number of Power Package	5	2	1	1	
Unit number per power package	4	2	1	1	
	20	4	1	1	26

POM 3,600 (Ksh./month) = 1,000 + 100 x 26
43,200 (Ksh./year)

Replacement Cost

Estimation of Replacement Cost

	PP2	PP1	PP0	Charging	Total
1 Number of Equipment					
Battery	5	2	1	1	9
Charging Controller	5	2	1	1	9
Inverter	5	2	1	1	9
2 Unit Price of Equipment					
Battery	54,000	38,000	19,000	19,000	
Charging Controller	11,000	9,000	9,000	11,000	
Inverter	35,000	25,000	25,000	25,000	
3 Amount of Equipment					
Battery	270,000	76,000	19,000	19,000	384,000
Charging Controller	55,000	18,000	9,000	11,000	93,000
Inverter	175,000	50,000	25,000	25,000	275,000
					752,000

$$P_{RP} = P_1 + P_2$$

Where, P_{RP}: replacement cost of major equipment
P_1: cost of procurement and installation of major equipment
P_2: commission charges (10% of above)

Replacement Cost of Battery

PRP1 = 384,000 + 384,000 x 40% = 537,600 (Ksh.) → 538,000 (Ksh.)

Replacement Cost of Charging Controller and Inverter

PRP2 = 93,000 + 93,000 x 40% = 130,200 (Ksh.) → 131,000 (Ksh.)
PRP3 = 275,000 + 275,000 x 40% = 385,000 (Ksh.) → 385,000 (Ksh.)

d) Existing Budget for Regular Operation

Free Primary Education Fund (FPEF) of 1,020 KSh./pupil/year is currently provided for general school operation. It includes electricity fee of 64 KSh./pupil/year which is assumed to be spent for regular operation of the solar PV system.

e) Revenue from Charging Service

Demand for charging service is subject to the location and type of surrounding community. It is assumed that the surrounding households are less than 50 and the village is dispersed. In the said case the monthly revenue is estimated at only KSh. 1,000 per month.

f) Cash Flow Projection

The cash flow projection based on the assumptions of the sample case of primary school is shown in below. The projection is expressed in 2014 constant price. The annual deficit from regular operation

amounts at KSh. 6,240 which will be borne by the primary school. During the system lifetime of 20 years, MoEST must allocate additional KSh. 2,646,000 in total for the budget for major replacements.

Cash Flow Projection (Primary School)

Year	Initial Cost	O&M Cost (KSh)					Revenue (KSh)			Balance (KSh)		Required Budget Allocation (KSh)		
		Regular Operation (Local Cost)	Major Replacement			Sub-total (1)	Existing Budget (Local)	Charging Service (Local)	Sub-total (2)	Per Year	Accumlation	Initial Cost **REA**	Reguar Operation **Dispensary**	Major Maintennace **County**
			Battery (Foreign	Inverter (Foreign	CC (Foreign									
		(a)	(b)	(c)	(d)	(e) = (a)+(b)+(c)+(d)	(f)	(g)	(h) = (f)+(g)	(i) = (h)-(e)	(j) = Σ (i)	(k)	(l) = (a) - (h)	(m) = (b)+(c)+(d)
0	2,050,000											2,050,000		
1		45,600				45,600	24,960	12,000	36,960	-8,640	-8,640	0	8,640	0
2		45,600				45,600	24,960	12,000	36,960	-8,640	-17,280	0	8,640	0
3		45,600				45,600	24,960	12,000	36,960	-8,640	-25,920	0	8,640	0
4		45,600				45,600	24,960	12,000	36,960	-8,640	-34,560	0	8,640	0
5		45,600	560,000			605,600	24,960	12,000	36,960	-568,640	-603,200	0	8,640	560,000
6		45,600				45,600	24,960	12,000	36,960	-8,640	-611,840	0	8,640	0
7		45,600		133,000	399,000	577,600	24,960	12,000	36,960	-540,640	-1,152,480	0	8,640	532,000
8		45,600				45,600	24,960	12,000	36,960	-8,640	-1,161,120	0	8,640	0
9		45,600				45,600	24,960	12,000	36,960	-8,640	-1,169,760	0	8,640	0
10		45,600	560,000			605,600	24,960	12,000	36,960	-568,640	-1,738,400	0	8,640	560,000
11		45,600				45,600	24,960	12,000	36,960	-8,640	-1,747,040	0	8,640	0
12		45,600				45,600	24,960	12,000	36,960	-8,640	-1,755,680	0	8,640	0
13		45,600				45,600	24,960	12,000	36,960	-8,640	-1,764,320	0	8,640	0
14		45,600		133,000	399,000	577,600	24,960	12,000	36,960	-540,640	-2,304,960	0	8,640	532,000
15		45,600	560,000			605,600	24,960	12,000	36,960	-568,640	-2,873,600	0	8,640	560,000
16		45,600				45,600	24,960	12,000	36,960	-8,640	-2,882,240	0	8,640	0
17		45,600				45,600	24,960	12,000	36,960	-8,640	-2,890,880	0	8,640	0
18		45,600				45,600	24,960	12,000	36,960	-8,640	-2,899,520	0	8,640	0
19		45,600				45,600	24,960	12,000	36,960	-8,640	-2,908,160	0	8,640	0
20		45,600				45,600	24,960	12,000	36,960	-8,640	-2,916,800	0	8,640	0
Total	2,050,000	912,000	1,680,000	266,000	798,000	3,656,000	499,200	240,000	739,200	2,916,800	-	2,050,000	172,800	2,744,000
Annual	-	45,600	84,000	13,300	39,900	182,800	24,960	12,000	36,960	145,840	-	-	8,640	137,200

Attachment I Materials for Solar PV System (Technical Part)

Attachment I-1 Photos for Installation of PV System

Attachment I-2 Site Memos for PV Investigation

Attachment I-1Photos for Installation of PV System

Pictures of Installation Works and Status of Installed System -1

Inspection of Material at Nairobi

5 W LED Lamp for Lighting

10 W LED Security Lamp

Electrical Components
(Joint Box, Socket, Isolator)

Construction of Charging House

Inside Charging House after Installation

Source: Taken by JET

Pictures of Installation Works and Status of Installed System -2

Installation Work (PV 1)
Illaut Primary School

Installation Works (PV 2)
Illaut Primary School

PV Array for Charging House (240 W, DC 12 V) (facing North)

480 W System (DC 24 V)
PV Array facing North

PV Array for Computer System (DC 48 V)
At Marti Pry. School (facing North)

Installations of PV Array (Tuum Pry. School)
(facing North)

Source: Taken by JET

Pictures of Installation Works and Status of Installed System -3

System Components 1
(Pattern of Installation)

System Components 2
(Pattern of Installation)

Lights after Installation
(Inside and Outside Facility)

Classroom 1 (with Installed Lights)

Dormitory with Installed Lights

Classroom 2 (with Installed Lights)

Source: Taken by JET

Pictures of Installation Works and Status of Installed System -4

Book Store Room (with Lights)

Teacher's Room (Office Building with Light)

Corridor Light at Latakweny Dispensary

Solar Drive Vaccination Fridge (MKS 044)

Operators Training

Operators Training (How-to of Tools)

Operators Training (Hands-on Training)

Source: Taken by JET

Pictures of Replacement and Related Works - 1

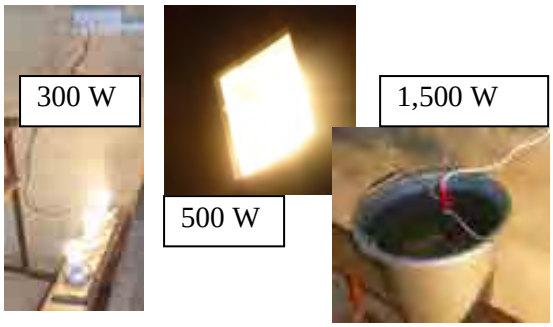
Measurement of CC after Replacement

Measurement of Battery after Replacement

Operators Training (Illaut)

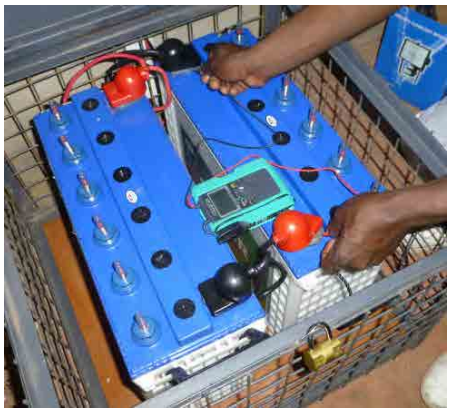
Operators Training (Angata)

Operation Test of Inverter and Measurements



Loads Test (to confirm Operation of Inverter)

Pictures of Replacement and Related Works - 2



Operation Test of Battery and Measurement

Operation Test of Lamps (Marti Pry School)

Project Signboard

Newly Replaced CC and Battery

Project for Establishment of Rural Electrification Model Using Renewable Energy
Sector: PV

Type Of Meeting	Meeting for the explanation of Lot-2 PV Projects
Date:	18th October 2013
List Of Attendees	1. Yuka Nakagawa- JET Project Team 2. Geofrey Ochieng –JET Project Team 3. Hannington Madegu-JET Project Team 4. Hanningtone Gochi-REA 5. (See respective item)

SUMMARY OF FINDINGS AND DISCUSSIONS

1. Meeting with Baragoi District Education Office

(1) Person in charge: Mr. Joel Murage, District Education Officer
Contact: 0721567331, E-mail: muragehoel66@gmail.com

(2) JET (JICA Expert Team) explained about the project objective, components of the project, project activities including income generation activities for mobile charging, overall schedule, and target primary school (Tuum, Marti, and Ilaut Primary Schools).

(3) District officer basically agreed with the project component.

(4) JET requested for close communication, reporting, and meeting before installation and O&M stage. JET also requested the financial support from school or local authority in case of generated income is not sufficient to replace battery. The District officer understood and agreed.

(5) Numbers of students in target primary schools are:
Ilaut: 250, Marti: 210, Tumm: 369.

(6) Tuum is a day school and there are plans to incorporate boarding section.

(7) District Education Officer mentioned that those target schools have no possibility to receive grid power in the near future and mobile charging will be most welcomed. Many people in the area already have mobile phones.

(8) In Tuum community, there is an NGO called Steven Covan who operates mobile charging business.

(9) District Officer mentioned that electricity supply for laptop is necessary provided by the Laptop project. He hopes to have 89 laptops in Tuum Primary School, which is equivalent to the number of students in class one in the school. JET mentioned if it needs to provide power to 100 number of laptops, the system will be quite large (20W x 5hrs x 100nos = 10kWh). JET mentioned that the original project purpose is to supply for lighting demand and other small demand only, and explained that it needs to have discussions for the demand of the laptops.

(10) Baragoi is electrified by a mini-grid of diesel power station. Electricity is supplied 24 hours. There is no grid between Poror and Baragoi.

Meeting at Baragoi District Education Office

2. Meeting with Baragoi District Health Office

(1) Person in charge: Mr. Leufaano Sanny (Nurse)
Contact: 0720598220

(2) The person in charge for the health office was not available. JET explained about the project objective, components of the project, project activities including income generation activities for mobile charging, overall schedule, and target Dispensary (South Horr, Masikita, and Angata Nyanukei) to the nurse. JET handed project papers to the nurse and requested to explain to District health officer.

Meeting at Baragoi Health Office

Baragoi District Health Office

3. Meeting with Marti Primary School

(1) Person in charge: Mr. Samuel Akular, Headteacher, Marti
Contact: 0720904934

(2) JET explained about the project objective, components of the project, project activities including income generation activities for mobile charging, and overall schedule.

(3) H/T (Head Teacher) understood and agreed the project component.

(4) The school was established in 1965. It has 437 students (boys 234, girls 203). There are 8 teachers.

(5) School operation hour is 8 am to 3 pm. Pupils also attend early morning and evening preps between the hours of 6.00am-7.00am and 7.00pm-9.00pm respectively.

(6) Dormitory is not currently used. As soon as budget is secured, the dormitory will be operated. Most of the students come from the vicinal village.

(7) 75 W x 3 nos of solar panels are already installed. One PV panel installed in boy's dormitory is under operation with 600W inverter. Mobile phone charging is conducted. One battery installed in a classroom is already deteriorated and a teacher was dispatched to a town purchase new battery. The overall capacity is not enough.

(8) For main usage of lighting, they use pressured petro lamps. Lighting usage is 7-9 pm and 6-7am.

(9) Water is supplied from a community borehole, 2km from the school. The school pays for diesel oil cost at 200 kSh/2-weeks for the usage of the water. Diesel oil is purchased at Maralal.

(10) Common wild game present around the school includes, ostrich, hyena, cheetah, gazelle, antelope, and leopard. Also rare species include gray zebra. The nearest protected wildlife area is Kalomndang conservancy. Aloe vera is a medicinal plant found in the area which needs protection.

(11) The school uses fuel wood for cooking. Fuel wood is collected by children from their homes.

(12) Marty village was recently surveyed as the target of diesel-solar hybrid system by GTZ. It was not selected for the implementation.

Marty School Classroom and existing PV Panel

Battery, 600V Inverter and Mobile Charging

Boy's Dormitory

Girl's Dormitory

4. Meeting with County NEMA Office in Maralal

(1) Person in charge: Mr. Michael Njiiru
Contact: _Michael Njiru-contact 0725 902 140, michaelnjiru@gmail.com

(2) JET (JICA Expert Team) explained about the project objective, components of the project, project activities including income generation activities for mobile charging, overall schedule, and target primary schools and dispensaries.

(3) The officer understood the project component and provided positive view on the project.

(4) JET explained that the project description will be submitted to NEMA head office in Nairobi for easier coordination of the project. NEMA head office is aware of the project and any decision made about the project will always be communicated to the county office.

(5) The officer inquired about battery disposal. JET explained that battery can be recycled by manufacturer, and it is important to provide information to users so that they can ask supplier for the old battery recycling when they purchase new battery.

(6) The officer inquired about safety measurement. JET explained that internal electric work is the same as grid energy that is provided to general household, and internal wiring according to standard work is necessary. About security, JET also explained that putting battery inside a room and arrangement of watchman is necessary to prevent the system being stolen.

Meeting at NEMA County Office in Maralal

Type Of Meeting	Samburu Site Survey Memo

SUMMARY OF FINDINGS AND DISCUSSIONS

SAMBURU SITE SURVEY MEETINGS MEMO

Date: 6th Feb. 2014

1) Meeting with the county director for Education

Venue: Maralal (Samburu county education offices)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Willie Machocho	Samburu County Director Education	0722352464
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

JICA Export Team (JET) explained the purpose of the visit and the system to be installed at selected institution and requested for cooperation of County and District office of Ministry of Education.

Mr. William Machocho promised to cooperate with the JET and the contractor.

2) Meeting with the county director for Health

Venue: Maralal (Samburu county health offices-Maralal Hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Dr. Martin Thuranira	Samburu County Director of health	0722423038
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JICA Export Team (JET) explained the purpose of the visit and the system to be installed at selected institution and requested for cooperation from the County and District office of Health.
- Dr. Thuranira promised to support the project and also promised to inform the County Executive Council (CEC-health) about the project.
- JET also requested for information on health policies on energy and Dr. Thuranira promised to get the information whatever he can inform JET.

Date:7th Feb 2014

1) Site survey meeting- Angata Nanyukie Dispesary

Venue: Angata Nanyukie Dispesary

S. No.	NAME	ORGANISATION	CONTANTS
1	John Salasi	Nurse in charge Angata nanyukie Dispensary	0713498355
2	Bista Deepak	JET solar expert	0703889077

3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- For the installation of system and its components JET, Nurse in charge of dispensary and contractor's representative inspected the site and decided the installation points. JET requested contractor's representative to conduct the installation works according to the decision made.
- The nurse in charge requested an extra socket to be installed on the corridor of the dispensary main building to power a television for the purpose of community health education. JET explained that as this is rehabilitation work for the dispensary and there is no any new power supply to be added in old system by JET side. Therefore, JET requested, it should be deal directly between dispensary and installer if any new arrangement is required.
- JET explained and requested that the tree next to the staff quarter will make shadow over PV module; therefore it is required to trim timely when it grows taller.
- JET also requested for arrangement to be made for four people from the community including staff of dispensary to be trained on maintenance of the solar systems during the installation period.
- JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

2) Site survey meeting-Marti primary school

Venue: Marti primary school

S. No.	NAME	ORGANISATION	CONTANTS
1	Petro Echuka	Chairman of School Management Committee (SMC)	0705017319
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of the visit and requested for cooperation from the stake holders side.
- For installation of system and its components JET, Chairman of SMC (on behalf of the school head teacher) and contractor's representative inspected the site and decided the installation points. JET requested contractor's representative to conduct the installation works according to the decision made.
- JET requested for arrangement to be made for four people from the community including school staff to be trained on maintenance of the solar systems during the installation period.
- JET explained that the walls of proposed computer room planned to be repaired shall be finished before the installation time and SMC agreed the request.
- JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

3) **Meeting with Samburu North District Education Officer**

Venue: Baragoi (Samburu North health offices-Baragoi hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS

1	Julius Leseeto	Samburu North- District Public Health Officer(DPHO)	0722228650
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

JET explained the purpose of visit and the system planned to be installed at selected institution and requested for cooperation from the district health officers.
Mr. Leseeto promised to cooperate with the JICA expert team and the contractor.
JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

4) Meeting with Samburu North District Education Officer

Venue: Baragoi (Samburu North district education offices)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Joel Moorage	Samburu North- District Education Officer	0721567331
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of visit and the system planned to be installed at selected institution and requested for cooperation from the district education officers during the implementation of the project.
- Mr. Murage promised to work with the JICA expert team and the contractor to make the project a success.
- JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

Date:8th Feb 2014

1) Site survey meeting- Tuum primary school

Venue: Tuum primary school

S. No.	NAME	ORGANISATION	CONTANTS
1	Mr. Juma	Senior Teacher	0714433030
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of the visit and requested for cooperation from the stake holders side.
- For installation of system and its components JET, Mr. Juma (on behalf of the school head teacher) and contractor's representative inspected the site and decided the installation points. JET requested contractor's representative to conduct the installation works according to the decision made.

- From School side Room No. 11 was proposed to be the computer room.
- JET requested for arrangement to be made for four people from the community including from school staff to be trained on maintenance of the solar systems during the installation period.
- JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

2) Site survey meeting- Ilaut primary school

Venue: Ilaut primary school

S. No.	NAME	ORGANISATION	CONTANTS
1	Lemuntures L. joseph	Deputy Head teacher	0715553602
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of the visit and requested for cooperation from the stake holders side.
- For installation of system and its components JET, deputy head teacher (on behalf of the school head teacher) and contractor's representative inspected the site and decided the installation points. JET requested contractor's representative to conduct the installation works according to the decision made.
- The deputy head teacher requested for installation of a solar system in the newly build girls dormitory which was not in place during the initial site survey (November, 2013). JET explained that it will be tabled to the team's discussion and will be informed to JICA at same time. But at present situation JET cannot either confirm or guarantee the additional installation of any system. JET will inform institution when it is decided.
- JET requested for arrangement to be made for four people from the community including from school staff to be trained on maintenance of the solar systems during the installation period.
- JET explained that after arrangement the detail schedule will be finalized and contractor will inform their schedule to your institution for installation work.

3) Site survey meeting- South Horr dispensary

Venue: South Horr dispensary

S. No.	NAME	ORGANISATION	CONTANTS
1	Mike lenkaak	Nurse in charge south Horr dispensary	0726017364
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of the visit and requested for cooperation from the stake holders side.
- For installation of system and its components JET, nurse in charge and contractor's representative inspected the site and decided the installation points. JET requested contractor's representative to conduct the installation works according to the decision

made.

- JET requested that the trees near the staff quarters to be trimmed to avoid a shadow on the solar panels once installed.
- JET also requested for arrangement to be made for four people from the community including from dispensary to be trained on maintenance of the solar systems during the installation period.
- JET also suggested that the existing PV panels to be shifted to more suitable position in order to increase the efficiency of the system

Date:9th Feb 2014

1) Site survey meeting- Latakweny dispensary

Venue: Latakweny dispensary

S. No.	NAME	ORGANISATION	CONTANTS
1	Robert lepuloote	Chairman management committee	072009499
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957
4	George kemboi	Power point ltd(contractor)	0725352868

Points of discussion

- JET explained the purpose of the visit to the chairman and requested for cooperation from the stake holders side.
- JET express their disappointment with the poor corporation from the nurse in charge.
- JET requested the chairman to discuss with the Nurse in charge on the purpose of each room ,make a decision on the installation point and contact JET before 12th Feb 2014.
- JET also requested for arrangement to be made for four people from the community including from dispensary to be trained on maintenance of the solar systems during the installation period.

NOTE:

a) On 11th Feb 2014 Julius Leseeto (Samburu North- District Public Health Office) called the JET and apologized for the inconveniences .He also informed JET that discussion was in progress with the Latakweny dispensary nurse in charge to decide on the installation points.

b) On 11th Feb 2014 Harison (Latakweny dispensary nurse in charge) called JET and appologized for the inconveniences. JET sent the site drawing to him for the marking of the installation point.

c) On 12th Feb 2014 JET received the marked drawings .Decision on the installation point have been decided.

Type Of Meeting	Samburu Sites Pre-installation Memo

SUMMARY OF FINDIGS AND DISCUSSIONS

Date: 3rdAPRIL, 2014

1) Meeting with the Samburu county Ministry of Education Staff

Venue: Maralal (Samburu county Education offices)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Joseph Mithamo	Samburu County quality Assurance and standards officer	0722680924
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

Mr. Deepak explained the purpose of the visit and the system to be installed at selected institution. He also requested for cooperation of County and District office of Ministry of Education during and after Installation of the PV systems.

Mr. Mithamo promised to cooperate with the JET and the contractor.

2) Meeting with the Samburu county Health Staff

Venue: Maralal (Samburu county health offices-Maralal Hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Julius leseeto	Samburu County ,Chief officer for health	0722228650
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

- Mr. Deepak explained the purpose of the visit and the system to be installed at selected institution. He also requested for cooperation of County and District office of Ministry of Education during and after Installation of the PV systems.
- Mr. Lesetho promised to cooperate with the JET and the contractor.

Date: 4thAPRIL, 2014

Meeting with Samburu North District Education Officer

Venue: Baragoi (Samburu North health offices-Baragoi hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Edwin Imbayi	Samburu North- District Public Health Officer(DPHO)	0722109723

2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

JET explained the purpose of visit and the system planned to be installed at selected institution and requested for cooperation from the district health officers.

Mr Deepak also give the installation schedule and requested the officer to inform the institutions on the installation dates .

Mr. Imbayi promised to cooperate with the JICA expert team and the contractor.

1) Meeting with Samburu North District Education Officer

Venue: Baragoi (Samburu North district education offices)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Joel Murage	Samburu North- District Education Officer	0721567331
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

- JET explained the purpose of visit and the system planned to be installed at selected institution and requested for cooperation from the district education officers during the installation and after installation.
- Mr Deepak also give the installation schedule and requested the officer to inform the institutions on the installation dates .
- Mr. Murage promised to work with the JICA expert team and the contractor to make the project a success.

Type Of Meeting	Samburu Sites Post Installation Site Memo
Date:	3rd May 2014

SUMMARY OF FINDINGS AND DISCUSSIONS

1) Meeting with the Samburu county Ministry of Education Staff

Venue: Maralal (Samburu county Education offices)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Samuel Sarafino	Standards officer	0720590498
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

- After explaining the purpose of the visit Mr. Deepak informed the officer that the installation work was completed in all the sites and the systems were now in operation. He also explained that some modifications were to be done in some of the systems.
- Mr. Deepak also informed the officer that the batteries and charge controllers were to be changed for all the sites .He explained that after arrangement with the contractor the detail schedule will be finalized and sent to the education office via email.
- Mr.sarafino thanked the JET team For the support.

Meeting with the Samburu county Health Staff

Venue: Maralal (Samburu county health offices-Maralal Hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Julius leseeto	Samburu County,Chief officer for health	0722228650
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

- After explaining the purpose of the visit Mr. Deepak informed the officer that the installation work was completed in all the sites and the systems were now in operation. He also explained that some modifications were to be done in some of the systems.
- Mr. Deepak also informed the officer that the batteries and charge controllers were to be changed for all the sites .He explained that after arrangement with the contractor the detail schedule will be finalized and sent to the health office by email.
- Mr. Deepak also requested the officer to assist in monitoring of the sites especially the vaccination fridge in Latakwenyi. He requested the officer to monitor and advise on the usage of the vaccination fridge.
- Mr.lesetho was very grateful of the project and Requested for more similar projects in

samburu.

Meeting with Samburu North District Health Staff

Venue: Baragoi (Samburu North health offices-Baragoi hospital)

Attendees

S. No.	NAME	ORGANISATION	CONTANTS
1	Mr leitoro	Clinical officer	0729857725
2	Bista Deepak	JET solar expert	0703889077
3	Francis mworia	JET assistant	0720788957

Points of discussion

After explaining the purpose of the visit Mr. Deepak informed the officer that the installation work was completed in all the sites and the systems were now in operation. He also explained that some modifications were to be done in some of the systems.

Mr. Deepak also informed the officer that the batteries and charge controllers were to be changed for all the sites .He explained that after arrangement with the contractor the detail schedule will be finalized and sent to the health office by email.

Mr. Deepak also requested the officer to assist in monitoring of the sites especially the vaccination fridge in Latakwenyi. He requested the officer to monitor and advise on the usage of the vaccination fridge.

Mr.Leitoro thanked the JET and JICA on behaf of the samburu north district health officer .

Type Of Meeting	Lot 2 Site Visit Report
Date:	16th June 2014

SUMMARY OF FINDIGS AND DISCUSSIONS

Site Name: Angata Nanyokie **Date visited:** 16th June, 2014

1. The socket for the fridge was not installed .
2. The rehabilitated solar system runs only for six(6) hours .
3. Orientation of the sockets in the charging house need to be changed to either face sidewise or upwards.

Site Name: Marti primary school **Date visited:** 16th June, 2014

1. Charging controller installed in ***Girls dormitory 2*** is faulty(The whole system is not working)
2. The inverters for system in ***room 1 to 3 and office rooms*** goes off after running for a few minutes when all the lights are switched on.
3. The systems installed in ***room 4 to 8*** and the one installed in ***room 9 to 11*** have similar problem to the one in 2 above.
4. The charge controller for the system installed in the ***dining hall*** had an Error code E07 but resumed normal functioning after leaving the system unused for three days.
5. Sometimes one of the security lights in the girls dormitory does not turn on.
6. Orientation of the sockets in the charging house need to be changed to either face sidewise or upwards

Site Name: Latakweny Dispensary **Date visited:** 17th June, 2014

1. When the inverter installed in the ***outpatient block*** is turned on, it affects the radio signal(The radio communication is not clear with the inverter turned on)
2. One of the security lights in the outpatient block has a problem.(The inverter goes off immediately when the light is switched on)
3. The fridge temperature is always above 6° C and sometimes goes above 10° C at around midday(The fridge is not in use since They are still monitoring the temperatures for the fridge)
4. Orientation of the sockets in the charging house need to be changed to either face sidewise or

upwards

Site Name: Tuum Primary School **Date visited:** 18th June, 2014

1. The inverters for system in ***room 1 to 5*** goes off after running for a few minutes when all the lights are switched on.
2. The systems installed in ***staffroom & room 6 to 7*** and the one installed in ***room 8 to 11*** have similar problem to the one in 1 above.

Site Name: South Horr Dispensary **Date visited:** 18th June, 2014

1. Orientation of the sockets in the charging house need to be changed to either face sidewise or upwards

Site Name: Illaut primary school **Date visited:** 19th June, 2014

1. The inverters for system in ***room 5 to 8*** goes off after running for a few minutes when all the lights are switched on.
2. One of the security lights in room 4(system for ***room 1 to 4***) has a problem.(The inverter goes off immediately when the light is switched on)
3. Orientation of the sockets in the charging house need to be changed to either face sidewise or upwards

Project for Establishment of Rural Electrification Model Using Renewable Energy

Sector:PV

Organization: Kenya Power

Type Of Meeting	Site Memo
Date:	09-12 July 2014
List Of Attendees	1. Mr. Bista Deepak, JET 2. Ms. Yuka Nakagawa, JET 3. Mr. Francis, JET

SUMMARY OF DISCUSSION

Iltumtum Mixed Primary and Secondary School

- Technical Aspect

(1) Battery and other status is summarized as in following table.

Location	Battery Voltage	ρ (acid density)	Other Status
Dining room		1.14-1.15	Wiring of batteries (100 Ah x 6 nos.) was once technically not appropriate, which was fixed after modification work. Battery fluid was added.
Class Room 1-3	11.8 V	<1.1	Issue of particular system operation had been reported. Battery is bad state. Battery fluid was added.
Class Room 4-6	12.8 + 12.7 = 25.5 V	<1.1	Indicator of C/C was problem.
Boys Dormitory	13.14	1.255	Battery is working properly.. Except one, all bulbs were removed.
Girls Dormitory		1.27	Battery is working properly.
Teacher's Quarter			Battery liquid level is too low. It requires refilling battery fluid.
Charging Station	13.5	1.28-1.29	Battery is working properly.

C/C: Charge controller, ρ : Density (specific gravity), ρ <1.15: Problem, ρ =1.20-1.30: good status

(2) The school is preparing construction of two other classrooms. The school requested to install additional PV systems. JET explained it is preferable to extend wires from existing system for new classroom.

(3) Reportedly, many bulbs were blown off and renewed. Out of those, only one bulb was remaining in the dormitory room. In the school, 5 bulbs are replaced in one month.

- Operational Aspect

(4) Lighting usage is as follows:

- Dormitory: from 7 pm to 6 am
- Night time class: 7 pm to 9:00 pm
- Morning class: 5:30 am -7:30am

(5) Charging business customers: 10-13/day, hair cut customers: 5 children/day and 5 adults/day in average. Both are charged 20 KSh/time.

(6) The school requested to provide solar lantern at preferable price. JET recommended lot purchase from solar suppliers with estimation comparison.

(7) Number of solar kit and SHS owner is increasing at the surrounding area of the school, and charging business income is predicted to be decreased in the future.

(8) In May 2014, the charging business income was 8,340 Ksh and expense was 7,720 KSh (of which, 4,000 KSh/month is for salary of operator)

Olemoncho School

- Technical Aspect

(1) Battery status checking was conducted on 11 July (1st day) and 12 July (2nd day). Battery and other status is summarized as in following table.

Location	Battery Voltage	ρ (acid density)	Other Status
Charging House	Initial 13.2 V After watering 13.2V 2nd day: 12.8V	2nd day: 1.16-1.19	Battery was totally dried. Battery fluid was added. In 2nd day, charge was ongoing.
Nursery	Initial 12.9 V After watering 12.8V	2nd day: 1.15	Battery was dried. PV module may be cracked. On 2nd day, isolator was off and charging was not conducted.
Staff Quarter	Initial 12.4 V After watering 12.4V 2nd day: 12.3V	2nd day <1.1	Battery was dried but inside pole was wet. Battery fluid was added in the second day.
Staff Room 1	13.0 + 12.9 = 25.9V 2nd day 27V	1st day: 1.29 2nd day: 1.24	Battery was OK. Small amount of battery fluid was added.
Staff Room 2	Initial: 12.8 + 12.9 V After watering: 24.7V 2nd day: 26.7V	2nd day <1.1	Battery was totally dried. Battery fluid was filled. Vo=41.6V and charging was started after refill.
Boys Dormitory (Classroom?)	Initial: 12.7+12.7 V After watering:25.5 V 2nd day: 27.0V		Battery was totally dried. Vo=41.7 V. Battery fluid was refilled. After refill, charging was started.
Girls Dormitory (Classroom?)	Initial: 12.8 + 12.8 V After watering:24.7V 2nd day: 27.4V	2nd day <1.1	Battery was almost dried. Battery fluid was refilled. It was not sure if battery can revive. At first C/C was not functional, but after treatment, it started to work.

Vo: Open Circuit Voltage, C/C: Charge controller, ρ : Battery Density (specific gravity), ρ <1.15: Problem, 1.20< ρ <1.30: good status

(2) As a whole, the maintenance of system is found not properly carried on, and many of batteries were dried up. Further instruction to user is necessary.

(3) TV disk antenna was installed at teachers room and staff room.

(4) There is very small mobile charging user (1 nos./day). Hair cut is used for 5 persons/day.

Action Items	Person Responsible
Further instruction of battery maintenance	JET all

Project for Establishment of Rural Electrification Model Using Renewable Energy
Sector: PV

Type Of Meeting	Site Visit
Date:	11th and 12th, July 2014
List Of Attendees	1. Mr. Bista Deepak, JET 2. M.s Yuka Nakagawa,JET 3. Francis Mworia,JET Assistant
Site Name	Olemoncho Primary School

SUMMARY OF FINDIGS AND DISCUSSIONS

1. The status the solar PV systems is as summarized as in following table.

Location	Status	Remark
Charging House	1. The electrolyte level of battery pockets were very low (dry).	• A little battery acid and battery water was added to get same level in every pockets of battery.
Nursery	1. The electrolyte level of the battery pockets were very low(Almost dry) 2. Out of 2 PV modules one is broken due to stone throwing.	• A little battery acid and battery water was added to get same level in every pockets of battery. • generated current was low from installed PV system. It seems one of the PV module is not generating power. Due to the time limit and availability of ladder it was not been able to confirm.
Girls dormitory (present staff quarters)	1. The electrolyte level of the battery pockets were very low 2. Battery voltage and specific gravity was low. 3. A TV antenna, television and DVD player have been installed in one of the rooms.	• Battery water was added to get same level in every pocket of the battery.
Staff quarters	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was slightly different between pockets. 3. The system was modified from DC 12V system to DC 24V system.	• The system performance preferable. • A small amount of battery water was added to get same level in every pocket of the battery.

Classroom 3 to 4 and staff room	1. The electrolyte level of the battery pockets were very low 2. Battery voltage and specific gravity was low. 3. The system was modified from DC 12V system to DC 24V system.	• Battery water was added to get same level in every pocket of the battery. • A TV antenna and a Television have been installed in the Staffroom(offices)Tv power rating is 45 - 180 Watts.
Boys Dormitory (Present Girls dormitory and classroom)	1. The electrolyte level of battery pockets were very low (almost dry). 2. The system was modified from DC 12V system to DC 24V system. .	• Battery water was added to get same level in every pocket of the battery.
Classroom 5-8(Present classes and boys dormitory)	1. The electrolyte level of the battery pockets were very low.(dry) 2. The system was modified from DC 12V system to DC 24V system.	• Battery water was added to get same level in every pocket of the battery.

2. As a whole, the maintenance of system is found not properly carried on, and many of batteries were dried up. Further instruction to user is necessary.
3. TV disk antenna was installed at teachers room(staff quarters formerly girls dormitory) and staff room.
4. There is very small mobile charging user (1 nos./day). Hair cut is used for 5 persons/day.

Action Items	Person Responsible
Monitoring and further instruction of PV system maintenance	JET all

Project for Establishment of Rural Electrification Model Using Renewable Energy
Sector: PV

Type Of Meeting	SiteVisit
Date:	13th-14th,July 2014
List Of Attendees	1. Mr. Bista Deepak, JET 2. Francis Mworia, JET Assistant
Site Name	Ilkinyetti Dispensary

SUMMARY OF FINDIGS AND DISCUSSIONS

(1) The status of the solar PV systems is as summarized as in following table.

Location	Status	Remark
Main building	1. Electrolyte level of some battery pockets were very low (almost dry). 2. The system was modified from 12V system to a 24V system. 3. One of the batteries had low specific gravity.	• A new battery was added to the system during the modification from DC12V to DC 24V system. • All batteries were refilled with battery water to the right levels • Out of three existing batteries one with low in specific gravity and voltage is replaced by the battery initially used for vaccination fridge. • Next day, the voltage of battery was normal. Specific gravity of electrolyte was still to recover.
Sub-consultation	1. Electrolyte level of one of the pockets of one battery was very low (almost dry).	• All the batteries were refilled to the right levels.
Staff Quarters	1. Battery electrolyte level was at lower side in all pockets.	• Battery initially used at main building was added to the system. • Battery water filled to the right level
Charging house	1. Battery electrolyte level was in higher side. 2. The electrolyte specific gravity is in good status.	• The system performance was preferable.
Fridge system	1. A new Solar direct drive vaccination fridge was installed. Existing solar panel (120W x 2 nos.) was used to supply power to newly installed fridge. 2. Unnecessary existing equipment was removed from the system. 3. The existing cable from PV module to the fridge is changed to larger size cable (16mm^2).	• Existing battery of vaccination fridge is installed at main building system, replacing the battery with lower specific gravity. • Monitoring of the fridge is ongoing (by person in charge of institution)

Action Items	Person Responsible
Monitoring and further instruction of PV system operation and maintenance.	JET all

Type Of Meeting	SiteVisit
Date:	17th July 2014
List Of Attendees	1. Mr. Bista Deepak, JET 2. Francis Mworia,JET Assistant
Site Name	Olkinyei Dispensary

SUMMARY OF FINDIGS AND DISCUSSIONS

(1) The status of installed solar PV systems is as summarized as in following table.

Location	Status	Remark
Main building	1. Battery electrolyte level was ok. 2. Battery electrolyte specific gravity and voltage was in good status.	• The system performance was preferable.
Staff Quarters 1	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was slightly difference between pockets.	• The system performance was preferable. • Battery water was added to get same level in every pockets of battery. • The cable from the charge controller to the battery is less than 10mm² recommended replacing with larger cable size (minimum 10mm²). • One of the wires between the charge controller and battery bank is blue in color recommended to change with proper color code wire/cable.
Staff Quarters 2	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was slightly difference between pockets.	• The system performance was preferable. • Battery water was added to get same level in every pockets of battery.
Charging house	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was slightly difference between pockets.	• The system performance was preferable. • Battery water was added to get same level in every pockets of battery.

Note:

All installed PV systems are well maintained.

Type Of Meeting	Site Visit(Monitoring of the PV system after modification)
Date:	18th,July 2014
List Of Attendees	1. Mr. Bista Deepak, JET 2. Francis Mworia,JET Assistant
Site Name	Olemoncho Primary School

SUMMARY OF FINDIGS AND DISCUSSIONS

1. The status the solar PV systems is as summarized as in following table.

Location	Status	Remark
Charging House	1. Battery voltage and electrolyte specific gravity was in good status.	• Battery voltage and specific gravity is recovering comparing to 1st inspection done on 11th July.
Nursery	1. Battery voltage was in good status. 2. Out of 2 PV modules one is broken due to stone throwing.	• PV module is charging the battery. • Due to one of the module is not generating any power, charging current became half hence, battery is taking longer time to recover. • Need demand side management to control the use until battery recovers.
Girls dormitory (present staff quarters)	1. Battery voltage and specific gravity is still low	• The installed DVD player with dish TV antenna is consuming more power. Required demand side management to recover battery.
Staff quarters	1. Battery voltage and electrolyte specific gravity was in good status.	• The system performance preferable
Classroom 3 to 4 and staff room	1. The battery voltage and electrolyte specific gravity is still at lower side.	• The Battery is still not yet recovered to final stage. Required demand side management of load utilization.
Boys Dormitory (Present Girls dormitory and classroom)	1. Battery voltage and electrolyte specific gravity level is preferable.	1. The battery voltage and electrolyte specific gravity is recovering well. Still need demand side management at load side use.
Classroom 5-8(Present classes and boys dormitory)	1. Battery voltage and electrolyte specific gravity is still at lower side.	2. The battery voltage and electrolyte specific gravity is recovering slowly. Still need demand side management at load side use.

2. From the hearing, installed Dish TV antenna with TV and DVD player in the teachers room is found to be used at least 2 to 3 hours a day. Though they haven't had any power problems JET inspection team advised them on how to conserve the power

especially on cloudy days to avoid over draining the battery.

3. Another Dish TV antenna with TV set installed in the staffroom (office) is being used at least 45minute a day.
4. JET inspection team suggested that teachers and staff using the TV set need to pay a some amount for watching the TV in order to contribute to maintenance cost of the PV systems. Teachers and school management committee to decide the price and keep monthly records.
5. It was noted that despite the advice on PV system management during our previous site inspection on 11th July 2014, not any definite/reliable decision/movement had made for the system operation and maintenance. There was no responsible person to deal with PV systems maintenance.

Action Items	Person Responsible
Monitoring and further instruction of PV system maintenance	JET all

Project for Establishment of Rural Electrification Model Using Renewable Energy
Sector: PV

Type Of Meeting	Site Visit
Date:	6th, November 2014
List Of Attendees	Francis Mworia,JET Assistant
Site Name	Iltumtum Primary School

SUMMARY OF FINDIGS AND DISCUSSIONS

1. The status the solar PV systems is as summarized as in following table.

Location	Status	Remark
Classroom 1 to 3	1. Battery voltage and specific gravity for battery Number 1 was Ok. 2. The specific gravity for pocket number 1 of battery number 2 was very low (less than 1.1) 3. The Electrolyte level was on the lower side apart from pocket 1 of battery number 2 which was on the maximum side.	• Teachers advised to refill the batteries with battery water.
Classroom 4 to 8	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was the lower side. 3. The isolator which was found not to be performing well during the inspection done on 7th Oct 2014 was replaced with a new one of the same type and rating.	• The system performance preferable. • Teachers advised to refill the batteries.
Staff quarters 1	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was the lower side.	• The system performance preferable. • Teachers advised to refill the batteries.
Staff quarters 2	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was the lower side.	• The system performance preferable. • Teachers advised to refill the batteries.
Boys Dormitory	1. Battery voltage and electrolyte specific gravity was in good status. 2. Battery electrolyte level was on the maximum side 3. The double pole circuit breaker which was installed temporally on 9th Oct 2014 was replaced with 35Amps isolator.	• The system is ok

Girls dormitory, store and kitchen	1. Battery voltage and electrolyte specific gravity was in good status. 2. Electrolyte level was on the maximum side.	• The system performance is ok
Dining Hall.	1. Battery electrolyte specific gravity was found to be less than 1.17 2. Electrolyte level was on the higher side.	• JET team advised the school teacher to practice demand management since present battery capacity is smaller than the designed capacity(broken battery was disconnected from the system by JET team on 7th Oct 2014)

Action Items	Person Responsible

Attachment J Additional Study on Grid Connection of Off-grid PV System

Attachment J-1 Assessment and Cash Flows for Grid Connection Case Study

Attachment J-1 Assessment and Cash Flows for Grid Connection Case Study

Table J-1.1 PV Energy and Benefit Calculation in 30 Years for Reverse-Flow System

Year	Iltumtum								Olemoncho							
	Generated PV energy	PV enerygy Consump-tion in School day	PV energy Consum-ption in Holiday	Annual Consum-ption	Excess PV energy in School days	Excess PV enegy in holidays	Annual Benefit	Benefit loss due to outage	Generated PV energy	PV enerygy Consump-tion in School day	PV energy Consum-ption in Holiday	Annual Consum-ption	Excess PV energy in School days	Excess PV enegy in holidays	Annual Benefit	Benefit loss due to outage
	kWh/day	kWh/day	kWh/day	kWh/yr	kWh/yr	kWh/yr	KSh.	KSh	kWh/day	kWh/day	kWh/day	kWh/yr	kWh/yr	kWh/yr	KSh.	KSh
1	9.98	7.49	4.14	2,413	669	561	67,385	5,980	7.84	5.93	2.99	1,883	513	465	52,945	4,699
2	9.88	8.24	4.55	2,654	440	511	66,704	5,920	7.76	6.53	3.29	2,071	333	429	52,410	4,651
3	9.78	9.07	5.01	2,919	192	458	66,023	5,860	7.68	7.18	3.62	2,278	136	390	51,875	4,604
4	9.68	9.68	5.51	3,132	-	400	65,343	5,799	7.60	7.60	3.98	2,428	-	348	51,341	4,556
5	9.58	9.58	6.06	3,158	-	337	64,662	5,739	7.52	7.52	4.38	2,444	-	302	50,806	4,509
6	9.48	9.48	6.67	3,189	-	270	63,981	5,678	7.44	7.44	4.82	2,465	-	252	50,271	4,462
7	9.37	9.37	7.33	3,226	-	196	63,301	5,618	7.37	7.37	5.30	2,490	-	198	49,736	4,414
8	9.27	9.27	8.07	3,269	-	116	62,620	5,558	7.29	7.29	5.83	2,520	-	140	49,201	4,367
9	9.17	9.17	8.87	3,319	-	29	61,939	5,497	7.21	7.21	6.41	2,554	-	76	48,667	4,319
10	9.07	9.07	9.07	3,311	-	-	61,259	5,437	7.13	7.13	7.05	2,595	-	7	48,132	4,272
11	8.97	8.97	8.97	3,274	-	-	60,578	5,376	7.05	7.05	7.05	2,573	-	-	47,597	4,224
12	8.87	8.87	8.87	3,238	-	-	59,897	5,316	6.97	6.97	6.97	2,544	-	-	47,062	4,177
13	8.77	8.77	8.77	3,201	-	-	59,217	5,255	6.89	6.89	6.89	2,515	-	-	46,527	4,129
14	8.67	8.67	8.67	3,164	-	-	58,536	5,195	6.81	6.81	6.81	2,486	-	-	45,993	4,082
15	8.57	8.57	8.57	3,127	-	-	57,855	5,135	6.73	6.73	6.73	2,457	-	-	45,458	4,034
16	8.47	8.47	8.47	3,091	-	-	57,175	5,074	6.65	6.65	6.65	2,428	-	-	44,923	3,987
17	8.37	8.37	8.37	3,054	-	-	56,494	5,014	6.57	6.57	6.57	2,399	-	-	44,388	3,939
18	8.27	8.27	8.27	3,017	-	-	55,813	4,953	6.49	6.49	6.49	2,370	-	-	43,853	3,892
19	8.16	8.16	8.16	2,980	-	-	55,133	4,893	6.42	6.42	6.42	2,342	-	-	43,319	3,845
20	8.06	8.06	8.06	2,943	-	-	54,452	4,833	6.34	6.34	6.34	2,313	-	-	42,784	3,797
21	7.96	7.96	7.96	2,907	-	-	53,772	4,772	6.26	6.26	6.26	2,284	-	-	42,249	3,750
22	7.86	7.86	7.86	2,870	-	-	53,091	4,712	6.18	6.18	6.18	2,255	-	-	41,714	3,702
23	7.76	7.76	7.76	2,833	-	-	52,410	4,651	6.10	6.10	6.10	2,226	-	-	41,179	3,655
24	7.66	7.66	7.66	2,796	-	-	51,730	4,591	6.02	6.02	6.02	2,197	-	-	40,645	3,607
25	7.56	7.56	7.56	2,759	-	-	51,049	4,531	5.94	5.94	5.94	2,168	-	-	40,110	3,560
26	7.46	7.46	7.46	2,723	-	-	50,368	4,470	5.86	5.86	5.86	2,139	-	-	39,575	3,512
27	7.36	7.36	7.36	2,686	-	-	49,688	4,410	5.78	5.78	5.78	2,110	-	-	39,040	3,465
28	7.26	7.26	7.26	2,649	-	-	49,007	4,349	5.70	5.70	5.70	2,081	-	-	38,505	3,417
29	7.16	7.16	7.16	2,612	-	-	48,326	4,289	5.62	5.62	5.62	2,052	-	-	37,971	3,370
30	7.06	7.06	7.06	2,575	-	-	47,646	4,229	5.54	5.54	5.54	2,024	-	-	37,436	3,322
Average	8.52	8.36	7.52	2,970	43	96	57,515	5,104	6.69	6.57	5.79	2,323	33	87	45,190	4,011

Table J-1.2 PV Energy and Benefit Calculation in 30 Years for Non Reverse-Flow System

Year	Iltumtum								Olemoncho							
	Generated PV energy	PV enerygy Consump-tion in School day	PV energy Consum-ption in Holiday	Annual Consum-ption	Excess PV energy in School days	Excess PV enegy in holidays	Annual Benefit	Benefit loss due to outage	Generated PV energy	PV enerygy Consump-tion in School day	PV energy Consum-ption in Holiday	Annual Consum-ption	Excess PV energy in School days	Excess PV enegy in holidays	Annual Benefit	Benefit loss due to outage
	kWh/day	kWh/day	kWh/day	kWh/yr	kWh/yr	kWh/yr	KSh.	KSh	kWh/day	kWh/day	kWh/day	kWh/yr	kWh/yr	kWh/yr	KSh.	KSh
1	9.98	7.49	4.14	2,413	-	-	44,637	-	7.84	5.93	2.99	1,883	-	-	34,834	-
2	9.88	8.24	4.55	2,654	-	-	49,100	-	7.76	6.53	3.29	2,071	-	-	38,318	-
3	9.78	9.07	5.01	2,919	-	-	54,010	-	7.68	7.18	3.62	2,278	-	-	42,150	-
4	9.68	9.68	5.51	3,132	-	-	57,943	-	7.60	7.60	3.98	2,428	-	-	44,910	-
5	9.58	9.58	6.06	3,158	-	-	58,420	-	7.52	7.52	4.38	2,444	-	-	45,223	-
6	9.48	9.48	6.67	3,189	-	-	58,995	-	7.44	7.44	4.82	2,465	-	-	45,607	-
7	9.37	9.37	7.33	3,226	-	-	59,677	-	7.37	7.37	5.30	2,490	-	-	46,069	-
8	9.27	9.27	8.07	3,269	-	-	60,478	-	7.29	7.29	5.83	2,520	-	-	46,616	-
9	9.17	9.17	8.87	3,319	-	-	61,409	-	7.21	7.21	6.41	2,554	-	-	47,257	-
10	9.07	9.07	9.07	3,311	-	-	61,259	-	7.13	7.13	7.05	2,595	-	-	48,002	-
11	8.97	8.97	8.97	3,274	-	-	60,578	-	7.05	7.05	7.05	2,573	-	-	47,597	-
12	8.87	8.87	8.87	3,238	-	-	59,897	-	6.97	6.97	6.97	2,544	-	-	47,062	-
13	8.77	8.77	8.77	3,201	-	-	59,217	-	6.89	6.89	6.89	2,515	-	-	46,527	-
14	8.67	8.67	8.67	3,164	-	-	58,536	-	6.81	6.81	6.81	2,486	-	-	45,993	-
15	8.57	8.57	8.57	3,127	-	-	57,855	-	6.73	6.73	6.73	2,457	-	-	45,458	-
16	8.47	8.47	8.47	3,091	-	-	57,175	-	6.65	6.65	6.65	2,428	-	-	44,923	-
17	8.37	8.37	8.37	3,054	-	-	56,494	-	6.57	6.57	6.57	2,399	-	-	44,388	-
18	8.27	8.27	8.27	3,017	-	-	55,813	-	6.49	6.49	6.49	2,370	-	-	43,853	-
19	8.16	8.16	8.16	2,980	-	-	55,133	-	6.42	6.42	6.42	2,342	-	-	43,319	-
20	8.06	8.06	8.06	2,943	-	-	54,452	-	6.34	6.34	6.34	2,313	-	-	42,784	-
21	7.96	7.96	7.96	2,907	-	-	53,772	-	6.26	6.26	6.26	2,284	-	-	42,249	-
22	7.86	7.86	7.86	2,870	-	-	53,091	-	6.18	6.18	6.18	2,255	-	-	41,714	-
23	7.76	7.76	7.76	2,833	-	-	52,410	-	6.10	6.10	6.10	2,226	-	-	41,179	-
24	7.66	7.66	7.66	2,796	-	-	51,730	-	6.02	6.02	6.02	2,197	-	-	40,645	-
25	7.56	7.56	7.56	2,759	-	-	51,049	-	5.94	5.94	5.94	2,168	-	-	40,110	-
26	7.46	7.46	7.46	2,723	-	-	50,368	-	5.86	5.86	5.86	2,139	-	-	39,575	-
27	7.36	7.36	7.36	2,686	-	-	49,688	-	5.78	5.78	5.78	2,110	-	-	39,040	-
28	7.26	7.26	7.26	2,649	-	-	49,007	-	5.70	5.70	5.70	2,081	-	-	38,505	-
29	7.16	7.16	7.16	2,612	-	-	48,326	-	5.62	5.62	5.62	2,052	-	-	37,971	-
30	7.06	7.06	7.06	2,575	-	-	47,646	-	5.54	5.54	5.54	2,024	-	-	37,436	-
Average	8.52	8.36	7.52	2,970	-	-	54,939	-	6.69	6.57	5.79	2,323	-	-	42,977	-

Table J-1.3 Result of Financial Analysis (Scenario: Reverse-flow without Battery, Iltumtum)

Financial Analysis (Scenario: Reverse-flow without battery, Iltumtum)

Tariff rate	18.5	KSh./kWh
Average Energy supplied from PV	2,551	kWh/year
Average Power Cut Hours	2.13	hrs/day
Average Benefit from PV system	55,512	KSh./year
Investment Cost	848,685	KSh.
Annual O&M Cost	41,291	
Discount rate	10%	
Project year	20	Years
Tax	0%	(Exempted)

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	2,199	1,120	61,404	848,685	41,291	889,976	-828,572
2	2,309	976	60,784		41,291	41,291	19,493
3	2,426	827	60,164		41,291	41,291	18,873
4	2,548	671	59,543		41,291	41,291	18,252
5	2,676	509	58,923		41,291	41,291	17,632
6	2,763	388	58,303		41,291	41,291	17,012
7	2,739	379	57,683		41,291	41,291	16,392
8	2,714	370	57,062		41,291	41,291	15,771
9	2,689	362	56,442		41,291	41,291	15,151
10	2,665	353	55,822		41,291	41,291	14,531
11	2,640	344	55,202		41,291	41,291	13,911
12	2,615	335	54,581		41,291	41,291	13,290
13	2,590	326	53,961		41,291	41,291	12,670
14	2,566	318	53,341		41,291	41,291	12,050
15	2,541	309	52,721		41,291	41,291	11,430
16	2,516	300	52,101		41,291	41,291	10,810
17	2,492	291	51,480		41,291	41,291	10,189
18	2,467	282	50,860		41,291	41,291	9,569
19	2,442	273	50,240		41,291	41,291	8,949
20	2,417	265	49,620		41,291	41,291	8,329
	Total		1,110,237	848,685	825,820	1,674,505	(564,268)

NPV(Benefit)= 488,402 NPV(Cost)= 1,123,065

FIRR= #NUM!

RoI= -33.70%

NPV= -634,663

B/C= 0.4349

Table J-1.4 Result of Financial Analysis (Scenario: Reverse-flow with Battery, Iltumtum)

Financial Analysis (Scenario: Reverse-flow with battery, Iltumtum)

Tariff rate	18.5	KSh./kWh	
Average Energy supplied from PV	2,799	kWh/year	
Average Power Cut Hours	2.13	hrs/day	
Average Benefit from PV system	60,918	KSh./year	
Investment Cost	993,735	KSh.	
Annual O&M Cost	71,810		
Discount rate	10%		
Project year	20	Years	Depreciation: 0%
Tax	0%	(Exempted)	

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	2,413	1,230	67,385	993,735	71,810	1,065,545	-998,160
2	2,534	1,071	66,704		71,810	71,810	-5,106
3	2,662	907	66,023		71,810	71,810	-5,786
4	2,796	736	65,343		71,810	71,810	-6,467
5	2,936	559	64,662		71,810	71,810	-7,148
6	3,033	426	63,981		71,810	71,810	-7,828
7	3,005	416	63,301		71,810	71,810	-8,509
8	2,978	407	62,620		71,810	71,810	-9,190
9	2,951	397	61,939		71,810	71,810	-9,870
10	2,924	387	61,259		71,810	71,810	-10,551
11	2,897	378	60,578		71,810	71,810	-11,231
12	2,870	368	59,897		71,810	71,810	-11,912
13	2,843	358	59,217		71,810	71,810	-12,593
14	2,816	349	58,536		71,810	71,810	-13,273
15	2,788	339	57,855		71,810	71,810	-13,954
16	2,761	329	57,175		71,810	71,810	-14,635
17	2,734	319	56,494		71,810	71,810	-15,315
18	2,707	310	55,813		71,810	71,810	-15,996
19	2,680	300	55,133		71,810	71,810	-16,677
20	2,653	290	54,452		71,810	71,810	-17,357
	Total		1,218,367	993,735	1,436,190	2,429,925	(1,211,558)

NPV(Benefit)= 535,970 NPV(Cost)= 1,514,750

FIRR= #DIV/0!

RoI= -49.86%

NPV= -978,781

B/C= 0.3538

Table J-1.5 Result of Financial Analysis (Scenario: Non Reverse-flow with Battery, Iltumtum)

Financial Analysis (Scenario: Non-reverse flow with battery, Iltumtum)

Tariff rate	18.5	KSh./kWh	
Average Energy supplied from PV	2,799	kWh/year	
Average Power Cut Hours	2.13	hrs/day	
Average Benefit from PV system	51,783	KSh./year	
Investment Cost	562,685	KSh.	
Annual O&M Cost	61,434		
Discount rate	10%		
Project year	20	Years	Depreciation: 0%
Tax	0%	(Exempted)	

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	2,199	1,230	44,637	562,685	61,434	624,119	-579,483
2	2,309	1,071	46,883		61,434	61,434	-14,551
3	2,426	907	49,243		61,434	61,434	-12,191
4	2,548	736	51,722		61,434	61,434	-9,713
5	2,676	559	54,325		61,434	61,434	-7,109
6	2,763	426	56,102		61,434	61,434	-5,332
7	2,739	416	55,600		61,434	61,434	-5,834
8	2,714	407	55,099		61,434	61,434	-6,336
9	2,689	397	54,597		61,434	61,434	-6,837
10	2,665	387	54,095		61,434	61,434	-7,339
11	2,640	378	53,594		61,434	61,434	-7,841
12	2,615	368	53,092		61,434	61,434	-8,342
13	2,590	358	52,590		61,434	61,434	-8,844
14	2,566	349	52,089		61,434	61,434	-9,345
15	2,541	339	51,587		61,434	61,434	-9,847
16	2,516	329	51,086		61,434	61,434	-10,349
17	2,492	319	50,584		61,434	61,434	-10,850
18	2,467	310	50,082		61,434	61,434	-11,352
19	2,442	300	49,581		61,434	61,434	-11,854
20	2,417	290	49,079		61,434	61,434	-12,355
	Total		1,035,666	562,685	1,228,686	1,791,371	(755,704)

NPV(Benefit)=	437,831	NPV(Cost)=	1,034,557
		FIRR=	**#DIV/0!**
		RoI=	**-42.19%**
		NPV=	**-596,726**
		B/C=	**0.4232**

Table J-1.6 Result of Financial Analysis (Scenario: Reverse-flow without Battery, Olemoncho)

Financial Analysis (Scenario: Reverse-flow without battery, Olemoncho)

Tariff rate	18.5	KSh./kWh	
Average Energy supplied from PV	1,975	kWh/year	
Average Power Cut Hours	2.13	hrs/day	
Average Benefit from PV system	43,616	KSh./year	
Investment Cost	712,065	KSh.	
Annual O&M Cost	32,086		
Discount rate	10%		
Project year	20	Years	Depreciation: 0%
Tax	0%	(Exempted)	

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	1,716	892	48,246	712,065	32,086	744,151	-695,905
2	1,802	779	47,759		32,086	32,086	15,673
3	1,893	662	47,271		32,086	32,086	15,185
4	1,988	541	46,784		32,086	32,086	14,698
5	2,088	414	46,297		32,086	32,086	14,211
6	2,088	388	45,809		32,086	32,086	13,723
7	2,088	362	45,322		32,086	32,086	13,236
8	2,088	335	44,835		32,086	32,086	12,749
9	2,085	312	44,347		32,086	32,086	12,261
10	2,066	305	43,860		32,086	32,086	11,774
11	2,046	298	43,373		32,086	32,086	11,287
12	2,027	291	42,885		32,086	32,086	10,799
13	2,008	284	42,398		32,086	32,086	10,312
14	1,988	277	41,911		32,086	32,086	9,825
15	1,969	270	41,423		32,086	32,086	9,337
16	1,949	263	40,936		32,086	32,086	8,850
17	1,930	257	40,449		32,086	32,086	8,363
18	1,910	250	39,961		32,086	32,086	7,875
19	1,891	243	39,474		32,086	32,086	7,388
20	1,872	236	38,987		32,086	32,086	6,901
	Total		872,329	712,065	641,720	1,353,785	(481,456)

NPV(Benefit)=	383,745	NPV(Cost)=	920,498
		FIRR=	**#NUM!**
		RoI=	**-35.56%**
		NPV=	**-536,753**
		B/C=	**0.4169**

Table J-1.7 Result of Financial Analysis (Scenario: Reverse-flow with Battery, Olemoncho)

Financial Analysis (Scenario: Reverse-flow with battery, Olemoncho)

Tariff rate	18.5	KSh./kWh	
Average Energy supplied from PV	2,167	kWh/year	
Average Power Cut Hours	2.13	hrs/day	
Average Benefit from PV system	47,864	KSh./year	
Investment Cost	751,765	KSh.	
Annual O&M Cost	52,432		
Discount rate	10%		
Project year	20	Years	Depreciation: 0%
Tax	0%	(Exempted)	

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	1,883	979	52,945	751,765	52,432	804,197	-751,252
2	1,978	855	52,410		52,432	52,432	-21
3	2,077	727	51,875		52,432	52,432	-556
4	2,182	593	51,341		52,432	52,432	-1,091
5	2,292	455	50,806		52,432	52,432	-1,626
6	2,292	426	50,271		52,432	52,432	-2,161
7	2,292	397	49,736		52,432	52,432	-2,695
8	2,292	368	49,201		52,432	52,432	-3,230
9	2,288	342	48,667		52,432	52,432	-3,765
10	2,267	335	48,132		52,432	52,432	-4,300
11	2,246	327	47,597		52,432	52,432	-4,835
12	2,224	320	47,062		52,432	52,432	-5,369
13	2,203	312	46,527		52,432	52,432	-5,904
14	2,182	304	45,993		52,432	52,432	-6,439
15	2,160	297	45,458		52,432	52,432	-6,974
16	2,139	289	44,923		52,432	52,432	-7,509
17	2,118	281	44,388		52,432	52,432	-8,043
18	2,097	274	43,853		52,432	52,432	-8,578
19	2,075	266	43,319		52,432	52,432	-9,113
20	2,054	259	42,784		52,432	52,432	-9,648
	Total		957,288	751,765	1,048,634	1,800,399	(843,110)
	NPV(Benefit)=		421,119			NPV(Cost)=	1,129,803
						FIRR=	**#DIV/0!**
						RoI=	**-46.83%**
						NPV=	**-708,684**
						B/C=	**0.3727**

Table J-1.8 Result of Financial Analysis (Scenario: Non Reverse-flow with Battery, Olemoncho)

Financial Analysis (Scenario: Non-reverse flow with battery, Olemoncho)

Tariff rate	18.5	KSh./kWh	
Average Energy supplied from PV	2,167	kWh/year	
Average Power Cut Hours	2.13	hrs/day	
Average Benefit from PV system	40,089	KSh./year	
Investment Cost	480,535	KSh.	
Annual O&M Cost	37,446		
Discount rate	10%		
Project year	20	Years	Depreciation: 0%
Tax	0%	(Exempted)	

Year	Internal consumption from PV (kWh)	Net energy sold to Grid (kWh)	Revenue	Cost			Benefit
				Initial Investment	O&M	Total Cost	
			KSh	KSh	KSh	KSh	NPR
1	1,883	979	34,834	480,535	37,446	517,981	-483,146
2	1,978	855	36,588		37,446	37,446	-858
3	2,077	727	38,429		37,446	37,446	984
4	2,182	593	40,364		37,446	37,446	2,918
5	2,292	455	42,395		37,446	37,446	4,950
6	2,292	426	42,395		37,446	37,446	4,950
7	2,292	397	42,395		37,446	37,446	4,950
8	2,292	368	42,395		37,446	37,446	4,950
9	2,288	342	42,334		37,446	37,446	4,888
10	2,267	335	41,940		37,446	37,446	4,494
11	2,246	327	41,546		37,446	37,446	4,100
12	2,224	320	41,151		37,446	37,446	3,706
13	2,203	312	40,757		37,446	37,446	3,312
14	2,182	304	40,363		37,446	37,446	2,917
15	2,160	297	39,969		37,446	37,446	2,523
16	2,139	289	39,575		37,446	37,446	2,129
17	2,118	281	39,181		37,446	37,446	1,735
18	2,097	274	38,787		37,446	37,446	1,341
19	2,075	266	38,392		37,446	37,446	947
20	2,054	259	37,998		37,446	37,446	553
	Total		801,788	480,535	748,914	1,229,449	(427,661)

NPV(Benefit)=	339,201	NPV(Cost)=	755,646
		FIRR=	**#DIV/0!**
		RoI=	**-34.78%**
		NPV=	**-416,445**
		B/C=	**0.4489**