The Republic of Kenya
Rural Electrification Authority

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

Project Completion Report
Volume 1 Main Report

March 2015

Japan International Cooperation Agency (JICA)

NIPPON KOEI
Challenging mind, Changing dynamics

KRI International Corporation

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Unless specified, the currency exchange rate as of Feb. 2015 is as follows:
1US$ =117.93JPY
1KSh.= 1.308JPY

List of Terms and Abbreviations

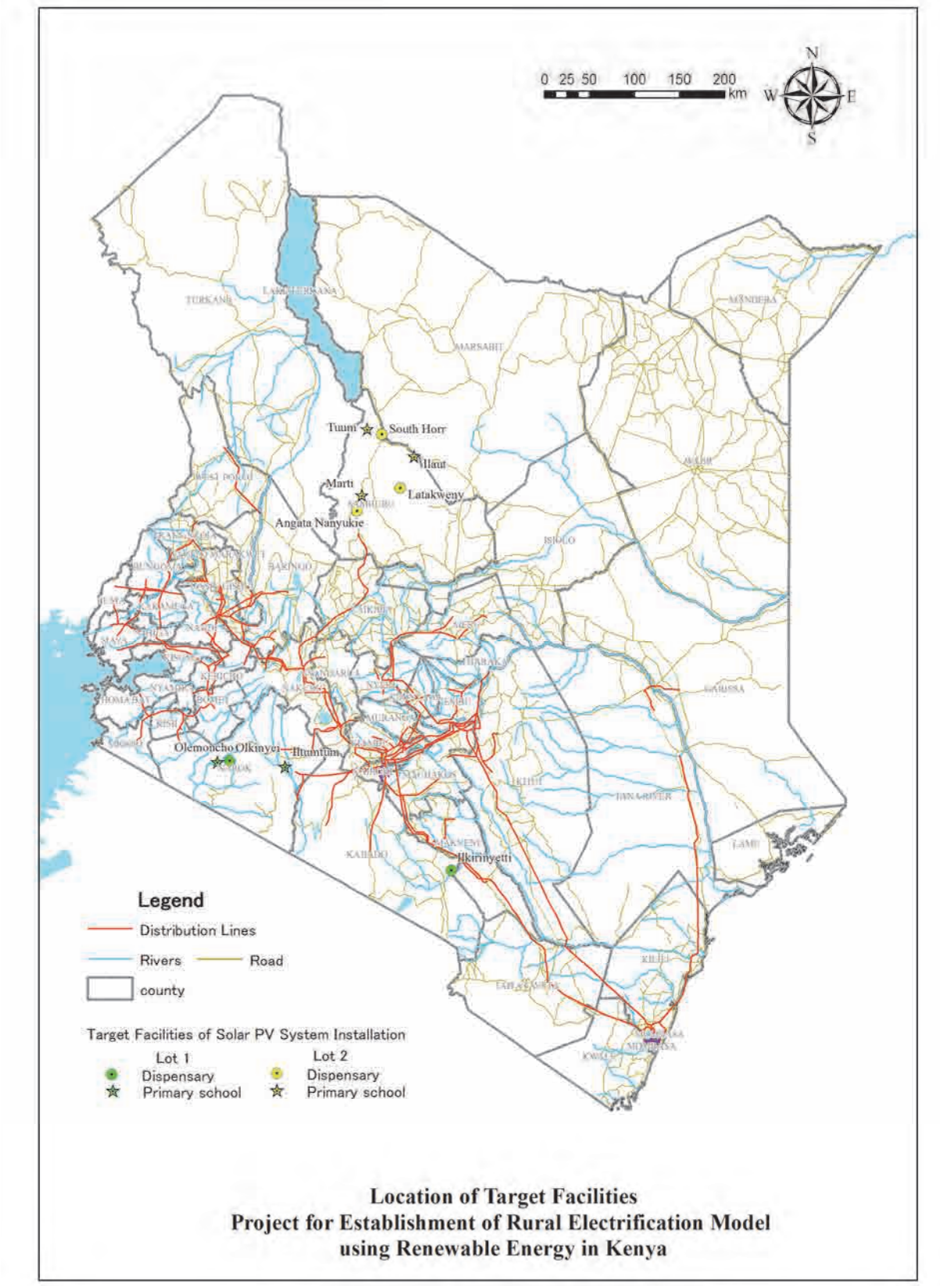
Abbreviation	Description
ABC-K	The Association of Biogas Contractors of Kenya
ABPP	Africa Biogas Partnership Programme
AC	Alternating Current
AIT	Ashikaga Institute of Technology
ASAL	Arid And Semi-Arid Lands
ASL	Above Sea Level
BCS	Battery Charging Station
BOD	Biological Oxygen Demand
BOQ	Bills of Quantity
C/P	Counterpart
CBO	Community Based Organization
CC	Charge Controller
CDF	Constituency Development Funds
CEO	Chief Executive Officer
CHP	Combined Heat and Power
CSS	Community Solar System
DBFZ	Deutsches Biomasse Forschungs Zentrum
DC	Direct Current
DRSRS	Department of Resource Surveys and Remote Sensing
EA	Environmental Audit
EIA	Environmental Impact Assessment
EIA-TAC	Environmental Impact Assessment Technical Advisory Committee
EMCA	Environmental Management and Coordination Act
ERC	Energy Regulatory Commission
FAO	Food and Agriculture Organization
FIRR	Financial Internal Rate of Return
FIT	Feed-In Tariff
FPEF	Free Primary Education Fund
DISCOs	Distribution Companies
GDC	Geothermal Development Company
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GNP	Gross National Product
GoK	Government of Kenya
GTZ	Deutsche Gesellschaft fur Technicshe Zusammenarbeit (German Society for International Cooperation)
HH	Household
Hivos	Humanist Institute for Development Cooperation
HSSF	Health Sector Service Fund
IBAs	Important Bird Areas
ICT	Information and Communication Technology
IEE	Initial Environmental Examination
IGAD	Intergovernmental Authority on Development
IPP	Independent Power Producer
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for the Conservation of Nature and Natural Resources
JCC	Joint Coordination Committee
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JET	JICA Expert Team

Abbreviation	Description
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KBS	Kenya Bureau of Standards
KENDBIP	Kenya National Domestic Biogas Programme
KETRACO	Kenya Electricity Transmission Company
KIRDI	Kenya Industrial Research and Development Institute.
KMD	Kenya Metrological Department
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power & Lighting Company
KSh.	Kenya Shilling
KTDA	Kenya Tea Development Agency
KWS	Kenya Wildlife Services
LED	Light Emitting Diode
LoU	Letter of Understanding
LPG	Liquefied Petroleum Gas
L2CET	Low Carbon Transmission Clean Energy Technology
MC	Management Committee
MEMR	Ministry of Environment and Mineral Resources
MHP	Micro Hydro Power
MoEST	Ministry of Education, Science and Technology
MoE&P	Ministry of Energy and Petroleum
MoH	Ministry of Health
MOU	Memorandum of Understanding
MRGI	Minority Rights Group International
NEAP	National Environment Action Plan
NEMA	National Environment Management Authority
NERA	National Electrification and Renewable Energy Authority
NGO	Non-Governmental Organization
NPED	National Policy on Environment and Development
NPV	Net Present Value
NRF	Non-Reverse Flow
NWMP	National Water Master Plan
ODA	Official Develpment Assistance
OFR	Overfrequency Protection Relay
OJT	On the Job Training
OPD	Out Patient Department
O&M	Operation and Maintenance
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Act
OVR	Overvoltage Protection Relay
UFR	Underfrequency Protection Relay
UVR	Undervoltage Protection Relay
PCR	Project Completion Report
PCs	Power Conditioner
PDM	Project Design Matrix
PO	Plan of Operations
PP	Power Package
PPE	Personal Protection Equipment
PR	Progress Report
PTA	Parents Teachers Association
PV	Photovoltaic
RE	Renewable Energy
REA	Rural Electrification Authority
REMP	Rural Electrification Master Plan
REP	Rural Electrification Programme

Abbreviation	Description
RNB	Reverse-flow with no Battery
RURA	Rwanda Utilities Regulatory Agency
RWB	Reverse-flow with Battery
SEA	Strategic Environmental Assessment
SMC	School Management Committee
SNV	Stichting Nederlandse Vrijwilligers (Netherlands Development Organization)
STC	Standard Test Condition
TC	Technical Cooperation
TERI	The Energy and Resources Institute
ToR	Terms of Reference
TOT	Training of trainers
ULH-MHP	Ultra-Low-Head Micro Hydro Power
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
WHO	World Health Organization
WRMA	Water Resource Management Authority
WG	Working Group

List of Electrical Terminology

Unit	Description
A (Ampere)	Unit of current
V (Volt)	Unit of voltage
kV (kilovolt)	1,000 volts
W (Watt)	Unit of electric power
kW (kilowatt)	1,000 watts
MW (Megawatt)	1,000 kW
Wh (Watt-hour)	Unit of energy
kWh (kilowatt-hour)	1,000 Wh
MWh (Megawatt-hour)	1,000 kWh
Wp (Watt-peak)	Unit of PV generation output
kWp (kilowatt-peak)	1,000 Wp
MWp (Megawatt-peak)	1,000 kWp



Prepared by JET

Location of Target Facilities

CHAPTER 1 PROJECT OUTLINE

1.1 Project Background

In Kenya, rural electrification was initially undertaken solely by Ministry of Energy and Petroleum (MoE&P). Rural Electrification Authority (REA) was established in 2007 and has been carrying out full-scale operation of projects since 2009.

The power grid covers 63% of the population in Kenya. However, the electrification rate of rural households is only 10%, and the gap in public service levels between rural and urban areas is wide. Furthermore, extension of the electric power system from urban to rural areas is inefficient due to broad stretches of land and dispersed villages. Consequently, it takes a long time to connect such rural villages to the electric power system. It is therefore considered that an off-grid electrification system powered by photovoltaics (PV) or Mini Hydro Power, for instance, is suitable for electrification of rural areas.

On this foundation, Japan International Cooperation Agency (JICA) conducted the "Dissemination of Renewable Energy into Rural Communities: Study on Photovoltaic and Small-hydro Projects in East Africa" project for Kenya and Uganda.

In addition, JICA conducted two preparatory surveys for renewable energy promotion in Africa. "Business Promotion and Financial Mechanism" and "Public Facility Electrification" were carried out from April to November 2009. Through the preparatory studies, the conceptual design of Community Solar System (CSS) was recommended and developed. CSS is a new idea, combining a solar PV system with a battery charging system (BCS) for the electrification of a public facility such as a health institution or school, open to the community in addition to the users of the public facility.

The basic CSS design was applied at three candidate sites from February to May 2010, after JICA gathered additional information required for the implementation of the pilot projects.

Cognizance was taken of other development agencies' contributions and activities in the electrification of rural areas using renewable energy technologies. The most notable is United Nations Industrial Development Organization (UNIDO), which has developed the "Energy Kiosk" concept focusing on industrial development in rural communities, mainly through Mini Hydro Power and biomass energy based approaches.

This summarily facilitated JICA's decision to establish the "Project for Establishment of Rural Electrification Model Using Renewable Energy in the Republic of Kenya", in consideration of a request from the Government of Kenya (GoK).

1.2 Project Objectives

1.2.1 Overall Goal

Rural electrification models using renewable energy are disseminated to improve the quality of life of rural communities in Kenya.

1.2.2 Project Purpose

Rural electrification models using renewable energy are established.

1.2.3 Project Outputs

i) A practical model for electrification of health service institutions in non-electrified areas using solar PV is developed through pilot projects.
ii) A practical model for electrification of schools in non-electrified areas using Solar PV is developed through pilot projects.

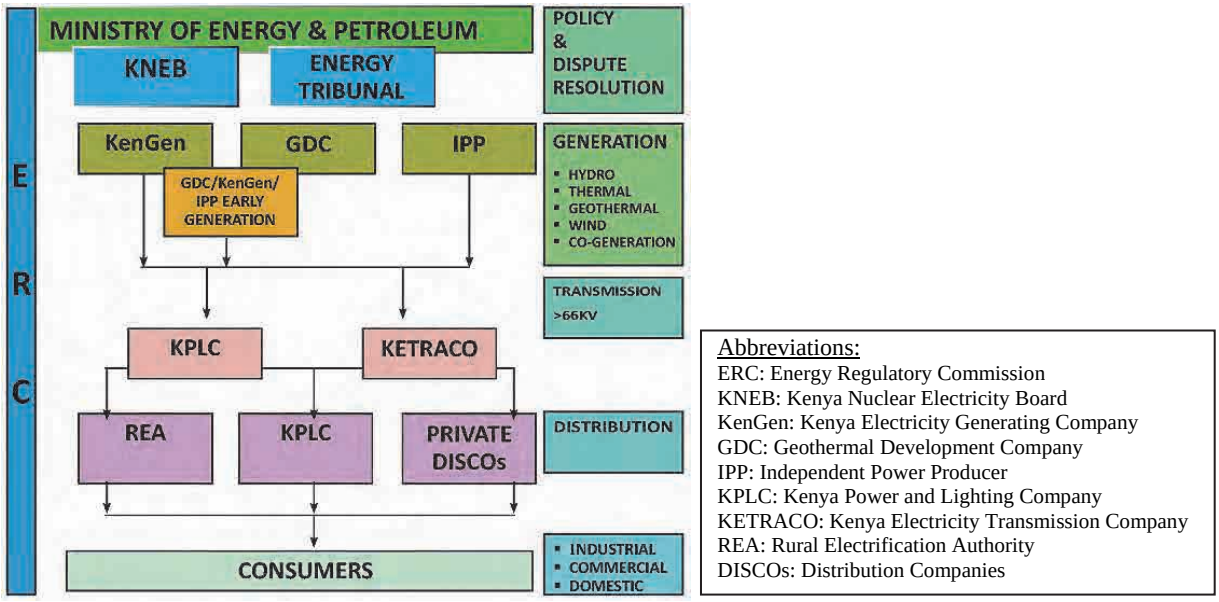
iii) The capacity of REA and MoE&P to undertake projects using Micro Hydro Power, biogas and wind technologies is enhanced.
iv) Necessary policy and institutional frameworks for spreading the models for rural electrification using renewable energy are recommended.

1.3 Current Situation of Rural Electrification

1.3.1 General

Rural electrification is one of the key issues given high priority in Kenya's "Vision 2030" by the government and "National Energy Policy (Draft)" as of February 2015 prepared by the MoE&P. Access to electricity is one of the fundamental pillars for socio-economic transformation and improvement in living standards of Kenyans. 100% electrification by 2030 is one of the national development goals specifically set out in the "Vision 2030".

The current institutional structure of Kenya's energy sector is shown below. Amongst these institutions, Rural Electrification Authority (REA) is the main executing agency for rural electrification.



Source: "5000+MW by 2016 Power to Transform Kenya", MoE&P, Page 5

Figure 1.3.1 Institutional Structure of Kenya's Energy Sector

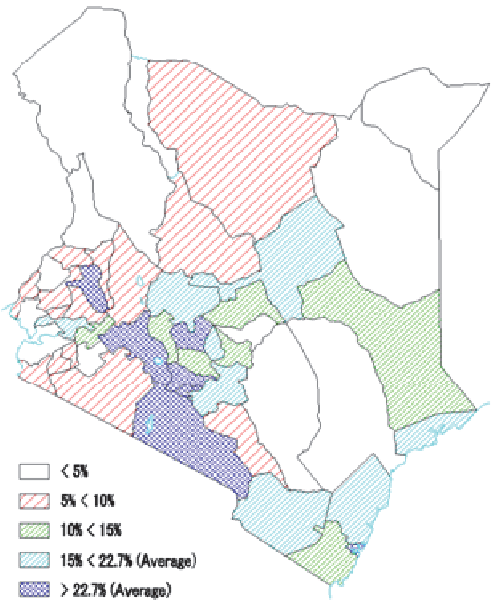
REA was established by the government in 2007 under the Energy Act No. 12 of 2006, as an executing agency to accelerate the pace of rural electrification, to facilitate achievement of the national development goal of 100% electrification. The functions of REA are outlined in the Act follows:

a) Management of the rural electrification programme fund,
b) Development and updating of the rural electrification programme master plan,
c) Implementing and sourcing of funds for the rural electrification programme,
d) Promotion and development of renewable energy sources, and
e) Management of the delineation, tendering and award of contracts for licenses and permits for rural electrification.

1.3.2 Current Status of Rural Electrification

(1) Household Electrification Rates

Household electrification rates based on the National Census of 2009 are summarized in the table below, which shows that the national average was 22.7%. Forty (40) out of forty seven (47) counties remain below the national average with Turkana County having the lowest electrification rate at 2.4%. In comparison Nairobi County -the national capital- has the highest at 72.4%.



Rank	County	Electrification Rate	Rank	County	Electrification Rate
1	Nairobi	72.4%	24	Trans Nzoia	8.9%
2	Mombasa	59.0%	25	Kisii	7.8%
3	Kiambu	53.0%	26	Marsabit	7.5%
4	Kajiado	39.8%	27	Elgeyo Marakwet	7.2%
5	Nakuru	34.0%	28	Vihiga	7.0%
6	Uasin Gishu	27.9%	29	Nandi	6.4%
7	Nyeri	26.3%	30	Samburu	6.2%
	Kenya average	22.7%	31	Nyamira	6.1%
8	Isiolo	18.5%	32	Busia	6.0%
9	Kisumu	18.3%	33	Makueni	5.9%
10	Laikipia	17.7%		Narok	5.9%
11	Lamu	17.0%	35	Kakamega	5.6%
	Machakos	17.0%	36	Migori	5.3%
13	Kilifi	16.7%	37	Kitui	4.8%
14	Kirinyaga	16.4%	38	Bungoma	4.5%
15	Taita Taveta	15.0%	39	Bomet	4.3%
16	Embu	14.9%		Siaya	4.3%
17	Murang'a	14.0%	41	Wajir	3.4%
18	Meru	13.1%	42	Homa Bay	3.3%
19	Kericho	11.8%	43	Tharaka-Nithi	3.0%
20	Garissa	11.6%	44	West Pokot	2.6%
21	Kwale	10.6%	45	Mandera	2.5%
22	Nyandarua	10.5%		Tana River	2.5%
23	Baringo	9.6%	47	Turkana	2.4%

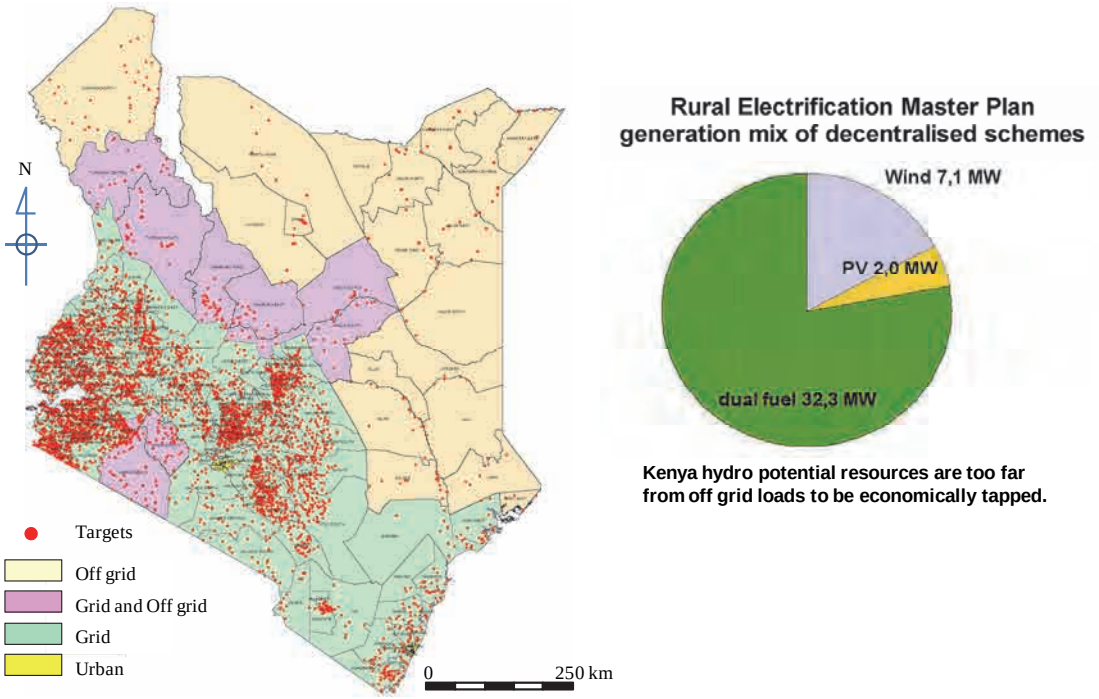
Source: Kenya County Fact Sheets Dec 2011/Kenya Open Data (http://www.opendata.go.ke/) and arranged by JET

Figure 1.3.2 Household Electrification Rate (as of 2009)

(2) Rural Electrification Plan

REA and MoE&P (formerly MoE) formulated “Rural Electrification Master Plan (REM 2009)”. Areas earmarked for rural electrification by both grid and off-grid methods were proposed as shown in the figure below. A mix of decentralized schemes was proposed for generation and supply of an additional total peak power demand of 41 MW by 2013. Power sources for off-grid schemes would consist of dual fuel diesel, wind power and PV systems.

It is noted that KETRACO and KPLC have individual master plans for extension of transmission and distribution networks, respectively, which are currently uncoordinated. MoE&P is planning to formulate a sole integrated master plan for rural electrification.



Source: Rural Electrification Master Plan (REM 2009), "Final Report Volume 1 – Main Report, Figure ES-3" and "Presentation of the Master Plan and the Five-year Action Plan (2009 – 2013) on 15 August 2009, Page 24" (arranged by JET)

Figure 1.3.3 Proposed Demarcation of Rural Electrification Method in REM 2009

(3) Ongoing Rural Electrification Projects

Rural electrification is mainly executed by grid extension, and by diesel generators and solar PV systems in off-grid areas. The current major rural electrification projects are:

i) Installation of new generator sets (Gen-sets) in off-grid stations by the government
ii) Decommissioning of old Gen-sets in off-grid stations by the government
iii) Electricity grid extension with financial assistance from World Bank
iv) Solar PV projects with financial assistance from Spanish Government
v) Installation of solar PV systems in primary schools for the Laptop Programme

(4) Challenges of Rural Electrification

Rural electrification is facing the following challenges:

i) Scattered human settlements in rural areas leading to long distribution lines, the construction, operation and maintenance costs of which become expensive,
ii) High costs of constructing distribution lines due to harsh terrains and underdeveloped road infrastructure, and high costs of compensating public institutions and land owners for way leaves,
iii) High operation and maintenance costs due to long distances and vandalism of power infrastructure such as theft of cables, fuel in transformers, etc.
iv) Low connectivity due to comparatively high connection charges for the majority of rural consumers,
v) Lack of manpower and capacity for manufacture, installation, operation and maintenance of generation and distribution equipment, and
vi) Lack of budget.

Low connectivity especially due to high connection charge is one of the major problems. In the case of domestic households, it is estimated that out of the 8.8 million households, approximately 7.0 million households are in rural areas. Only about 1.8 million (26%) have electricity while the remaining 5.2 million households (74%) are not electrified.

MoE&P is currently formulating the second strategic plan (2013/14 – 2017/18) which includes a mass connection programme for all households by 2020. The programme will entail:

i) Review of specifications of materials used,
ii) Removal of the upfront connection charge and creation of an alternative payment system,
iii) Connection of all domestic households within range of a transformer,
iv) Use of Reddy Boards to reduce wiring costs, and
v) Funding of Low Voltage (LV) networks by the Government.

The ultimate goal of the second strategic plan is to ensure that every Kenyan household has electricity by 2030.

1.3.3 Electrification of Public Facilities

REA's first strategic plan (2008/09 – 2012/13) adopted a target of connecting all major public facilities by the fiscal year 2012/13. This target was almost reached, with 22,998 (90%) out of 26,177 major public facilities becoming electrified.

The electrification rates of public facilities as of June 2014 are summarized in the table below. This shows that 84% of major public facilities were electrified.

Table 1.3.1 Electrification of Public Facilities (as of June 2014)

(Unit: number)

No.	Public Facility	Electrified	Non Electrified	Total
I.	**Main Public Facilities**			
1	Trading centre	9,174	2,868	12,042
2	Public Secondary Schools	7,879	335	8,214
3	Health Centers	3,905	768	4,673
	Sub-total I	20,958 84.1%	3,971 15.9%	24,929 100.0%
II.	**Other Public Facilities**			
4	Primary Schools & Nursery	15,157	6,065	21,222
5	Administrative Offices/ Police Posts	2,674	2,197	4,871
6	Water Project/ Boreholes/ Beaches	1,967	1,784	3,751
7	Tea Buying centers/ Coffee Factories	2,227	1,189	3,416
8	Social Halls/ Churches & Mosques	8,039	5,956	13,995
	Sub-total II	30,064 63.6%	17,191 36.4%	47,255 100.0%
	Total (I+II)	**51,022 70.7%**	**21,162 29.3%**	**72,184 100.0%**

Source: REA (arranged by JET)

It is noted that the number of major public facilities decreased by 1,248 (from 26,177 in FY 2012/13 to 24,929 in FY 2013/14). However, JET was unable to obtain clarification from REA in regards to this discrepancy.

1.4 Project Area

The target area of the project is the Republic of Kenya. JET selected pilot project sites where distance from the existing grid was considerable and there was no immediate plan for grid connection.

CHAPTER 2 PROJECT ACTIVITIES

2.1 Project Management

As tools for project management, PDM, PO and Work Plan were prepared in the initial stage of project. PDM and PO are revised several times due to the cancellation of pilots for MHP, Biogas and Wind. Latest progress of PDM is summarized in this Chapter. Working group which consists of staff of REA, MoE&P and JET was organized in the project. In addition, other management activities as shown the following list are explained in this Chapter.

- Project Design Matrix (PDM) and Plan of Operations (PO)
- Work Plan
- Working Group
- Counterpart Training
- Provision of Equipment
- Regular Reports and Meetings
- Joint Coordinating Committee
- Midterm and Terminal Evaluations

2.1.1 Project Design Matrix (PDM) and Plan of Operations (PO)

Project Design Matrix and Plan of Operations are used as analytical and management tools for project management. The project was carried out according to content of PDM and timeline of PO. PDM and PO were revised based on the change of surrounding circumstances and agreed at Joint Coordinating Committee. The following lists show titles of revised PDM and PO. All PDM and PO are attached Attachment A-1: PDM and Attachment A-3: PO respectively.

(1) PDM

- PDM Version 1.0, June 2012
- PDM Version 1.4, November 2012
- PDM Version 2.1, December 2012
- PDM Version 3.1, October 2013

(2) PO

- Plan of Operation ver.1.0, June 2012
- Plan of Operation ver.1.1, November 2012
- Plan of Operation ver.2.1, October 2013

Following Table 2.1.1 and Table 2.1.2 show achievement of the project activities in PDM.

Table 2.1.1 Objectively Verifiable Indicators and Achievement in PDM version 3.1

OBJECTIVELY VERIFIABLE INDICATORS	Achievement
Overall Goal: Rural electrification models using renewable energy are disseminated in the country to improve the quality of Kenyan's life.	
1. Number of public facilities who apply and follow the model has increased all over the non-electrified areas in Kenya.	1. Developed model will be applied in REA project 2015 / 2016. For technical model, the 48 V system was installed in two public facilities in Baringo County in January 2015.
2. Dissemination structure of national and county governmental agencies is established.	2. Memorandum of Understanding (MOU) on O&M for dispensaries is expected to be signed between REA and MoH. For primary schools, REA opted not to sign MOU with MoEST, however, ideas on O&M budget are being developed between REA and MoEST.
Project Purpose: Rural electrification models using renewable energy are established	
1. The developed guidelines and manuals are applied to the projects implemented by REA and MoE&P (C/P).	1. In the solar PV project that REA carries out in 2014/2015 and 2015/2016, guideline and manual prepared in this project are expected to be adopted.
2. The Outputs of the Project are incorporated into implementation of REA Annual Renewable Energy Work Programme (Performance Contract).	2. In 2015/2016 Annual Renewable Energy Work Programme of REA, implementation of the demonstration project using developed model will be written.
3. Renewable energy facilities installed by the Project are operated and maintained properly with sustainable.	3. There was a clause on O&M in the handover agreement from JICA to REA.
4. Implementation structures of national/county governmental agencies and local stakeholders are established.	4. Implementation structures of national/county governmental agencies and local stakeholders were established. According to the changes in external conditions, REA will modify the structures.
5. Variety of expertise in renewable energy is increased among members of C/P (C/Ps).	5. Technical transfer on MHP, Biogas and Wind were conducted to the counterpart. Expertise is increased among member of CPs.
Output: l. A practical model for PV electrification of health service institutions in non-electrified areas is developed through pilot projects.	
0. All level	
0-0 All sub-group working members for Output 1 participate monitoring at least twice as a monitoring team member.	0-0 Lot 1: 3 times Hannington (2 times Ilkilnyeti; financial training, Olkinyei: technical) Colleta (1 time Olkinyei) monitoring Lot 2: 1 time Hannington (1time to 3 dispensaries) baseline survey
0-1 Monitoring trainings for the monitoring team members including both technical and environmental/community development staff at REA and MoE&P are provided based on their Objective & Achievement Sheet through OJT; On the Job Training.	0-1 Lot 1: 5 times Lot 2: 2 times
0-2 At least 3 monitoring team members achieve their objectives through trainings. Achievements are confirmed by trainee's self-assessment and evaluation by Japanese Experts (JEs).	0-2 3 monitoring team members achieved their objectives through trainings. Objective & Achievement test was carried out.
0-3 PV electrification, operation and maintenance manual for health service institutions with battery charging business is prepared for C/Ps including user manual and accounting manual.	0-3. Guideline (manual) and user manual were prepared.

0-4 At least 2 people from health institution and management committee as well as the operator of charging center are trained to have accurate understanding and to be able to conduct proper O&M of PV facilities including disposal of solar panels, batteries and toxic materials.	0-4. Lot 1: Olkinyei: O&M1: 7, O&M2: 15 Ilkilnyeti: O&M1: 5, O&M2: 10, O&M3: 5 Lot 2: Latakweny: 5 South Horr: 3 Angata Nanyukei: 3
1. National Level	
1-1 Collaboration among relevant governmental agencies is started and maintained at national level to support the establishment and dissemination of the model.	1-1. Information sharing meeting was carried out among MoEST, REA and MoE&P twice. The first meeting was on Mar. 14, 2014 and the second was on Jan. 19, 2015
1-2 Key criteria of the site selection are analyzed and established and sites for Lot 1 and Lot 2 are selected accordingly.	1-2. Sites for Lot 1 and Lot 2 were selected according to the following criteria. ・ Not near to the existing grid line ・ Not belonging to private or mission ・Not overlapping with candidate sites of other donors ・Confirmed safe security environment
2. County/Sub-county Level	
2-1 Collaboration among C/Ps, county and sub-county medical officers is started and maintained to the level of supporting the establishment, operation and maintenance of the model.	2-1. Information sharing meetings were carried out among County education department, REA and MoE&P twice in 2014. Narok County: Jun 16 and Nov. 11, Samburu County: Jun.19 and Nov.14.
3. Local/Institutional Level	
3-1. The target health institutions secure the money from battery charging business and other financial source(s) for sufficient maintenance cost such as future purchase of batteries.	3-1. Draft MOU between REA and MoH is under examination of the Attorney General. Agreements on O&M which secure the budget for future replacement will be signed between County health department and REA.
3-2. Periodical monitoring is carried out by the monitoring team at least 3 times for Lot 1 and twice for Lot 2. Satisfaction for the system is conformed through monitoring.	3-2. Lot 1: 5 times Lot 2: 2 times
3-3. Awareness raising activities on installed solar PV systems at target health institutions and communities are held at least 3 times for each Lot 1 sites and 2 times for Lot 2 sites.	3-3. (2014.8.31) Lot 1: 9 times Lot 2: 6 times
Output 2: A practical model for PV electrification of schools in non-electrified areas is developed through pilot projects.	
0. All level	
0-0 All sub-group working members for Output 1 participate monitoring at least twice as a monitoring team member.	0-0 Lot 1: 2 times Colleta (Iltumtum,Olemoncho) monitoring Hannington (Iltumtum,Olemoncho) technical monitoring Lot 2: 1 time Hannington (3 schools) baseline survey
0-1 Monitoring trainings for the monitoring team members including both technical and environmental/community development staff at REA and MoE&P are provided based on their Objective & Achievement Sheet through OJT.	0-1 Lot 1: 5 times Lot 2: 1 time
0-2 At least 3 monitoring team members achieve their objectives through trainings. Achievements are confirmed by trainee's self-assessment and evaluation by JEs.	0-2. 4 monitoring team members achieved their objectives through trainings. Objective & Achievement test was carried out.
0-3 PV electrification, operation and maintenance manual for schools with battery charging business is prepared for C/Ps including user manual and accounting manual.	0-3. Guideline (Manual) and user manual were prepared.

0-4 At least 3 people from school and management committee as well as the operator of charging center are trained to have accurate understanding and to be able to conduct proper O&M of PV facilities including disposal of solar panels, batteries and toxic materials.	0-4 Lot 1: Iltumtum: O&M1: 35, O&M2: 4 Olemoncho: O&M1: 30, O&M2: 10 Lot 2: Marti: 7, Tuum: 10, Illaut: 3
1. National Level	
1.-1 Collaboration among relevant governmental agencies is started and maintained at national level to support the establishment and dissemination of the model.	1-1. Information sharing meetings were carried out among MoEST, REA and MoE&P.
1.-2 Key criteria of the site selection are analyzed and established and sites for Lot 1 and Lot 2 are selected accordingly.	1-2. Sites for Lot 1 and Lot 2 were selected according to the following criteria. ・ Not near to the existing grid line ・ Not belonging to private or mission ・Not overlapping with candidate sites of other donors ・Confirmed safe security environment
2. County/Sub-county Level	
2.-1 Collaboration among C/Ps, County and Sub-county education officers is started and maintained level to support the establishment, operation and maintenance of the model.	2-1. Information sharing meetings were carried out among County education department, REA and MoE&P twice in 2014. Narok County: Jun 16 and Nov. 11, Samburu County: Jun.19 and Nov.14.
3. Local/Institutional Level	
3-1. The target schools secure the money from battery charging business and other financial source(s) for sufficient maintenance cost such as future purchase of batteries.	3-1 O&M budget for solar PV system is still under the discussion among REA, MoEST and the other governmental institutions.
3-2. Periodical monitoring is carried out by the monitoring team at least 3 times for Lot 1 and twice for Lot 2. Satisfaction for the system is conformed through monitoring.	3-2.Lot 1: 5 times Lot 2: 2 times
3-3. Awareness raising activities on installed solar PV system at target schools and communities are held at least 3 times for each Lot 1 sites and 2 times for Lot 2 sites.	3-3. Lot 1: 9 times Lot 2: 6 times
Output 3: The Capacity of REA MoE&P to undertake project using MHP, Biogas and Wind technologies is enhanced.	
3-1. OJT is conducted with at least 2 C/Ps for each renewable energy technology through manual development.	3-1. MHP: 3 (Mr. Semekiah Ongong'a, Ms. Judith Kimeu, Mr. Anthony Wanjara) Biogas: 2 (Ms. Caroline Kelly, Mr. Gilbert) Wind: 2 (Mr. Hannington Gochi, Ms. Colleta)
3-2. Manual Development Committee is established and holds meetings at least twice for each renewable technology (MHP, Biogas and Wind).	3-2. Manuals (guidelines) were developed . Manual Development Committee was established in October 2014.
3-3. Manuals are adopted and utilized by relevant ministries, governmental agencies and County/Sub-county offices.	3-3. Manuals (guidelines) will be used by staff of REA and MoE&P.
3-4. Seminar and training for technical transfer are conducted for C/Ps based on their Objective & Achievement Sheets.	3-4. MHP : 1 time Biogas: 1 time Wind: 1 time
3-5. At least 6 C/Ps achieve their objective through training. Achievements are confirmed by trainee's self-assessment and evaluation by JEs.	3-5. Objective & Achievement tests were carried out.

3-6. At least one pre-feasibility study document for future practical model for MHP, Biogas and Wind is prepared.	3-6. Progresses of simple pre-F/S are: MHP (100%), Biogas (100%), Wind (100%).
Output 4: Necessary policy and institutional frameworks for rural electrification using renewable energy are recommended.	
4-1. International workshop is held to share the results of the project (e.g. EAC conference).	4-1. International workshop was held in February 2015.
4-2. Technical transfer workshops for C/Ps are held 3 times.	4-2. total 3 times Solar PV: 1 time (27 Sept 2013) MHP/Biogas : 1 time (25 Oct 2013) Wind：1 time (15 Nov 2013)
4-3. Recommendations for C/P to implement the effective electrification by renewable energy are provided to be reflected on their rural electrification policy.	4-3. Recommendations were finalized.

Prepared by JET

Table 2.1.2 Activities in PDM

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
	For Preparation	
1	Set up a Working Group (WG) consisting of 3 sub-groups for Outputs 1, 2 and 3, with clarified roles and functions of the counterpart personnel.	(1) 2.1.3 (2) Member of Working Group is updated at JCC 2nd (3) 100% (4) 2013/10/3
	For all Outputs	
1.	A weekly project status report is prepared and shared by both C/Ps and JICA Experts (JEs).	(1) 2.1.6 and 3.1 (2) The weekly project status has been shared (3) 49 times (4) 2014/12/8
2.	Monthly project meeting is held by REA.	(1) 2.1.6 and 3.1 (2) Minutes of meeting are attached on Attachment B-2. (3) 13 times (4) 2014/12/9
3.	Progress report is prepared by JEs including the progress summary table according to PDM to monitor and report the progress of indicators to achieve outputs.	(1) 2.1.6 (2) “Progress Summary Table” is prepared in PCR, as well as the previously submitted progress reports. (3) 100% (4) 2015/2/6
1	For Output 1 (The Health service institution Model)	
1-1	National Level	
1-1-1	Review policies, studies, surveys and projects related to electrification of health service institutions using Solar PV.	(1) 2.2.1 (2) The number of solar PV installations at public facilities is summarized. (3) 100% (4) 2014/12/8
1-1-2	Organize a progress and information sharing meetings with REA, MoE&P, and MoH at least twice to discuss on model establishment and dissemination at national level.	(1) 2.5.4 / Attachment B-3 (2) Meetings with JET, REA, MoE&P and MoH have been carried out twice. (3) 100% (4) 2015/2/6
1-1-3	Prepare policy recommendations with institutional framework to promote the health institution model(s).	(1) 5.2 (2) Recommendation for health institution model is summarized. (3) 100% (4) 2015/2/6

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
1-1-4	Prepare a proposal for the disposal of solar panels, batteries and toxic materials according to the current conditions and regulations	(1) 2.13.7 (2) A proposal for the disposal of solar panels, batteries and toxic materials was prepared. (3) 100% (4) 2015/2/6
1-2	County/Sub-county Level	
1-2-1	Account book and cash flow statement are submitted to County Medical Officer(s) of the project sites at least twice for Lot 1 and once for Lot 2.	(1) 2.5.2 / Attachment H-3 (2) Account books and cash flow statements are submitted for all the pilot project sites. (3) Lot 1: 100% (4/4) Lot 2: 100% (3/3) (4) 2015/2/6
1-2-2	O&M reports are submitted to County Medical Officer(s) twice for Lot1 and once for Lot 2.	(1) 2.5.2 / Attachment H-3 (2) O&M reports were made and submitted. (3) Lot 1: 100% (4/4), Lot 2: 100% (3/3) (4) 2015/2/6
1-2-3	Organize a progress and information sharing meetings with REA, MoE&P (monitoring team members), and County and Sub-county medical officers at least twice to discuss on model establishment and dissemination at County/Sub-county level.	(1) 2.5.4 / Attachment B-4 (2) Meetings with JET, REA, MoE&P and County/Sub-county medical officers were carried out twice. (3) Lot 1: 100%, Lot 2: 100% (4) 2015/2/6
1-2-4	Conduct the baseline survey at the target facilities and surrounding communities	(1) 2.2.3 / Attachment G-2 (2) Baseline survey was conducted at all the pilot project sites. (3)Lot 1: 100% (2/2), Lot 2:100% (3/3) (4) 2014/2/28
1-2-5	Conduct capacity & needs assessment of County/Sub-county medical officers in terms of renewable energy utilization and dissemination.	(1) 2.2.4 (2) Capacity & needs assessment has been conducted. (3)Lot 1: 100%, Lot 2 100% (4) 2015/2/6
1-3	Local/Institutional Level	
1-3-1	Conduct capacity & needs assessment of target communities and other stakeholders.	(1) 2.2.4 (2) Capacity & needs assessment has been conducted. (3)Lot 1: 100%, Lot 2: 100% (4) 2015/2/6
1-3-2	Sustainable financial plan is prepared.	(1) 2.6.3 (2) Financial model is presented. (3) Lot 1: 100% , Lot 2: 100% (4) 2015/2/6
1-3-3	Sufficient financial trainings for the operator of charging center, staff of health institution, and members of management committee are provided through lectures and OJT.	(1) 2.4.4 and 2.5.1 (2) Sufficient trainings were done. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/9/15
1-3-4	The operator of the charging center accurately records daily sale.	(1) 2.5.2 (2) All sites record daily sales. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/12/8
1-3-5	Assigned nurse, a treasurer and a chairperson of the management committee accurately records an account book and cash flow statement.	(1) 2.5.2 / Attachment H-3 (2) Account books and cash flow statements are submitted for all the pilot project sites. (3) Lot 1: 100% (4/4) Lot 2: 100% (3/3) (4) 2011/12/8
1-3-6	Assigned nurse and a chairperson of the management committee prepare O&M reports.	(1) 2.5.2 / Attachment H-3 (2) O&M reports were prepared. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2015/2/8

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
1-3-7	Identify and manage to obtain agreement with the agencies and/or organization to provide financial support to sustain the model according to the income by battery charging system.	(1) 2.6.3 (4) (2) Draft MOU is under examination of the Attorney General (3) 80% (4) 2015/2/7
1-3-8	Prepare detailed plans of the pilot projects including “System design” and “Sustainable O&M” with staff of REA and MoE&P through OJT.	(1) 2.3.1 and 2.7.3 (2) “System design” and “Sustainable O&M” were prepared and transferred to C/P through OJT. (3) Lot: 1: 100%, Lot 2: 100% (4) 2014/12/8
1-3-9	Organize a stakeholder meeting with the members of management committee and owners of facility to discuss on operation and maintenance at least once for each pilot facility.	(1) 2.4.3 and 2.4.6 / Attachment B-5 (2) Stakeholder meetings were done at all the pilot project sites. (3) Lot 1:100%, Lot 2:100% (4) 2014/9/15
1-3-10	Organize an information sharing meeting with users of pilot facility and County/Sub-county medical officer(s) at least once for each pilot facility.	(1) 2.5.3 Meetings were done with all the medical offices. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/9/15
1-3-11	Organize an evaluation meeting with the members of management committee and owners and users of facility, County and Sub-county medical officers at the end of the project period at least once for each pilot facility.	(1) 2.5.5 / Attachment B-6 (2) Evaluation meetings were held at all the pilot project sites. (3) 100% (4) 2014/12/8
2.	For Output 2 (School model)	
2-1	National Level	
2-1-1	Review policies, studies, surveys and projects related to electrification of schools using Solar PV.	(1) 2.2.1 (2) The number of solar PV installations at public facilities is summarized. (3) 100% (4) 2014/12/8
2-1-2	Organize a progress and information sharing meetings with REA, MoE&P, and MoEST at least twice to discuss on model establishment and dissemination at national level.	(1) 2.5.4 / Attachment B-3 (2) Meetings with JET, REA, MoE&P and MoEST have been carried out twice. (3) 100% (4) 2015/2/6
2-1-3	Prepare policy recommendations with institutional framework to promote the school model(s).	(1) 5.2 (2) Recommendation for school model is summarized. (3) 100% (4) 2015/2/6
2-1-4	Prepare a proposal for the disposal of solar panels, batteries and toxic materials according to the current conditions and regulations.	(1) 2.13.7 (2) A proposal for the disposal of solar panels, batteries and toxic materials was prepared. (3) 100% (4) 2015/2/6
2-2	County/Sub-county Level	
2-2-1	Account book and cash flow statement are submitted to County Education Officer(s) of the project sites at least twice for Lot 1 and once for Lot 2.	(1) 2.5.2 / Attachment H-3 (2) Account books and cash flow statements are submitted for all the pilot project sites. (3) Lot 1: 100% (4/4) Lot 2: 100% (3/3) (4) 2015/2/6
2-2-2	O&M reports are submitted to County Education Officer(s) twice for Lot1 and once for Lot 2.	(1) 2.5.2 / Attachment H-3 (2) O&M reports were made and submitted. (3) Lot 1: 100% (4/4), Lot 2: 100% (3/3) (4) 2015/2/6

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
2-2-3	Organize a progress and information sharing meetings with REA, MoE&P (monitoring team members), and County and Sub-county education officers at least twice to discuss on model establishment and dissemination at County/Sub-county level.	(1) 2.5.4 / Attachment B-4 (2) Meetings with JET, REA, MoE&P and County/Sub-county education officers were carried out twice. (3) Lot 1: 100%, Lot 2: 100% (4) 2015/2/6
2-2-4	Conduct the baseline survey at the target facilities and surrounding communities	(1) 2.2.3 / Attachment G-2 (2) Baseline survey was conducted at all the pilot project sites. (3)Lot 1: 100% (2/2), Lot 2:100% (3/3) (4) 2014/2/28
2-2-5	Conduct capacity & needs assessment of County/Sub-county education officers in terms of renewable energy utilization.	(1) 2.2.4 (2) Capacity & needs assessment has been conducted. (3)Lot 1: 100%, Lot 2 100% (4) 2015/2/6
2-3	Local/Institutional Level	
2-3-1	Conduct capacity & needs assessment of target communities and stakeholders.	(1) 2.2.4 (2) Capacity & needs assessment has been conducted. (3)Lot 1: 100%, Lot 2:100% (4) 2015/2/6
2-3-2	Sustainable financial plan is prepared.	(1) 2.6.3 (2) Financial model is presented. (3) Lot 1: 100% , Lot 2: 100% (4) 2015/2/6
2-3-3	Sufficient financial trainings for the operator of charging center, staff of school, and members of management committee are provided.	(1) 2.4.4 and 2.5.1 (2) Sufficient trainings were done. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/9/15
2-3-4	The operator of the charging center accurately records daily sale.	(1) 2.5.2 (2) All sites record daily sales. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/12/8
2-3-5	Head teacher, a treasurer and a chairperson of the management committee accurately record an account book and cash flow statement.	(1) 2.5.2 / Attachment H-3 (2) The account book and cash flow statement were prepared. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2015/2/6
2-3-6	Head teacher and a chairperson of the management committee prepare O&M reports.	(1) 2.5.2 / Attachment H-3 (2) O&M reports were prepared. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2015/2/6
2-3-7	Identify and manage to obtain agreement with the agencies and/or organization to provide financial support to sustain the model according to the income by battery charging system.	(1) 2.6.3 (4) (2) O&M budget for solar PV system is still under the discussion among governmental institutions. (3) 50% (4) 2015/2/7
2-3-8	Prepare detailed plans of the pilot projects including “System design” and “Sustainable O&M” with staff of REA and MoE&P through OJT.	(1) 2.3.1 and 2.7.3 (2) “System design” and “Sustainable O&M” were prepared and transferred to C/P through OJT. (3) Lot: 1: 100%, Lot 2: 100% (4) 2014/12/8
2-3-9	Organize a stakeholder meeting with the members of management committee and owners of facility to discuss on operation and maintenance at least once for each pilot facility.	(1) 2.4.3 and 2.4.6 / Attachment B-5 (2) Stakeholder meetings were done at all the pilot project sites. (3) Lot 1:100%, Lot 2:100% (4) 2014/9/15

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
2-3-10	Organize an information sharing meeting for the users of the pilot facility and County and Sub-county education officer(s) at least once for each pilot facility.	(1) 2.5.3 Meetings were done with all the education offices. (3) Lot 1: 100% (2/2), Lot 2: 100% (3/3) (4) 2014/9/15
2-3-11	Organize an evaluation meeting with the members of management committee and owners and users of facility, County and Sub-county education officers at the end of the project period at least once for each pilot facility.	(1) 2.5.5 / Attachment B-6 (2) Evaluation meetings were held at all the pilot project sites. (3) 100% (4) 2014/12/8
3.	For Output 3 (MHP, Biogas and Wind)	
3-1	Conduct inventory and review of existing studies on MHP, Biogas and Wind.	(1) 2.10.1 MHP, 2.11.1 Biogas, 2.12.1 Wind (2) Inventory and review of existing studies are summarized. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2015/2/6
3-2	Prepare guidelines for rural electrification using renewable energy (MHP, Biogas, Wind) according to the contents of the technical trainings in terms of planning, design, procurement, monitoring and maintenance.	(1) 2.10.4 / Attachment K-1 (MHP), 2.11.4 / Attachment L-1 (Biogas), 2.12.4 / Attachment M-1 (Wind) (2) Technical Guidelines have been finalized. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2015/2/6
3-3	Conduct technical training for REA / MoE&P staff on MHP, Biogas and Wind.	(1) 2.10.2 / Attachment K-3 and K-4 (MHP), 2.11.2 / Attachment L-3 and L-4 (Biogas), 2.12.2 / Attachment M-3 and M-4 (Wind) (2) Technical transfer through training was conducted. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2014/12/8
3-4	Carry out simple pre-feasibility study focusing on technical examination for MHP, Biogas and Wind.	(1) 2.10.3 / Attachment K-2 (MHP), 2.11.3 / Attachment L-2 (Biogas), 2.12.3 / Attachment M-2 (Wind) (2) Simple Pre-F/S's have been finalized. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2015/2/6
3-5	Prepare technical recommendation for rural electrification using MHP, Biogas and Wind.	(1) 2.10.5 MHP, 2.11.5 Biogas, 2.12.5 Wind (2) Technical recommendations are summarized. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2015/2/6
3-6	Collect necessary data and equipment for technical trainings and development of the guidelines.	(1) 2.10.4 MHP, 2.11.4 Biogas, 2.12.4 Wind (2) Collected toward finalization of Guidelines. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2015/2/6
3-7	Hold workshops for stake holders to validate guidelines on MHP, Biogas and Wind.	(1) 2.10.4 MHP, 2.11.4 Biogas, 2.12.4 Wind (2) The workshops for stakeholders were held. (3) MHP (100%), Biogas (100%), Wind (100%) (4) 2014/12/8
4	For Output 4 (Policy recommendations)	
4-1	Implement and monitor the preparation activities of policy recommendations of Output 1, 2 and 3.	(1) 5.1 and 5.2 (2) Policy recommendations are outlined. (3) 100% (4) 2015/2/6

Activities		Progress (1) Chapter in PCR (2) Summary of the report (3) Progress (4) Progress Confirmation Date
4-2	Organize workshop(s) on rural electrification models using renewable energy and/or present the results of the project by C/Ps at the domestic or international conference for information sharing with other stakeholders and donors in the energy sector of Kenya and East Africa.	(1) Attachment O / 2.14.1, 2.14.3 and 2.15 (2) Five workshops were held for domestic stakeholders. C/Ps made presentations at international workshop. (3) 100% (4) 2015/2/6
4-3	Compile policy recommendations.	(1) 5.1 and 5.2 (2) Policy recommendations are compiled. (3) 100% (4) 2015/2/6
4-4	Initiate and strengthen the concept of Academic-Private Sector Platform in collaboration with JICA experts of "the Project for Capacity Development for Promoting Rural Electrification Using Renewable Energy."	(1) 2.14.1, 2.14.2 and 2.14.3 (2) County Health officials have attended a solar PV training conducted by "the Project for Capacity Development for Promoting Rural Electrification Using Renewable Energy." C/Ps presented at JKUAT conferences. (3) 100% (4) 2015/2/6

Prepared by JET

2.1.2 Work Plan

Work plan was prepared at the beginning of the project. It was revised due to the cancellation of pilots projects for MHP, Biogas and Wind. Work Plan (1) was submitted to JICA in June 2012. Considering cancellation of the pilot projects Work plan (2) was prepared. Work plan (2) was explained and accepted at 1st JCC. Work Plan (2) was submitted December.

- Work Plan (1) June 2012
- Work Plan (2) December 2012

Work flow chart which summarizes contents of work plan is attached at Attachment A-2.

2.1.3 Working Group

(1) List of Working Group

The following table shows the list of the Working Group.

Table 2.1.3 Working Group (as of December 2014)

Project Director	
Mr. N'gang'a Munyu	Ag. Chief Executive Officer, REA
Project Manager	
Eng. Ephantus Kamweru	Chief Manager, Renewable Energy Department, REA
Eng. Isaac N. Kiva	Senior Principal Superintending Engineer (RE), MoE&P
Working Group	
Mr. James Muriithi	Senior Engineer, Renewable Energy Department, REA
Mr. Hannington Gochi	Senior Technician, Renewable Energy Department, REA
Mr. Anthony Wanjara	Technician, Renewable Energy Department, REA
Ms. Colleta Koech	Assistant Engineer, Renewable Energy Department, REA
Ms. Caroline Kelly	Assistant Officer, Renewable Energy Department, REA
Mr. Gilbert Gichunge	Training Engineer, Renewable Energy Department, REA
Mr. Semekiah Ongong'a	Assistant Engineer, Renewable Energy Department, REA
Ms. Judith Kimeu	Assistant Engineer, Renewable Energy Department, REA

Ms. Peninah Karomoh	Environmental Scientist, Renewable Energy Department, REA
Mr. Alex Makori	Technician, Renewable Energy Department, REA
Ms. Eunice Wambui	Economist, Corporate Planning Department, REA
Ms. Lucy Muricho	Senior Communications Officer, Communications Department, REA
Mr. Samson Kasanga	Assistant Director, Renewable Energy, MoE&P
Mr. Jacob Chepkwony	Assistant Engineer, Renewable Energy, MoE&P
Mr. Edwin Owiti	Assistant Engineer, Renewable Energy, MoE&P
Mr. Mungai Kihara	Engineer, Renewable Energy, MoE&P
Mr. Dickson Kisoa	Principal Renewable Energy Assistant (RE), MoE&P

Prepared by JET

(2) Counterparts' Achievements through Trainings

A questionnaire (Objective & Achievement Sheet) was distributed to each counterpart of REA in November 2014. In the questionnaire, the following questions were asked.

a) Objectives of the project activities and individual goals in the OJT

b) Achievements corresponding to the above-mentioned individual goals (Score 1 to 5, 1=lowest, 5=highest)

Table 2.1.4 shows a summary of responses to the above questions.

Table 2.1.4 Objectives and Achievements answered by REA Counterparts

Field	Objectives of the project activities and individual goals in the OJT	Achievements*
Solar PV (Technical)	Designing a solar PV system	4
	Monitoring the performance of a solar PV system	4
Solar PV (Monitoring)	Interacting with the government officials of the area and helping understand what the project entails	4
	Helping light up the rural areas and also assisting in activities such as phone charging	5
MHP	Determining the area demand and hydro power potentials	4
	Designing a MHP system	4
	Operating various measuring equipment	5
Biogas	Designing a biogas system with or without a generator system	5
	Preparing a bidding document including technical specification	5
	Monitoring existing systems and conducting analysis of the biogas obtained and conditions of the digester	5
Wind	Conducting pre-feasibility study on wind power technology	4
	Conducting wind data analysis	4
	Sizing of hybrid systems (wind/solar/diesel)	4

*Achievements corresponding to the above-mentioned individual goals (Score 1 to 5, 1=lowest, 5=highest)

Source: Objective and Achievement Sheets (arranged by JET)

The individual Objective and Achievement Sheets filled by REA counterparts are attached in Attachment C-4.

2.1.4 Counterpart Training

Counterpart trainings were conducted three times in Japan, India and Thailand respectively. JET assisted with preparation of necessary documents for the training such as acceptance letter, resumes of candidate participants and training schedule, and coordination during the trainings.

The subjects covered by the trainings are as follows:

- Solar Energy

- Solar PV Technology and O&M
- Business Models
- Small and Micro-hydropower
- Biomass Energy
- Wind Power
- Rural Electrification
- Economic and Financial Analysis
- Sustainable Rural Development

The summary of the trainings is as shown in table below.

Table 2.1.5 Contents of Counterpart Trainings

1st Year (conducted in Japan)	
1) Course Title	Rural Electrification using Renewable Energy
2) Overall Goal	To learn the sustainable planning and managing methodology of renewable energy projects in Japan and other countries and apply into the policies, development plan and legislative system of Kenya
3) Duration	29th August-14th September 2012
4) Trainees (age) at the time of the training	Mr. Anthony Oredo (34), Technician, Renewable Enegy Department, REA
	Mr. Edwin Owiti (30), Assistant Engineer, Renewable Energy, MOE&P
	Mr. Jacob Chepkwony (31), Assistant Engineer, Renewable Energy, MOE&P
2nd Year (conducted in India)	
1) Course Title	Rural Electrification using Renewable Energy
2) Overall Goal	To apply the planning and managing methodology from renewable energy projects in rural India into the policies, development plan and legislative system of the Republic of Kenya
3) Duration	9th November-22nd November 2013
4) Trainees (age) at the time of the training	Mr. Semekiah Ongon'ga (37), Assistant Engineer, Renewable Energy Department, REA
	Ms. Caroline Kelly (34), Assistant Officer, Renewable Energy Department, REA
	Ms. Peninah Karomoh (31), Environmental Scientist, Renewable Energy Department, REA
	Mr. Dickson Kisoa (50), Principal Renewable Energy Assistant, Renewable Energy, MOE&P
3rd Year (conducted in Thailand)	
1) Course Title	Rural Electrification using Renewable Energy
2) Overall Goal	To learn the renewable energy technologies and to apply the sustainable planning and managing methodology of renewable energy projects in rural Thailand into the policies, development plan and legislative system of Kenya
3) Duration	2nd August-16th August 2014
4) Trainees (age) at the time of the training	Mr. Gilbert Gichunge (34), Training Engineer, Renewable Energy Department, REA
	Mr. Hannington Gochi (38), Senior Technician, Renewable Energy Department, REA
	Mr. Benson Mwakina (47), Senior Principal Superintending Engineer, Renewable Energy, MOE&P

Prepared by JET

The trainings consisted of the two main components below:

(1) Lecture/Case Study/Hands-on Training
(2) Site Visits

The schedules as well as modality of the trainings for each year are attached in Attachment C-1, C-2 and C-3.

As results of the training, a total of 10 trainees compiled reports and stated new tasks/roles that they intend to put into practice, which include:

- Ensuring adequate planning time for projects
- Introducing solar stills for making distilled water
- Making solar lantern charging facilities using DC

- Improving solar PV design by taking consideration of properties of each system component
- Conducting financial and economic analysis in the designing stage
- Utilizing poultry manure for biogas projects
- Designing a biomass gasifier
- Practicing waste management in biomass projects
- Promoting clean gas in biomass projects
- Training other colleagues in the organization

2.1.5 Provision of Equipment

For effective implementation of the Project, equipment was deemed necessary and therefore provided. The provided equipment falls into either of the below categories.

a) Necessary equipment for operation in the Project Office
b) Necessary equipment during the site trips
c) Monitoring equipment for renewable energy projects

All the equipment was handed over to REA before the end of the Project.

For c), the procurement of the same was conducted along the way of the Project since there was an arising need for showing the REA counterparts how to use the relevant equipment and for actual demonstration. The use of the equipment enhanced the technical transfer activities. In addition, the REA counterparts will be able to use them for future activities of REA. The list of equipment provision is shown in the table below.

Table 2.1.6 List of Provision of Equipment

Item	Nos. of Units	Model	Cost in KSh.	Cost in JPY	Date of Purchase
Desktop Computers (computers with anti-virus software)	3	HP	342,000		29 May 2012
Photocopy Machine (with A3/A4 laser printing and scanner function)	1	S/NFAJ11641 (2020L)	380,000		30 May 2012
Auto CAD	1	LT 2013	95,000		31 May 2012
Projector	1	Epson ES01 2600 Lumens	56,000		29 May 2012
UPS	3	1500KVA Mercury Smart	42,000		29 May 2012
GPS	1	Garmin eTrex30		29,907	5 June 2014
Satellite Phones	2	Thuraya XT	255,351		24 March 2014
Refractometer (for density measurement)	2	RHA-200ATC		13,889	28 June 2014
Refractometer (for density measurement, Additional)	2	B-012		9,574	29 Sep 2014
Current Meter	1	UC-200V		427,464	27 June 2014
AC/DC Digital Clamp meter	2	KEW MATE 2012R		27,709	20 June 2014
pH Meter	1	M610T		5890	19 May 2014
ORP Meter	1	RM-30P		58,500	27 June 2014
Methane Gas Detector	1	XP-3140		158,400	5 June 2014
Laser Distance Meter	1	GLM 80		19,395	19 May 2014

The letter concerning the equipment handover is attached in Attachment A-5.

2.1.6 Regular Reports and Meetings

(1) Management Meeting

Up to the 2nd JCC Meeting, issues arising between annual JCC meetings had been discussed and concluded in the management meetings. The meeting consisted of the members of the working group, project managers and JET. Which members gathered for the meeting much depended on the issues. However, demanding schedule of the counterparts at times prevented a timely occurrence of the meeting. Since the meeting was not prescheduled, it had become difficult over time to make the meeting happen. This presented a need for a better alternative.

(2) Weekly Email

In the 2nd JCC Meeting, it was agreed that more information sharing would be necessary. Sending weekly emails that contain weekly reports was one of the countermeasures. The email was addressed to the counterparts in REA and MoE&P, JICA HQ, JICA Kenya Office, BRIGHT Project and JET. JET had been submitting the schedule to REA by mid-week, asking REA to confirm/modify by the end of the week, and circulating the message.

(3) Monthly Progress Meeting

Another measure taken after inadequate information sharing was pointed out was holding monthly progress meetings. The members to attend the meeting were the counterparts in REA and JET, and the meeting was usually chaired by either Ag. CEO or Project Manager of REA. The agenda was composed of the project progress including technical transfer, future schedule and any other pertinent subjects. The summary of monthly progress meetings is shown in the table below.

Table 2.1.7 Monthly Progress Meetings (October 2013 to January 2015)

Months of Monthly Meeting	Main Contents	Chaired By
October 2013	1. Revised PDM 2. Progress report 3. Future events/schedule	Mr. Munyu
December 2013	1. Progress report 2. Confirmation of PDM/PO 3. Training in India 4. Evaluation of knowledge transfer 5. Future events/schedule	Mr. Munyu
January 2014	1. Progress report 2. Future schedule 3. Evaluation of knowledge transfer	Eng. Kamweru
February 2014	1. Progress report 2. Future schedule 3. Evaluation of knowledge transfer	Mr. Munyu
March 2014	1. Progress report 2. Future schedule 3. Progress of assignments from JET	Mr. Munyu
April 2014	1. Progress report 2. Future schedule 3. Upcoming counterpart training in Thailand	Eng. Kamweru
May 2014	1. Progress report 2. Future schedule 3. Evaluation of knowledge transfer	Eng. Kamweru
June 2014	1. Progress report 2. Future schedule 3. Optimization of solar designs for Laptop Programme	Mr. Munyu
July 2014	1. Progress report 2. MOU for ownership and maintenance of the project 3. Optimization of solar designs for Laptop Programme 4. Overview of model 5. International workshop	Eng. Kamweru
August 2014	1. Progress report	Eng. Kamweru

Months of Monthly Meeting	Main Contents	Chaired By
	2. Ownership and maintenance MOU 3. Optimizing solar designs for Laptop Programme 4. Overview of the JICA model 5. International Workshop preparation and progress	
September 2014	1. Progress report 2. MOU 3. JKUAT Conference 4. International Workshop preparation and progress	Eng. Kamweru
November 2014	1. Progress report 2. JKUAT Conference 3. Finalization of Guidelines 4. MOU 5. International Workshop 6. PV Systems Handover	Mr. Semekiah Ongong'a
December 2014	1. Progress Report 2. International Workshop preparation and progress 3. MOU	Eng. Kamweru
January 2015	1. Progress Report 2. International Workshop preparation and progress 3. MOU 4. Finalization of Guidelines	Eng. Kamweru

Prepared by JET

The monthly progress meetings served as official information sharing occasions, where REA takes initiative to prepare the agenda and chair the meeting. The meeting also discusses any arising issues and check if each field is progressing as scheduled. Overall, the meeting proved to be a practical occasion for information sharing. The minutes of the same are attached in Attachment B-2.

(4) Progress Report

As part of reporting activities, Progress Report 1, 2, 3, 4 and 5 were submitted biannually. Copies of the respective reports were shared with counterpart organizations as well as JICA.

In all the Progress Reports, the following contents were compiled.

1) Project Outline
2) Contents of Activities
3) Issues on Project Management, Best Practices and Lessons Learnt
4) Plan for Next Project Activities

2.1.7 Joint Coordinating Committee

In JCC, progress of the project was shared and issues were discussed with project counterparts of REA and MoE&P. The main discussions at the JCC were as shown below. Minutes of Meeting of each JCC are attached Attachment B-1 Minutes of JCC.

(1) 1st JCC (30 November 2012)

Cancellation of the component for Rural Electrification Model for industrial facilities and pilot projects (MHP, Biogas, Wind)

The new project component of technical transfer to REA /MoE&P (MHP, Biogas, Wind)

(2) 2nd CC (3 October 2013)

The JICA Midterm Evaluation Team gave a presentation on the evaluation results and emphasized on the need to speed up the Lot 2 implementation since the project was running behind schedule.

The draft PDM Version 3.1 was confirmed and agreed by the meeting.

(3) 3rd JCC (14 October 2014)

The JICA Terminal Evaluation Team gave a presentation on the evaluation results.

Preparation of work plan to the end the project was suggested.

(4) 4th JCC (13 February 2015)

The outputs of the project were discussed. The five guidelines (Solar PV in Health Institutions, Solar PV in Schools, MHP, Biogas and Wind) were submitted to REA and MoE&P. REA and MoE&P promised to distribute the guidelines to the concerned parties. Monitoring and Ex-Post Evaluation were discussed.

2.1.8 Midterm and Terminal Evaluations

As for project evaluation method, JICA adopted “the Five Evaluation Criteria”. The following table shows the results of evaluation by five criteria at Midterm and Terminal Evaluation. PDM was revised at the 2nd JCC which was held during the Midterm Evaluation. Therefore "Impact" and "Sustainability" were not evaluated. In the terminal evaluation, “Effectiveness” was “fair at present” because there are some remaining activities which have to be done in the project. If ongoing activities are completed smoothly and effectively, “effectiveness” is expected to be higher at the completion of the Project. Details of both evaluations are explained in Chapter 4.1 and 4.2 respectively.

Table 2.1.8 Results of Evaluation by Five Criteria

Item	Midterm Evaluation (October 2013)	Terminal Evaluation (October 2014)
1) Relevance	high	relatively high.
2) Effectiveness	moderate	fair at present
3) Efficiency	low to moderate	fair
4) Impact	too early to evaluate	fair
5) Sustainability	too early to evaluate	fair

Prepared by JET

2.2 Preparation of the Pilot Projects for Public Facilities by Solar PV

2.2.1 Review of Data and Information

Solar PV systems are being installed by MoE&P since FY2005/2006. Table 2.2.1 summarizes the number of public institutions that MoE&P has installed solar PV system from FY2005/2006 to FY2012/2013.

Table 2.2.1 The Number of Public Institutions with Solar PV Systems by MoE&P

Fiscal Year (FY)	Public Institutions (No.)	Total Installed Capacity (kW)
2005/2006	16	39.53
2006/2007	40	158.16
2007/2008	40	158.51
2008/2009	54	64.56
2009/2010	125	260.54
2010/2011	191	430.00
2011/2012	274	524.35
2012/2013	212	439.52
Total	951	2,075.17

Source: MoE&P, arranged by JET

There is an ongoing solar PV project supported by Spanish Government beside the installed Solar PV system in above table. The target of Spanish project is to install PV systems in 380 public facilities.

The main features of Spanish project are as summarized below.

- Number of targeted facilities: 380 nos.
- Procured total no. of PV module for the project: 7,000 (each 160 W PV module).
- The procurement of material started: from August 2013.
- The actual installation at site started: from March 2014.
- Number of installation completed: 280 nos. up to December 2014
- The target of installation completion: April 2015.

In the Spanish Project, installation of the solar PV system should have completed by the end of September 2014, however, only around 50% was installed by around the end of September 2014. The delay on the implementation of the Spanish Project was mainly due to the rapid extension of power distribution grid in rural areas. It is important to prepare the list of public institutions that will not be connected to national power grid in near future. MoE&P has installed solar PV system at public facilities as shown in the Table 2.2.1 and additionally, REA installed PV system in FY2009/2010 and FY2010/2011. There was no PV system installed by REA in FY2011/2012 and FY2012 /2013.

Table 2.2.2 shows the number of institutions where solar PV systems were installed by REA during the period of FY2009/FY2010 and FY2010/FY2011.

Table 2.2.2 The Number of Public Institutions with Solar PV System installed by REA

Fiscal Year (FY)	Public Institutions (No.)	Total Installed Capacity (kW)
2009/2010	34	53.770
2010/2011	31	69.190
Total	65	122.960

Source: MoE&P, arranged by JET

Besides the projects mentioned above, REA has been installing solar PV systems for Laptop program since November of 2013. The laptop program is announced by the Government of Kenya and REA's role is to provide power for primary schools by extending power grid and installing solar PV systems. For the primary schools for installing solar PV system, REA made tender from the 4th quarter of FY2013/2014.

Under the Laptop program, 667 schools have already been installed with PV systems including lighting system of 240 W at each site.

The following shows current condition of lap top program using solar PV system.

i) Total number of targeted schools for solar PV systems installation: around 3,000 nos.
ii) Installation started: March 2014 (4th quarter of FY2013/2014)
iii) Target of completion of program: June 2015 (FY2014/2015)
iv) Completed number of installation (schools): 667 nos. (as of 18 December 2014)
v) Solar PV capacity for lighting at installation completed school: 240 W (each system, installed together with Laptop system, i.e. 1,440 W + 240 W = 1,680 W at each site)

2.2.2 Site Selection for Pilot Project

For installation of PV system at public institutions in the pilot project, 4 sites were selected for Lot 1 and 6 sites were selected for Lot 2. Candidate sites were selected on the basis of possibilities of grid connections in near future, social aspects, willingness of required cooperation of institutions and community, and so on.

Lot 1

The selection criteria for pilot projects determined by REA at the time of preliminary studies are as shown below.

- Not near to the existing grid line
- Not belonging to private or mission
- Not overlapping with candidate sites of other donors
- Confirmed Safe security environment

Lot 1 site were selected along with the selection criteria mentioned in above based on the discussion between JET and REA. Lot 1 sites are indicated in the table below.

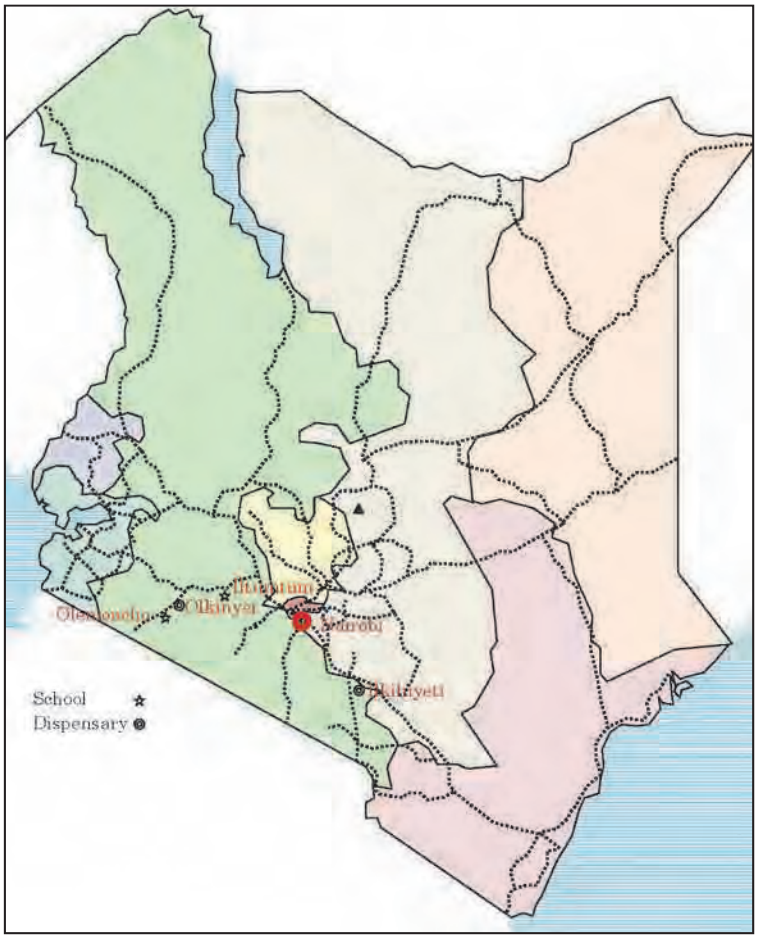
Table 2.2.3 The List of Public Institutions of Lot 1 Installation

S. No.	Community	County	District (Sub-county)	Type of Institution
1	Ilkilnyetti	Kajiado	Kajiado Central	Dispensary
2	Iltumtum	Narok	Narok North	Primary school
3	Olemoncho	Narok	Narok South	Primary School
4	Olkinyei	Narok	Narok South	Dispensary

Prepared by JET

At first, Meto Dispensary in Kajiyado County was included in the selected five sites for Lot 1, however, distribution line extension was confirmed during installation work. Accordingly, Meto Dispensary was excluded from Lot 1 target, and the number of Lot 1 sites became four as shown in the table above.

The location of each institution is as shown in below Figure 2.2.1.



Prepared by JET

Figure 2.2.1 Location of Lot 1 Installation Sites

Lot 2

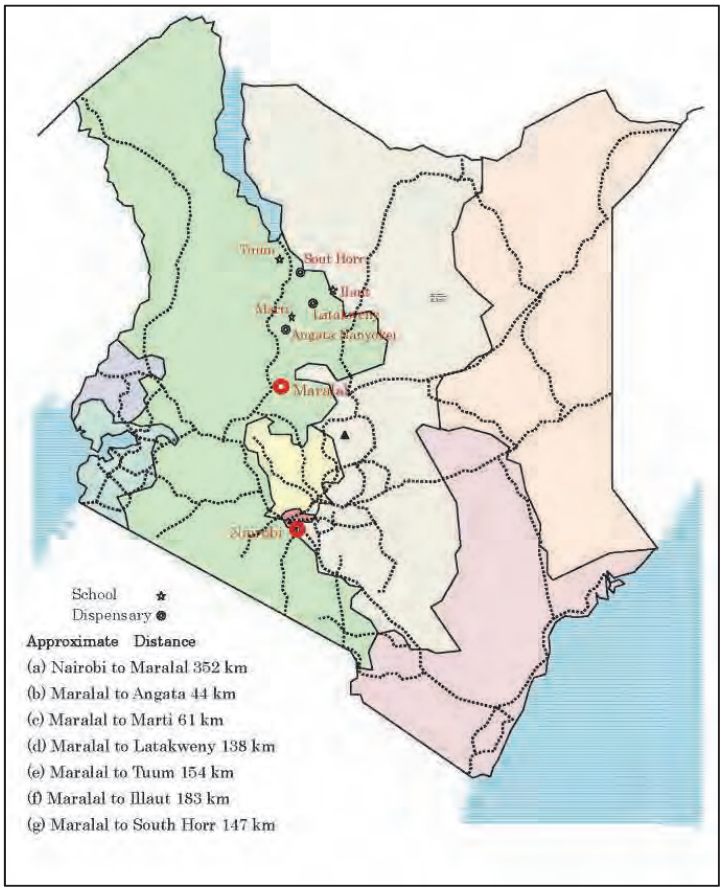
For Lot 2, site selections were carried out using same selection criteria for Lot 1. At a candidate site of Lot 1, extension of distribution line was progressed rapidly. To avoid same situation in Lot 2, several discussions were made between REA and JET for the site selection. Accordingly, all Lot 2 sites were selected in Samburu County. The list of selected public institution for Lot 2 solar PV systems installation is as shown in below Table 2.2.4.

Table 2.2.4 The List of Public Institutions Where PV System was Installed for Lot 2

S. No.	Community	County	District (Sub-county)	Type of Institution
1	Tuum	Samburu	North Samburu	Primary school
2	Illaut	Samburu	North Samburu	Primary school
3	Marti	Samburu	North Samburu	Primary school
4	Latakweny	Samburu	North Samburu	Dispensary
5	South Horr	Samburu	North Samburu	Dispensary
6	Angata Nanyokei	Samburu	Central Samburu	Dispensary

Prepared by JET

The location of each institution and the distance from Nairobi to Maralal (capital center of Samburu County) and to each site are as shown in Figure 2.2.2.



Prepared by JET

Figure 2.2.2 Location of Lot 2 Installation Sites

2.2.3 Baseline Survey

(1) Objectives

The main objective of the baseline survey was to obtain information on the basic social and economic status of the pilot project facilities and the communities in proximity to the target facilities. Results of

the survey were used to inform PV system design including O&M, management system planning, setting of electrical tariffs and monitoring indicators.

(2) Methodology

The baseline survey was undertaken in November 2012 for Lot 1 sites[1] and October 2013 for Lot 2 sites. The survey was implemented by using questionnaires developed by the JET members. The questionnaires consisted of interviews addressed to staff of the pilot project facilities, management committees, and elders of surrounding communities. Also they interviewed to households and local authorities for the Lot 1 sites.

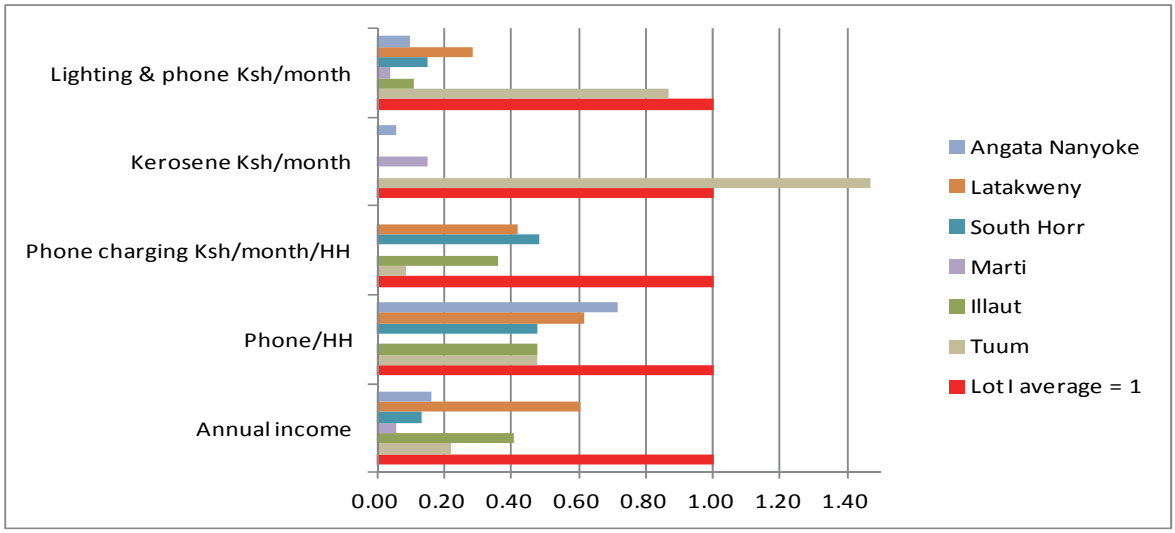
(3) Important Findings of the Baseline Survey (Lot 1 and Lot 2)

- All target facilities use kerosene lamp for night lighting. Expenditure for kerosene depended on the size of the facility but it costs more than KShs 1,000 per month. Dispensaries have vaccine refrigerator using LPG. Monthly expense of kerosene, dry cell for radio and LPG was estimated between KSh 1,660 and KSh 5,365. They paid for kerosene and LPG from HSSF and FPEF but all facilities claimed it was insufficient.
- Four of the five project sites in Lot 1 had solar systems installed which were functional, while all target facilities in Lot 2 sites except Illaut Primary School were installed with one or two solar PV systems. However, not all systems were in good condition: all facilities experienced system failures/errors. Knowledge and skills to carry out O&M and financial management were inadequate and budgets were unstable. Facility staff operated the system and O&M cost was paid from facility funds such as FPEF and HSSF.
- The most preferred use of electricity was mobile phone charging where network was available. The unit price of phone charging varies from place to place and ranges between KSh. 20 and KSh. 40 in November 2012 (Lot 1 survey) but the price decreased in a short time and it was KSh 20 in October 2013 (Lot 2 survey).
- However, there was no stable telephone network coverage at Meto (Lot 1) and all Lot 2 target sites except South Horr, but a few inhabitants own mobile phones. It was said that mobile phone companies like Safaricom would expand their service area and the number of mobile phones and frequency of telephone use would increase. JET expected that the charging service at Lot 2facilities would generate more income than that of Lot 1 sites because it will be the front runner of charging business.
- The Government established management committee (MC) t all dispensaries and primary schools in Kenya. The MC has responsibility of ensuring administration, management and decision making processes are run smoothly. The JICA expert decided these committees as the appropriate organizations to take over the responsibility of managing the solar PV systems after they are installed.

(4) Comparison with Lot 1 Sites

JET found remarkable differences between Lot 1 and Lot 2 sites in social and economic conditions. They compared the result of the baseline survey of four sites of Lot 1 and six sites of Lot 2 of important socio-economic factors, such as average income, number of mobile phones per household, monthly expenses for mobile phone charging and kerosene, and total expense for lighting and charging. Figure 2.2.3 shows the factors when the average of Lot 1 sites is set as 1.00. It shows that all the six Lot 2 sites are lower than the average of Lot 1 sites except the expense for kerosene at Tuum. Especially social and economic factors of Marti are extremely low. It is a village established recently by the people who fled from Turkana because of ethnic conflicts and it actually seems like a camp.

[1] JET implemented baseline survey at five candidate sites including Meto Dispensary, which was canceled before system installation in 2013.



Prepared by JET

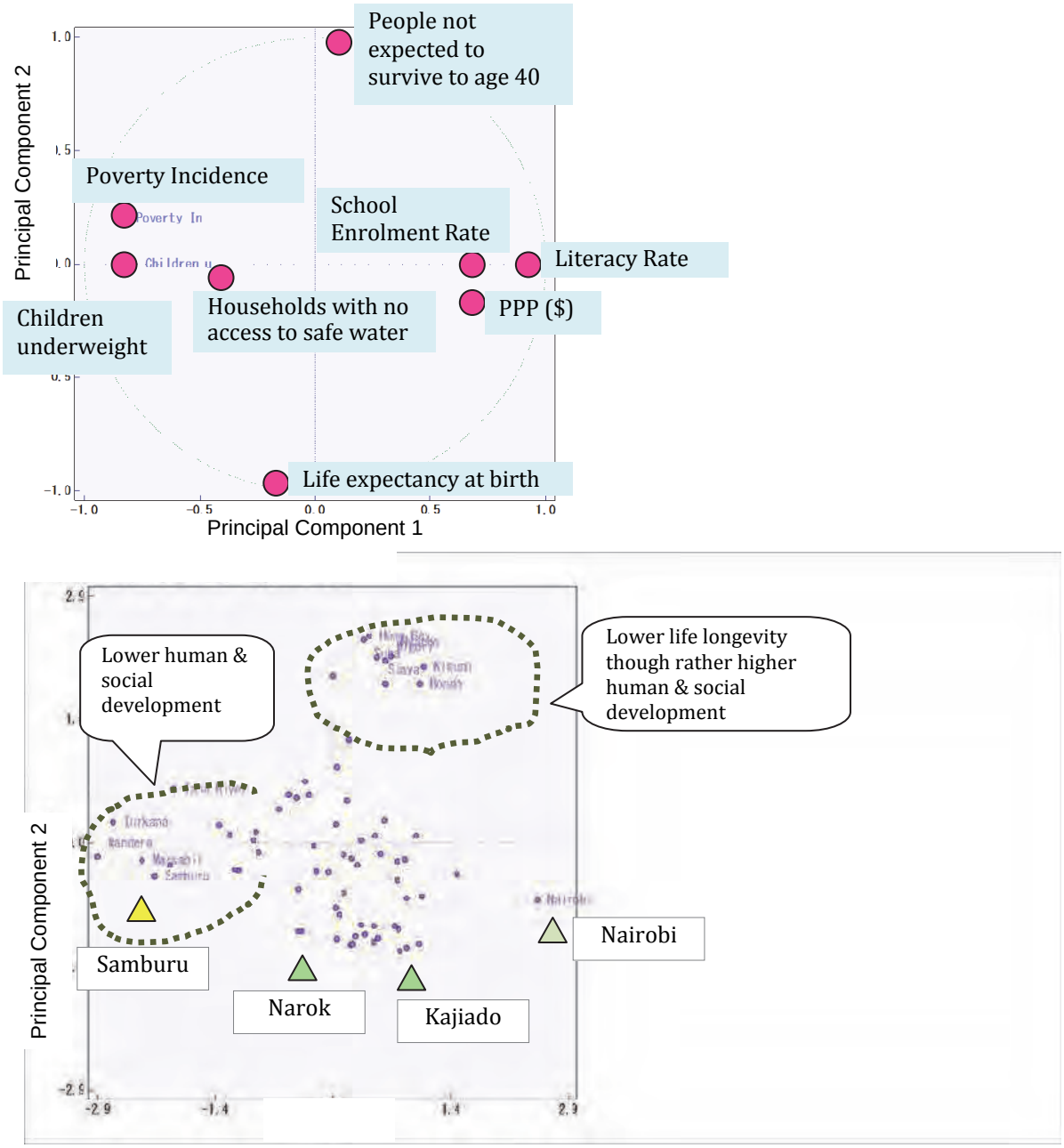
Figure 2.2.3 Comparison of Social and Economic Factors of Lot 1 and Lot 2 Sites

(5) Classification of former Districts in Kenya from a Social Development Perspective

The purpose of the Project is to establish an electrification model using renewable energy, one which will be applicable in all other non-electrified rural areas in Kenya. Rural electrification is often regarded as an element of improving the quality of life. JET found during the process of Lot 2 site selection that the potential areas are remote counties located on the border with Somalia, Ethiopia and Uganda. In these areas, both public and private sectors as well as donors avoid to invest due to remoteness, weak infrastructures including road and lack of security.

It is important to understand the overall social and economic condition of candidate area of the electrification by solar PV system and application of the Model. The JICA expert classified the Kenyan administration areas by evaluation of social and economic indicators of the former districts[2] from a social development perspective to understand the overall condition of the target area. As social development data for the new Counties (post 2013 reforms) was not available, the JICA expert has adopted data for the old Districts, as described in the "Kenya National Human Development Report 2009 (UNDP Kenya and Government of Kenya, June 2010)" and "Kenya Integrated Household Budget Survey 2007 (KNSB)". The specific indicators applied here are: (i) Life Expectancy at birth, (ii) People not expected to survive to age 40 (P40) as humanity factor[3]; (iii) Literacy rate, (iv) School enrolment rate, (v) households without access to safe water, (vi) underweight children as basic human need factor, (vii) purchasing power parity (PPP)[4] and (viii) poverty incidence estimated by Kenya National Statistic Bureau as economic development factor. Electrification rates at the District level are unavailable at the time of analysis.

[2] Districts existed before 2008 rural administration reform.
[3] These two factors relates closely but reversibly.
[4] The purchasing power (PPP) of a country's currency is the number of units of that currency required to purchase the same representative basket goods and services (or similar basket of gods and services) would buy in the United States. PPP could also be expressed in other currencies or in SDRs.



Prepared by JET

Figure 2.2.4 Distributions of Factor Loading (Above) and Scores of Principal Component (Below)

By application of the principal component analysis, the following results were obtained. As Figure 2.2.4 shows, Samburu District (almost same area of present Samburu County) is one of the districts within the group of “low human development” together with Turkana, Mandera, or Marsabit.

2.2.4 Capacity and Needs Assessment

(1) Objectives and Methodology

1) Objectives

The goal of the project is to establish and disseminate a rural electrification model using renewable energy. The model will be applied in rural public facilities. To achieve this goal, the responsible government institutions are to take initiative in planning, budgeting and assigning human resources as well as providing necessary support to the facilities.

In response to the TOR, JET focused the assessment on the needs and capacity of county and sub-county on dissemination of the renewable energy and that of target facilities on the charging service management. Dissemination of renewable energy included awareness raising, education on renewable energy and dissemination of the model. In the TOR for this Project, JICA instructed that JET implemented needs and capacity assessment of: (i) target facilities, surrounding communities and private sector on the management of energy provision service business, and (ii) local governments on raising awareness and building capacity regarding renewable energy that was addressed to local people, users and service providers. As the target of the Project is public facilities, it did not involve community people and private sectors so much at both county and facility levels.

2) Methodology

Needs and capacity of each institution were assessed in relation to its role as a stakeholder in the electrification and its ability to achieve the goals defined below:

- Public facility: operates, maintains and manages installed PV system in technically, institutionally and financially sound condition under an appropriate management structure;
- County and sub-county (then district) MoH, MoEST offices: supports the target public facility in several ways (in response to its specific needs) including raising awareness and providing education on renewable energy;
- REA: (i) pilot project implementation in collaboration with JET, (ii) providing technical advise and support to facilities and relevant ministries, (iii) carrying out activities in providing education on O&M techniques and management, (iv) providing necessary materials and in some cases finance, (v) raising awareness on the value of electrification by RE and its requirements and (vi) dissemination of the established model to other non-electrified rural areas in future.

It might be appropriate to collect information of the target institutions by convening discussion and brainstorming sessions. However due to time constraints, information was collected by administering questionnaires and conducting interviews with staff members of the target institutions.

3) Analytical framework

JET applied three elements of organizational capacity to the capacity assessment: technical capacity, core capacity and enabling environment. These are defined in “Capacity Assessment Handbook (JICA Research Institute, 2008)”.

i. Technical capacity：techniques, particular knowledge and tacit knowledge of the organization etc.
ii. Core capacity ：management (practical administration capabilities), leadership, will and attitude, and awareness etc. which form the core elements for ‘capabilities for handling issues’.

iii. Enabling environment: conditions that allow the target organization to utilize its capabilities and produce results, including policy framework, resources, formal and informal institutions, social capital and social infrastructure, etc.

In order to carry out more detailed assessment, JICA expert made breakdown of the three elements into 'breakdown indicators". Breakdown indicators should be quantitative or easily converted into numerical score in order to maintain objectivity and make comparisons among organizations. The analytical framework used for capacity assessment is shown in the table below[5].

Table 2.2.5 Breakdown of the required Capacity of Concerned Organizations

Technical capacity	Core capacity	Enabling environment
Public facility		
(i) Knowledge of PV system (ii) Knowledge and technique of operation and maintenance of PV system (iii) Knowledge of financial and organizational management	(i) Intention of staff members to manage solar PV system (ii) Intention of staff members to manage charging service (iii) Preparation of service management in terms of staff, materials, banking system (iv) Unity of the management structure: internal rules, meeting, information sharing, transparent decision making system	(i) Relevant ministries (MoEST, MoH) authorize public facilities under their supervision carry out electricity provision service. (ii) They allocate budget for O&M and management of the solar PV system (iii) Assistance from REA in terms of training in O&M of solar PV system (iv) Assistance from County and Sub-county officers for management of electricity provision service
County and Sub-county officers (education officer, public health officer) (They were District health and education officer at the time of assessment)		
(i) Basic knowledge of O&M of PV system (ii) Knowledge and know-how of charging service (iii) Knowledge and skill in raising awareness and providing education on renewable energy	(i) Intention to support facilities under their supervision (in electrification) (ii) Intention and preparedness to support facilities in PV system management in terms of staff, materials, and finance (iii) Preparedness to support facilities in PV system management, in terms of staff, materials and finance (iv) Intention to monitor the electricity management	(i) It is their duty to support the target facilities in electrification and management of renewable energy. (ii) It is their duty to raise awareness and provide education on renewable energy to facilities and community. (iii) Budget is allocated to support the electrification of facilities using renewable energy.
Governmental institutions (MoE&P, REA)		

[5] JET did not have clear perception of actual roles ad duties roles of stakeholders and their relation to the solar PV system at the time of making this table.

Technical capacity	Core capacity	Enabling environment
	Public facility	
(i) Knowledge and experience of renewable energy (ii) Knowledge and experience in raising awareness and providing education on renewable energy to rural communities	(i) Having a mission to raise awareness and provide education on RE (ii) Establishment of an action plan for raising awareness and providing education on renewable energy (iii) Degree of achievement of action plan (vi) Real activity for raising awareness and providing education on renewable energy in non-electrified areas (v) Result of activity for raising awareness and providing education on renewable energy: frequency and recipients (iv) Assessment of inhabitants' needs for electrification in non-electrified areas (v) Understanding of the real situation of electrification in the project sites (vi) Understanding of the real socio-economic condition of the PP sites (vii) Understanding of constraints to electrification of pilot project sites using renewable energy (viii) Understanding of the real electricity and socio-economic conditions in the non-electrified communities in general (ix) Understanding of the necessity and method of ensuring sustainability (x) Experience of monitoring (xi) Ready to disseminate the model to other non-electrified rural communities	(i) Raising awareness and providing education on renewable energy is authorized mandate of the institution (ii) Resources necessary to implement the action plan: (iii) human resources: number, academic background, professional background (iv) social resources: opportunity for training on raising awareness and providing education on renewable energy (v) social resources: relationship with local community (vi) financial resources: budget for raising awareness and providing education on RE (vii) Physical resources: means of transportation (vehicles), materials for raising awareness and providing education on RE (viii) Training opportunity for staff members, on raising awareness and providing education on renewable energy

Prepared by JET

(2) REA

REA's main task is to spread electricity into rural areas in Kenya. Strategic Plan (2008-2012), describes the following objectives:

- Promotion of development and use of renewable energy and strengthening of staff capacity;
- Implementation of strategies corresponding to the strategic objectives:
  - disseminate information on renewable energy to the public,
  - install solar PV in Schools and health centers located far from the grid,
  - implement biomass based electricity generation systems for institutions and communities,
  - partner with institutions to build capacity in design and installation of renewable energy,
- The Strategic Plan also indicates that REA's capacity needs in relation to promotion of renewable energy are:
  - inadequate trained human capacity, and;
  - limited awareness on use of renewable energy (of rural society).

In order to achieve these goals, REA indicates its priority needs as (i) sufficient social resource on staff education and (ii) increase in the number of staff in order to implement additional activities to raise awareness and provide education on renewable energy to rural communities.

First, REA needs development of institutional framework which guarantees sustainability of renewable energy systems to facilitate the growth of electrification rates. Second, REA needs to invest in raising awareness to users and providing them education in renewable energy to ensure they are capable of managing the system.

In addition to needs responding to technical and financial aspects, human and social factors should be considered such as (i) appointment of staff members responsible for raising awareness and providing education on renewable energy , (ii) appointment of staff members responsible for monitoring and providing support to system owners, (iii) official inclusion of activities for raising awareness and providing education in staff members responsibilities and (iii) capacity building on raising awareness and providing education, providing support to communities and monitoring of projects.

JET found at the interview to REA that (i) renewable energy was not mainstreamed into all of REA's rural electrification strategies, (ii) most of REA's budget was used for grid extension and (iii) non-technical components had generally not been adequately factored into projects in Kenya. JET supposed these issues might explain why raising awareness and providing education on renewable energy was not a priority need for REA and a core activity. It was therefore assessed that the REA's role of disseminating renewable energy was not sufficiently implemented and they needed more awareness, knowledge, budget and human resources. In summary, REA did not seem to have enough capacity in raising awareness and providing education on renewable energy and, thus, in implementing non-technical components of the pilot project.

(3) County and Sub-county Offices

Sub-counties (Districts at the time of assessment) were the frontline government offices representing each ministry in addressing needs, subsequent to the local administration system reforms in 2012-2013. At the beginning of the Project, JICA expert conducted interviews to officers in all the districts. The interview result shows that none of the officers, with the exception of the Narok South sub-county education officer, were responsible for projects related to electrification. They could therefore not identify needs related to electrification.

All officers provided recommendations on their areas of need in regards to raising awareness and providing education on renewable energy. These needs included those required to implement development activities in general, such as (i) skilled and capable human resource, (ii) social resource which was defined as official inclusion of electrification and renewable energy dissemination in their role, (iii) physical resources such as materials and facilitation, and (iv) finance.

County and Sub-county offices of MoH and MoEST had the responsibility of maintaining the facilities' equipment and operational budget. Awareness raising and provision of education on renewable energy was not a part of this mandate. The county offices showed little knowledge of renewable energy and low motivation to support facilities under their supervision regarding solar PV system. Therefore, for sustainable management of the solar PV systems, JET found it necessary to raise the awareness and increase the understanding of county and sub-county offices, involve them as project collaborators and monitoring.

(4) Target Facilities and Other Stakeholders

All pilot project target facilities evaluated themselves weak in self-reliant O&M activities. This status quo validates the ranking of appropriate knowledge and skills to operate the system (technical training) as a high priority need. Facility staff members also did not have experience and knowledge of charging service such as accounting.

Generally facilities did not get enough budgets from ministries and made requests for several forms of support. They submitted these requests to a number of needs relevant to government institutions and JICA, including training/technical support and funding/financial support.

JET concluded that target facilities had little experience, knowledge and technical know-how of O&M and financial management though their intention to manage was not weak. Despite not having any experience, facilities were keen to receive PV system and intend to carry out charging services. However, they were not fully aware of the capacity required to ensure success and sustainability of the project. It could be concluded that capacity in O&M and small business management needs to be enhanced for successful power generation and provision of service.

(5) Conclusions

The capacity assessment shows that all the stakeholders did not place emphasis on the non-technical components including dissemination and charging service business. The level of understanding and extent to which issues of O&M and organizational& financial management had been incorporated into their normal operations and programs was low. A capacity building plan needed to be developed by the JICA expert, to support public facilities, MoE&P and REA as part of the model.

Facing this assessment, JET planned capacity building plan both for facility and REA. Capacity building of public facilities focused on strengthening knowledge of technical and management issues and providing experience in charging service (book keeping, budgeting and marketing and promotion to communities). Capacity building of REA in the form of technical transfer focused on strengthening understanding of local rural communities and their conditions in order to reflect these insights on electrification strategies and policies and JET planned to conduct this plan through OJT of the soft component of the pilot project.

Result of assessment was reflected in the planning of the pilot project and the model.

2.2.5 Review of Environmental and Social Conditions

(1) Lot 1 Pilot Project

1) Lot 1 Pilot Project Sites

The exact locations of the proposed Lot 1 pilot projects are shown in Table 2.2.6.

Table 2.2.6 GPS Positions of Lot 1 Sites

Lot 1 Sites			GPS		Altitude
County	Community	Facility	South	East	(m ASL)
Kajiado	Ilkilnyeti	Dispensary	2.29268	37.61312	1,035
	Meto*	Dispensary	2.41089	36.54955	1,686
Narok	Iltumtum	Primary School	1.24511	35.95778	1,855
	Olkinyei	Dispensary	1.18395	35.40691	1,973
	Olemoncho	Primary School	1.19849	35.28584	1,799

Note: m ASL: meters Above Sea Level

* Meto Dispensary was cancelled in July 2013, just before the installation works, due to grid extension.

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A map of protected and conservation areas (including “Ramsar” and “Natural Heritage” sites) in Kenya, on which approximate locations of the Lot 1 pilot project sites are indicated is shown in Attachment N-2. Several of these protected areas are at close proximity to Lot 1 sites as shown in Table 2.2 7.

Table 2.2.7 Nearest Protected Areas around Lot 1 Sites

Lot1 Sites		Nearest Protected Areas	Approximate Direct Distance (km)	Direction
1	Ilkilnyetti	Tsavo West National Park	13	South East
2	Meto*	Amboseli National Park	70	South East
		Ol Doinyo Orok Mountain Forest Reserve	20	South East
		Lake Magadi	59	North West
3	Iltumtum	Hell's Gate National Park	54	North East
		Loita Forest	46	South West
		Mount Suswa	45	East
4	Olkinyei	Maasai Mara National Reserve	45	South West
		Chepalungu Forest	41	North West
		Maasai Mau	79	North East
5	Olemoncho	Maasai Mara National Reserve	35	South West
		Chepalungu Forest	37	North West
		Maasai Mau	83	North East

* Meto Dispensary was cancelled in July 2013, just before the installation works, due to grid extension.

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In addition, another map of archeological, cultural sites and facilities (including "Cultural Heritage" and "Natural Heritage" sites), on which approximate locations of the Lot 1 pilot project sites are indicated, is shown in Attachment N-2 Figure N-2.2.2.

These sites and facilities are located at a considerable distance from the nearest protected areas around Lot 1 project sites (see Table 2. 2. 7 and Attachment N-2 Figure N-2.2.2) excluding the Narok Site Museum. However, the direct distance from the nearest Lot 1 project sites (Iltumutum and Olkinyei) to the Narok Site Museum is about 30 km for each.

2) Surrounding Environmental and Social Conditions of Lot 1 Pilot Project Sites

The Lot 1 pilot project sites and their vicinities have been reconnoitered by the JICA expert in order to observe the surrounding environmental and social conditions. Table 2.2.8 and 2.2.9 summarize the surroundings of the Lot 1 Pilot Project Sites (corresponding to photographs shown in Attachment N-3 Project Description Report)

Table 2.2.8 Surroundings of Kajiado Sites

Site	**Ilkilnyeti**	**Meto***
Facility	Dispensary	Dispensary
District	Kajiado Central/ Kajiado County	Kajiado South/ Kajiado County
1. Facility Description	✓ One main building with construction almost complete (i.e. drainage and sewer infrastructure). ✓ Two buildings which are fairly in good conditions. ✓ One Concrete structure water tank. ✓ One plastic water tank, approximately 1,000 ℓ capacity. ✓ One double door pit latrine. ✓ One single door pit latrine. ✓ No fence around the facility.	✓ Two permanent buildings: The Dispensary block and a block (near completion) housing 2 Dispensary personnel. ✓ Two blocks of double door pit latrines. ✓ The Dispensary is enclosed by a live fence and access is by a metallic gate.
2.Topography	✓ Generally flat.	✓ The site has a gentle slope, with the slope taking a north easterly direction. ✓ General topography is rugged marked by alternating hills and valleys.
3. Soils and geology	✓ The soils are characterised by fairly deep red volcanic soils ✓ The rocks are also of volcanic origin but having gone through some weathering process.	✓ The site is generally characterized with red volcanic soils. ✓ The site has no visible rocks exposed to the surface
4. Flora & Fauna	✓ The site and surrounding vegetation is majorly stressed shrubs and thorny acacia as is the common characteristic with arid and semi arid climatic conditions.	✓ The site and the general surrounding area is characterized by acacia trees, euphobia and scrubs denoting aridity of the area.

5. Water & Sanitation	✓ No permanent stream, spring within or any natural water body in the immediate vicinity (at least not within 2km radius). ✓ No piped water network available for the site. ✓ Shallow wells dug on dry river bed approximately 500m provide water for the Dispensary. ✓ A bore hole was sunk within a 500m radius to serve the Dispensary and surrounding community but according to the hospital administration, the chemical composition of the water was found to be above limits allowable for human consumption. ✓ One concrete built water tank and one plastic water tank. ✓ One double door pit latrine and one single door pit latrine. ✓ Incomplete soak pits and septic tanks.	✓ A natural spring exists about 800m South West of the site ✓ The spring provides piped water system to the site. ✓ There is 1,000L capacity plastic water storage tank for rain water harvesting. ✓ No permanent rivers within the immediate vicinity and within the general area of Kajiado South. ✓ What exist are dry river beds.
6.Solid Waste Management	✓ No proper solid waste management system in place. ✓ Solid wastes including medical wastes are burnt indiscriminately in a shallow pit just at the backyard of the Dispensary. ✓ The net effect of burning is that not all materials especially the empty medical bottles are not completely reduced to ashes hence posing danger ✓ No incineration facility for medical wastes. ✓ There are no planned handling methods for used batteries after their end of life.	✓ Inadequate solid waste management characterized by no separation of wastes. ✓ Burning of wastes in an open shallow pit. ✓ Traces of syringes and needles could be spotted in the pit hence posing danger. ✓ No incineration facility for the medical wastes.
7. Roads/ Access	✓ Site is approximately 17km off Mombasa-Nairobi highway. ✓ Access road is earthen road in fairly good condition	✓ Site is approximately 35km East of Namanga-Kajiado road.
8. Surrounding development	✓ No visible homestead within a radius of 1km from the Dispensary. ✓ A Primary School approximately 500m from site.	✓ No major development neighbouring the site. ✓ Meto Primary and Meto mixed Secondary are within the immediate vicinity of the Dispensary.

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

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Table 2.2.9 Surroundings of Narok Sites

Site	**Iltumtum**	**Olkinyei**	**Olemoncho**
Facility	Primary Boarding School	Dispensary	Primary Boarding School
District	Narok North/Narok County	Narok South/ Narok County	Narok South/ Narok County
1. Facility Description	✓ One Class room block housing classes 1-8 (permanent structure). ✓ Two dormitory blocks (permanent structures); each for girls and boys. ✓ One permanent structure block housing for four teachers. ✓ One semi permanent structure for two teachers and one permanent block housing the kitchen. ✓ The School is fenced with barbed wire and has a gate.	✓ One main building housing the Dispensary. ✓ Two staff houses housing two Dispensary staff. ✓ Three plastic tanks each with a capacity of 1,000L (one plastic tank for the three buildings). ✓ Two double door pit latrines. ✓ No fence around the facility.	✓ The School has two blocks of classroom; one permanent structure block and another of semi permanent material. ✓ Semi permanent structures used as girls' dormitory, teachers' houses and kitchen. ✓ No fence around the School.
2. Topography	✓ The site is generally flat.	✓ The site is generally flat.	✓ The site is generally flat.
3. Soils and geology	✓ The site is generally characterised with red soils. ✓ The site has no visible rocks exposed to the surface.	✓ The site is characterised with red soils in some areas and also white clay soils in some section. ✓ The site has no visible exposed rock to the surface.	✓ The site is characterised with red soils in some areas and also black cotton soils in other areas. ✓ The site has no visible rocks exposed to the surface.

4. Flora & Fauna	✓ The site has a mix of planted and wild trees shrubs and grass. ✓ The site's surrounding environment has thickets, shrubs and short trees. ✓ The area (according to information from the teacher on site) is inhabited with wild animals like elephants, leopard hyenas among others.	✓ The site and surrounding vegetation is majorly shrubs and thorny acacia, euphorbia plants and grass depicts the arid and semi arid conditions as is the common characteristic with arid and semi arid climatic conditions. ✓ The area generally within the Maasai mara conservancy area hence wild animals like wildebeests, gazelles, zebras among others generally roam the area.	✓ The site and its immediate vicinity (about 500m) are generally bare of vegetation apart from patches of grass. ✓ The sites generally within the Maasai mara conservancy area hence wild animals generally roam the area. This includes wildebeests, gazelles, and zebras among others.
5.Water & Sanitation	✓ Water pan by Iltumtum community water project through the sponsorship of Greater Horn of Africa Rainwater Partnership/Kenya Rainwater Association (GHARP/KRA) Secretariat in 2008 is approximately 150m on the western side of the School. ✓ No piped water system; but water storage tanks (1 permanent structure measuring $50m^3$ and 1,000L capacity) for rain water harvesting. ✓ Two pit latrine blocks and two bath shelters serving boys and girls. ✓ One pit latrine serving the teachers.	✓ No natural stream, spring within or any natural water body in the immediate vicinity (at least not within 2km radius) ✓ Piped water system with the source being a bore hole. ✓ Three water tanks for storing the water from the bore hole and rain water harvesting. ✓ Two-double-door pit latrines to handle human waste.	✓ There is a seasonal river, Oletorotua for watering domestic animals ✓ The stream is approximately 1.5 km to the south of the site. ✓ No piped water system. ✓ Water for domestic use is sourced from Olemoncho spring. ✓ 1 small plastic tank for rain water harvesting (only at the wooden structures and only approximately 100L in capacity). ✓ One bath shelter.
6.Solid waste management	✓ Solid waste handled by burning, composting. ✓ Food remains are thrown away to be scavenged on by roaming dogs. ✓ Plastic papers menace exists. ✓ No collection system for solid waste from any service provider.	✓ Transports medical wastes to Eindoinyo Narasha Dispensary where there is an incinerator. ✓ However there are still some used medical bottles at a shallow pit for burning other wastes. ✓ Burning is the main method of handling wastes. ✓ No collection system from any solid waste service provider.	✓ Burning in shallow pits is the main method of solid waste handling ✓ No clue on how used batteries will be handled. ✓ No collection from any service provider.
7.Roads/ Access	✓ The site is approximately 30 km South of Narok Town. ✓ Road from Narok town is earth road in a motor-able condition.	✓ The site is approximately 45km South West of Narok Town. ✓ Access road is earthen road in fairly good condition.	✓ The site is approximately 1.5 km from Aitong' centre and 60 km South West of Narok Town. ✓ The road from Aitong' centre is in a condition that renders it impassable during rainy periods.
8.Surrounding development	✓ No major development in neighbouring the site. ✓ A shopping centre (Ntulele market) is approximately 800m North of the Iltumtum.	✓ No visible homestead within a radius of 1km from the Dispensary. ✓ A shopping centre 500m North of the site	✓ There exists homesteads around the site ✓ A shopping centre (Aitong') is within 1.5 km radius.

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(2) Lot 2 Pilot Projects

1) "Former" Lot 2 Pilot Project Sites

Table 2.2.10 shows "former" (initially selected candidate sites) Lot 2 pilot project sites. The "former" Lot 2 pilot project sites were visited by the environmental and social considerations expert from JET to conduct field survey for identifying the environmental and social conditions.

Table 2.2.10 GPS Positions of "Former" Lot 2 Sites

"Former" Lot 2 Sites			GPS		Altitude (m ASL)
County	Community	Facility	Latitude	Longitude	
Tharaka-Nithi	Maragwa	Primary B. School	S 0.33611	E 38.30972	642
	Iruma	Primary B. School	S 0.34888	E 37.22055	482
Laikipia	Naiperere	Primary B. School	N 0.55527	E 37.09972	17,06
	Kimanjo	Dispensary	N 0.60722	E 37.22055	1,890
Baringo	Barsemoi	Dispensary	N 0.63611	E 36.01944	1,273

Note: m ASL: meters Above Sea Level

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However, due to the present conditions around the "former" Lot 2 pilot project sites and technical considerations, the sites have been cancelled as the sites and changed to "New" Lot 2 pilot project sites (hereinafter referred to as "Lot 2 pilot project sites" or "Lot 2 sites") as follows.

2) "New" Lot 2 Pilot Project Sites

The exact locations of the newly selected Lot 2 pilot projects are shown in Table 2.2.11.

Table 2.2.11 GPS Positions of Lot 2 Sites

(New) Lot 2 Sites			GPS		Altitude (m ASL)
County	Community	Facility	Latitude	Longitude	
Samburu	Tuum	Primary (Boarding) School	N 2.14533	E 36.77296	1,426
	Ilaut	Primary (Boarding) School	N 1.86749	E 37.24077	785
	Marti	Primary (Boarding) School	N 1.47290	E 36.71998	1,642
	Latakweny	Dispensary	N 1.54728	E 37.10295	906
	South Horr	Dispensary	N 2.09171	E 36.92031	1,015
	Angata Nanyokei	Dispensary	N 1.31809	E 36.67377	2,155

Note: m ASL: meters Above Sea Level

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A map of protected and conservation areas (including "Ramsar" and "Natural Heritage" sites) in Kenya, on which approximate locations of the Lot 2 pilot project sites are indicated in Attachment N-2.

These protected areas are located in relation to Lot 2 sites as shown in Table 2.2.12.

Table 2.2.12 Nearest Protected Areas around Lot 2 Sites

Lot 2 Sites	Nearest Protected Areas	Approximate Direct Distance (km)	Direction
1 Tuum	Lake Turkana South Island National Park	58	NW
	Mt. Kulal Biosphere Reserve	66	NE
	Loisai National Reserve	43	SE
	Maralal Game Sanctuary	111	NW
	South Turkana National Reserve	116	SW
2 Illaut	Loisai National Reserve	43	SE
	Marsabit National Park	86	NE
	Mt. Kulal Biosphere Reserve	100	NW
	Maralal Game Sanctuary	104	SW
	South Island National Park	111	NW
3 Marti	Maralal Game Sanctuary	37	SW
	Engare Narok Game Sanctuary	60	S
	Lake Mbarigon Game Sanctuary	61	S
	Mugie Wildlife Conservancy	81	S
	Losai National Reserve	95	NE
4 Latakweny	Loisa National Reserve	51	NE
	Maralal Game Sanctuary	69	SW
	Lake Baringo	74	SW
	Engare Narok	81	SW
	Samburu National Reserve	113	SE
5 South Horr	Mt. Kulal Biosphere Reserve	69	N
	South Island National Park	70	NW
	Loisai National Reserve	87	SE
	Maralal Game Sanctuary	109	SW
	Marsabit National Park	116	E
6 Angata Nanyokei	Maralal Game sanctuary	19	SW
	Engare Narok Game Sanctuary	42	S
	Lake Mbarigon Game Sanctuary	42	SE
	Mugie Wildlife Conservancy	63	S
	Samburu National Reserve	124	SE
	Losai National Reserve	104	NE

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In addition, another map of archeological, cultural sites and facilities (including “Cultural Heritage” and “Natural Heritage” sites) on which approximate locations of the Lot 2 pilot project sites are indicated, is shown in Attachment N-2 Figure N-2.2.4.

These sites and facilities are located at a considerable distance from the Lot 2 project sites (See Table 2.2.12 and Attachment N-2 Figure N-2.2.3).

3) Surrounding Environmental and Social Conditions of Lot 2 Pilot Project Sites

The Lot 2 pilot project sites and their vicinities have been reconnoitered by the JICA expert in order to observe the surrounding environmental and social conditions. Table 2.2.13., 2.2.14 and 2.2.15 summarize the surroundings of the Lot 2 sites (corresponding to photographs shown in Attachment N-2).

Table 2.2.13 Surroundings of Samburu Sites (Tuum and Illaut)

Community	Tuum	Illaut
Facility	Primary School	Primary School
County	Samburu	Samburu
1. Site	✓ Location of the site is shown in Table 2.2.11. ✓ One 'L' shaped permanent structure partitioned into classes, staffroom and administration office. ✓ One hall to be used for girls' dormitory. ✓ A pre-school building. ✓ School compound is secured by barbed wire and wire mesh and entry to the school is restricted to two gates strategically placed in front and at the back. ✓ One solar panel donated by a catholic mission serving class 8.	✓ Location of the site is shown in Table 2.2.11. ✓ Administration block, Classrooms, boys dormitory, kitchen and staff houses built with permanent material and all detached from each other. ✓ 10 water tanks each with a capacity of 10,000 litres. ✓ One solar panel installed providing light for standard 8 pupils.
2. Topography	✓ Topography of the site slopes from the highest peak of Mt. Ng'iro (North of school) and reaches almost zero gradient at the school.	✓ Site lies in a fairly flat ground sandwiched between two hills; Poi to the South and Ngiro mountains to the North.
3. Soils and geology	✓ The site and the surrounding areas have a soil characteristic ranging from thin & rocky soils towards the mountain to fairly deep fine sandy soil on the lower areas. ✓ Rock formation displays a layer like property.	✓ The soil and geological formation is characterised by sandy soils and exposed rocks.
4. Flora & Fauna	✓ Vegetation includes acacia and mainly grass. ✓ Undomesticated fauna reportedly includes hyenas, jackals, leopards, ostriches and antelopes.	✓ Mainly acacia trees and scanty patches of grass. ✓ Undomesticated fauna reportedly include hyenas (most common), elephants (from nearby Keno community conservancy), leopards and occasional lions.
5.Water & Sanitation	✓ Water for use in the school is sourced from natural spring at the foot of Ng'iro Mountain about 5 kilometres from the school. ✓ The roofs have been fitted with gutters for rain water harvesting although only one plastic tank with a capacity of 10000 litres is available. ✓ Pit latrines are available for both pupils and teachers.	✓ 10 water tanks each with a capacity of 10000 litres for rain water harvesting. ✓ Pit latrines constructed at strategic places for human waste disposal.
6. Solid Waste Management	✓ No public solid waste collection and disposal system available. ✓ Solid wastes (mainly waste papers) are managed by burning and disposal in a dug out pit.	✓ Solid wastes mainly consist of waste papers and food remains disposed by burning and burying. ✓ No public waste collection system available.
6.Roads/Access	✓ Accessed by Baragoi-Tuum road, an earthen road is in fairly good condition during dry seasons.	✓ Access is via Leisamis-South Horr road in fairly usable by types of vehicles during the dry seasons. ✓ Sections of the road usually become impassable due to rapid storm water cutting across during rainy season.
7.Surrounding development	✓ Surrounding environment is marked by a trading centre (Tuum), and villages. ✓ Major economic activities include small livestock rearing, scale trading, and small scale farming.	✓ Scattered manyattas (homesteads) with livestock keeping as the main economic activity.

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Table 2.2.14 Surroundings of Samburu Sites (Marti and Latakweny)

Community	Marti	Latakweny
Facility	Primary School	Dispensary
County	Samburu	Samburu
1. Site	✓ Location of the site is shown in Table 2.2.11. ✓ The School has permanent and temporary structures housing classrooms, dormitories kitchen and administration office. ✓ The boundary of the school is marked by barbed wire and live fencing. ✓ 6 water tanks-1 concrete and 5 plastic ranging each with a capacity of 1,000 litres. ✓ Three solar panels installed; one each in both girls and boys dormitories and one of the classes.	✓ Location of the site is shown in Table 2.2.11. ✓ The dispensary has one main building as the consultation and treatment area, a staff house and one recently completed structure proposed to be used as maternity ward. ✓ The compound of the dispensary is secured by a barbed wire fence and a metal gate. ✓ 4 water tanks; one concrete and the other three are made of plastic with capacities of 5,000 litres and 10,000 litres for harvesting and storing rain and borehole water. ✓ One concrete built tank not yet in use.
2. Topography	✓ The site is generally smooth and flat.	✓ The site lies on a slightly sloping land with surrounding comprising of hills and valleys. ✓ The surrounding hill is called Sererit Mountain.
3. Soils and geology	✓ Surface soils are red in colour. ✓ Site is also stony and rocky.	✓ The site and the surrounding areas is made up of thin sandy soils with most areas having stones and rocks exposed to the surface.
4. Flora & Fauna	✓ Main vegetation are shrubs, acacia trees and aloe which is a special plant due to its medicinal value. ✓ Among the wild game found around the site include gazelle, ostrich, cheetah, leopard, and hyena. ✓ Gravy zebra also exist and it is protected due to its dwindling numbers.	✓ The site and surrounding is majorly characterized by the stressed vegetation. ✓ Main vegetation consists of acacia, aloe, shrubs and patches of grass. ✓ Wild animals consisting of hyenas, jackals, foxes wild and elephants, and gazelles reportedly roam the area.
5.Water & Sanitation	✓ No spring, stream or River within the immediate environment. ✓ Piped water sourced from community borehole approximately 2km away serves the school. ✓ 6 Water tanks used for storing borehole water and harvesting rain water. ✓ A total of 10 pit latrines are available.	✓ Nearest rivers, Barsaloi and Seya intersect join into each other approximately 12 kilometres from the site. ✓ The point of the intersection of the two rivers is referred to as Milgis according to the local dialect. ✓ Piped water is sourced from a community borehole approximately 5 km away. ✓ Rain water harvesting and storage is done by the plastic and concrete water tanks. ✓ A total of three (two-double doors and one single door) pit latrines serving both in usable condition serving both patients and staff.
6. Solid Waste Management	✓ Major solid wastes include waste papers, food remains and fallen leaves. ✓ No public solid waste management system. ✓ Solid waste mainly handled through burning in a dug out pit.	✓ No public solid waste collection system available around. ✓ Major solid wastes consist of medical wastes including used needles and syringes, bandages, gloves expired drugs and minor surgical equipment. ✓ Sharps (used needles and surgical knives are usually packed in safety boxes provided by the Ministry of health and periodically transported to Baragoi for incineration. ✓ Other forms of solid wastes are disposed of by burning in a dug out pit within the dispensary compound.
6.Roads/Access	✓ The site is accessible Maralal-Baragoi road, fairly in good condition.	✓ Site is accessible via Baragoi Wamba Road ✓ The road is usable mostly by four wheel drive cars.
7.Surrounding development	✓ Surrounding area is basically an expanse of plain land dotted with scattered homesteads.	✓ The surrounding area is basically an expanse of fairly rough topography with hills alternating with valleys dotted with scattered manyattas (villages).

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Table 2.2.15 Surroundings of Samburu Sites (South Horr and Angata Nanyokei)

Community	South Horr	Angata Nanyokei
Facility	Dispensary	Dispensary
County	Samburu	Samburu
1. Site	✓ Location of the site is shown in Table 2.2.11. ✓ Two blocks of permanent structure are used as consultation and treatment and also as store. ✓ One staff house. ✓ The dispensary is not fenced.	✓ Location of the site is shown in Table 2.2.11. ✓ Two permanent structures; one housing the dispensary and the other one serving as staff quarter for the nurse in charge. ✓ Dispensary already installed with solar panels by ministry of Energy but the charging system is faulty. ✓ Dispensary is fenced all round using barbed wire.
2. Topography	✓ The site lies adjacent to a hill on a gently sloping terrain. ✓ Surrounding relief consists of Ng'iro Mountains to the North and Ndonyo Mara hills to the South.	✓ The site stands at a fairly flat ground at an elevation of 2,155m.
3. Soils and geology	✓ Soils depth differs with the terrain with flat sections consisting of fairly deep and red in colour. ✓ The hilly sections majorly range from sandy to stony and rocky.	✓ The site is generally characterised with red soils with no visible rocks exposed to the surface.
4. Flora & Fauna	✓ Majorly acacia species and shrubs. ✓ No major wild animals roam the site's surrounding areas.	✓ The site is approximately 3kilometres from the hedge of a gazetted forest-Kirisia forest. ✓ Wild game like lions, leopards, buffalo, among others from the nearby forest. ✓ The forest influences the rainfall and temperature of the site.
5.Water & Sanitation	✓ Piped water is sourced directly from South Horr River without any form of treatment. ✓ One plastic tank with a capacity of 5,000 litres for storing the piped water. ✓ No rain water harvesting. ✓ Two double door pit latrine for handling defecation.	✓ Nearby stream-Ntumot River is approximately 5 kilometres away. ✓ Water for the dispensary use is harvested rain water stored in two 5,000 litres capacity tanks ✓ No piped water system. ✓ One double door pit latrine for handling defecation.
6. Solid Waste Management	✓ Medical sharps including used needless and surgical blades are collected in safety boxes and transported to Baragoi for incineration. ✓ However when no transport is available, the said waste is burned and buried alongside other common wastes like waste papers. ✓ No public solid waste collection and handling services available to the dispensary.	✓ No solid waste management service provided by public institution. ✓ All types of solid wastes are managed by on site burning done indiscriminately in a shallow dug out pit. ✓ No waste segregation system available. ✓ No incineration facility for the medical wastes hence used needles and other sharps are packed in safety boxes and transported to Maralal on a monthly basis for incineration.
7.Roads/Access	✓ The site is accessible via Baragoi-South Horr-Leisamis Road which, an earth road in fairly good condition.	✓ Site is accessible via an earthen road in fairly good condition approximately 20 km North East of Maralal town. ✓ The road is in fairly well maintained and in a motor able condition.
8.Surrounding development	✓ The surrounding is marked by settlement villages, South Horr centre and a hilly topography on both Northern and Southern expanse.	✓ The surrounding is characterised by farms and livestock rearing activities.

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2.3 Detailed Planning of the Pilot Projects

Through the site visits for pilot project preparation, JET found that many cases with functional disorder of batteries and charging controllers are occurring in the existing solar PV system in Kenya. JET evaluated the major reason of these functional disorders is that no proper operation and maintenance (O&M) works had been conducted because of no budget for O&M works of solar PV system had been prepared.

In the pilot project, charging service has been considered as one of the measure to obtain O&M cost of solar PV system. Public facilities can earn some income from the provision of charging services to the nearby communities.

In order to establish reasonable O&M structures and funding structures of the solar PV system throughout its life time, JET prepared the detailed plan consisting of system design, O&M plan, and financial plan for the pilot project to examine the impact and effectiveness of charging service.

2.3.1 System Design

The construction of public facilities such as schools and dispensaries in rural areas are comprised of several buildings to serve different types of services and required activities. At schools, there are buildings of classrooms, dormitories (boys and girls separately), dining hall, staff quarters, and so on. At dispensaries, there is Outpatient Department (OPD), delivery room, maternity ward, patient ward, store room, and so on. In each facility, some buildings exist independently. The power consumption pattern and the total consumption differ from facility to facility. Therefore, to supply power to different types of buildings effectively, solar PV systems were designed individually to match the demand for each type of building.

There are some advantages for designing solar PV system individually. As for individual solar PV systems, it is easier to design with adequate capacity of solar PV system for each demand. The power consumption can be controlled easily by the demand side management of users. In addition, if one of the systems breaks down or needs to stop the operation for some reasons, it will not affect the other systems in different buildings. Furthermore, each system design can be simplified by avoiding complicated configuration of solar PV system. The replacement cost of system components such as battery storage bank can be minimized. An individually-installed small solar PV system is advantageous in that it can supply suitable quantity of electricity than a centralized large solar PV system for scattered small demands.

For Lot 1, the solar PV systems were designed in DC 12 V system based on the experiences of MoE&P and REA. After some period of system operation, it was found that battery was not fully charged in some systems due to the voltage drop. Therefore, the solar PV systems with more than 480 W PV array capacities were readjusted to DC 24 V system configuration.

For Lot 2, on the basis of lessons learnt from Lot 1, except the system for charging service and the system with daily load demand less than 300 Wh, all systems were designed in DC 24 V for power generation side.

The Government of Kenya is providing laptops for primary schools, and in the Project, additionally new power supply system for Laptop Programme was also added in designing. As the required capacity of PV array and charging current is rather high, the DC system voltage for laptop system was designed in DC 48 V.

In system designing, in accordance with the load pattern and load demand of each facility, the required PV array capacity also differs. Therefore it is necessary to collect required information of power demand at each facility to design the system adequately. To determine the PV array capacity for each purpose, besides the power consumption pattern and total load demand, the type of load and importance of power supply are also vital factors.

(1) Method of calculation to determine required PV array capacity

To estimate the load demand of each facility, a survey of load utilization pattern and site inspection was conducted. The wattage of lamps of each room was decided by the size of the room and lighting requirement of installation in Lot 1.

In Lot 2, the number of low wattage lamp were installed to light up the whole room to get almost same brightness instead of installing one or two large wattage tube light. The wattage of each light was reduced and the number of lights and switches in a room was increased. Many switches make it possible to manage power consumption by demand side management.

To calculate minimum required solar PV array capacity, solar irradiation and coefficient factors for system design are very important. For the preparation of tendering documents, adjustment of PV array capacity is required due to market availability of the product. Therefore, the capacity of PV array in the tendering documents and calculated required capacity differ to some extent.

The other required points that are considered in system designing are as follows.

(i) To determine the PV array capacity, instead of country annual average solar irradiation, country annual minimum average solar irradiation is taken, which is around 10% lower than the country annual average.

(ii) To determine the PV array capacity, the applied total system design factor is 70% in REA's practice. However, it is not clear what kind of correction factors and values of the factors are applied in designing. To make sure and to be more conservative for prevention of unwanted problems in the long run of system operation, the taken total value as a correction factor for system design is 52% for Lot 1 and Lot 2. This is around 18% higher than the existing practice in Kenya.

(iii) In actual practice, the orientation and inclined angle of PV array installation are not decided factors and they are left to technician's decision. In general, most technicians install along existing roofs, at the same angle and direction of the existing roof. Therefore, even in the same institution, the direction and inclined angle of installed PV array differs by building. The same design concept was adopted in Lot 1 and found out that it takes more time to charge battery fully in some cases, depending on the season and intensity of solar irradiation. In the worst case the battery is not charged fully. Considering the situation in Lot 1, for Lot 2, the installation of PV array in light of its direction and inclination, it was decided in such a way that the power generation of system is almost same throughout the year.

(iv) In the areas where solar PV systems are planned for installation, there is very rare case of continuous rain for a whole day in rainy season. Therefore, storage battery is designed with only minimum required capacity to support the power supply for low solar irradiation days.

Together with above points, to determine the size of required minimum PV array installation capacity, the equation below was applied.

PV Array capacity (A_{cap}) = Total load (demand) / H_A x K' ---------- (i)

Where,

H_A: Country minimum annual average solar irradiation (kWh/day)

K' (Design coefficient factors) = $K_{HD} \times K_{PD} \times K_{PM} \times K_{PA} \times K_{PIX} \times \eta_{INV} \times \eta_{BA} \times \eta_{CC} \times K_{PT}$

K_{HD}: Annual irradiation deviation

K_{PD}: PV module degrading

K_{PM}: PV array load matching

K_{PA}: PV array circuit correction

K_{PIX}: PV array installation orientation and inclined angle correction

η_{INV}: Inverter conversion efficiency

η_{BA}: Battery charge/discharge correction

η_{CC}: Charge controller consumption

K_{PT} (Power reduction due to temperature rise) = $1+ \alpha_{Pmax} + (T_m - 25) / 100$

α_{Pmax}: PV cell/module temperature rise coefficient (-%/°C)]

T_m: PV cell/module temperature (°C) = $T_{av} + \Delta T$

T_{av}: Ambient temperature (°C)

ΔT: Temperature rise on PV cell/module (°C)

From the above equation, the installed capacity of PV system for each institution is determined and summarized in the table below.

Table 2.3.1 Installed Total PV Array Capacity for each Institution

LOT 1			LOT 2		
S. No.	Institutions	Installation Capacity (W)	S. No.	Institutions	Installation Capacity (W)
1	Iltumtum Pry School	3,360	1	Tuum Pry School	5,250
2	Olemoncho Pry School	2,640	2	Illaut Pry School	5,000
3	Ilkilnyeti Dispensary	1,680	3	Marti Pry School	6,750
4	Olkinyei Dispensary	800	4	Latakweny Dispensary	2,500
--	-----	---	5	Angata Nanyokei Dispensary	750
--	-----	---	6	South Horr Dispensary	500
Total		8,480	Total		20,750

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(2) Voltage drop in the system

It is necessary to calculate the voltage drop in cables and include required corrections in the system design. The calculation of the voltage drop is a critical point in the system design to estimate supply power and for charging battery to full charge state. Therefore, considering lessons learnt from Lot 1 installation and to minimize voltage drop for Lot 2, the DC system voltage for charging service and the system using only one PV module is designed on DC 12 V. For other systems and laptop power supply system, the system voltage is designed on DC 24 V and DC 48 V respectively.

In the system design, voltage drop calculation is applied in the condition of generation voltage of PV module at high ambient temperatures and minimum required cable size for each section. The applied points for voltage drop calculation are:

(i) Effect on power generation due to temperature rise of PV cell/module surface (Si-crystalline cell)
(ii) Voltage drops across the cables (for each section).

In actual system operation, charging voltage from charge controller (CC) is influenced by battery voltage. The charging currents decrease with the increase of the charging voltage toward the full charge state of battery. However, it is not possible to say each time in which current the battery is being charged. Therefore, to be on the safe side, the voltage drop calculation is carried out assuming that there is rated current flow from installed PV array toward storage battery through CC.

To calculate the voltage drops across the cable of each section, the applied equation is as shown below.

$e = 36.5 \times L \times I / 1{,}000 \times A$

Where, e: Voltage drop across the cable (V)

A: Cross section area of cable (mm^2)

L: Length of the cable (m)

I: Rated Current (A) flow

The equation shown above holds when phase conductors of the circuit are in equilibrium and copper cable conductance is 97%.

The method of detail calculation to determine PV array capacity, storage battery capacity, voltage drops across the cable and value of correction factors is summarized in Guideline for Solar PV System in Health Institutions and Guideline for Solar PV System in Schools.

2.3.2 O&M Plan

(1) Responsibility and Benefit Demarcation of Stakeholders for PV System Management

Target of the pilot projects for Lot 1 and Lot 2 are public facilities and therefore government institutions, under the jurisdiction of the relevant ministries, MoH and MoEST. At the planning, JET planned that these ministries would therefore take responsibility for supervision during the pilot project period and would have ownership of the PV systems after termination of the project, while target facilities who were the direct beneficiaries would take responsibility for management. JET expected that facilities would be responsible for O&M of the PV systems, including generation of electricity and providing charging services.

Dispensary/school management committee (MC) exists in each target facility, which consists of facility staff (nurses or teachers) and community members (elders, parents). The local administration (chiefs and assistant chiefs) periodically participates in the committee meetings. They are responsible for financial management and decision making on important issues of the facility. Therefore, JET regarded MCs to be responsible for management of the solar PV systems. For this to be implemented, each facility will be required to establish a new separate account and budget for management of the solar PV system. It was expected that the committee would employ a worker who would get trained to carry out O&M and charging service.

Communities located in neighbourhood of the facilities receive indirect benefit from solar PV system by improved services at the facility. JET expected that communities would contribute to sustainability of the solar PV system by using charging services as customers. JET also expected that the community would benefit from reduction in time and expenses related to obtaining charging services.

The important matter to be noted here is that JET have tried to find realistic financial sources and practical human resources for sustainable use of solar PV system throughout the pilot project. At the planning and beginning of the pilot project, according to the TOR, JET considered at this time charging service was the key factor of the sustainable management of the solar PV system. JET planned that the facilities would use the income generated from charging service for replacement of batteries, controllers, and inverters when necessary, with additional financing by facilities if the need arises (Refer to 2.6.1 for the detail of their financial and organizational situation that JET assessed throughout the pilot project).

(2) Stakeholders of the Pilot Project

At the commencement of the pilot project, JET identified stakeholders relating to the pilot projects as follows:

- Target facilities as responsible institution
- Sub-county (then District) offices (education and health) as supervisors of the facilities
- MC members as management bodies

- REA and MoE&P (then MoEn) who were counterpart personnel as project collaborators
- Community members as users of the target facilities and potential customers of charging service
- Local administration (chiefs and assistant chiefs of the concerned areas) as coordinator of facilities and surrounding communities
- Local leadership (elders) as local coordinator of facilities and surrounding communities
- JICA Expert Team as facilitator

2.3.3 Financial Plan

(1) Projection of Financial Balance of Lot 1

JET specified basic conditions for the financial planning, as summarized in the following table, through system design and baseline survey in November and December 2012 for Lot 1 facilities:

Table 2.3.2 Conditions for the Financial Planning of Lot 1

Items	Specified Condition
1. Life Span of Solar PV System	20 years
2. Financial Resource	Income from charging service
3. Expenditure	1). Replacement cost of major equipment: a) Battery : to be replaced each 5 years b) Inverter : to be replaced each 7 years c) Charge controller : to be replaced each 7 years JET estimated replacement cost based on the market prices as of January 2013 and number of equipment in each PV system. The lifetime was estimated as on average under proper O&M conditions.
	2). Regular O&M cost : KSh 3,000/month It is the daily operational expenses which include distilled water, consumables (cable, lining checks, etc.), transportation, etc.
	3). Salary for operator : KSh 3,500 to 4,000/month Operator is required for financial and technical aspects of the system. The monthly salary was discussed and decided by each MC.
	4). Miscellaneous cost : 1% of the initial cost
4. Charging Service	1). Operating days : 22 to 26 days/month
	2). Number of customers : 20 persons/day
	3). Charging fee : KSh 20 or 30/charging (market price) Only mobile phone charging was taken to simplify the simulation.

Prepared by JET

On the basis of the above conditions, the financial balance for Lot 1 was projected in April 2013 as shown in the table below.

Table 2.3.3 Initial Projection of Financial Balance of Lot 1

Description	Unit	Ilkilnyeti Dispensary	Iltumtum Primary School	Olkinyei Dispensary	Olemoncho Primary School	Meto Dispensary	Notes
Given Condition (Designed & estimated by JET)							
a. System Capacity	kW	1.47	2.98	0.74	2.35	1.21	
b. System Initial Cost	Ksh.	1,864,765	3,359,595	1,359,065	2,539,575	1,461,815	
c. Batterie's cost per replacement	Ksh.	240,200	460,700	145,700	346,500	177,200	5 year of lifespan
d. Invertor's cost per replaceemnt	Ksh.	96,000	256,000	82,000	202,000	42,000	7 year of lifespan
e. CC's cost per replacement	Ksh.	102,000	186,000	70,000	149,000	79,000	7 year of lifespan
A Expenditure	**Ksh./year**	**178,973**	**272,879**	**142,445**	**222,839**	**145,344**	(= 1+2+3+4)
1 Replacement Cost	**Ksh./year**	**76,326**	**155,283**	**50,854**	**119,443**	**52,726**	(= f + g + h)
f. Annualized battery cost	Ksh./year	48,040	92,140	29,140	69,300	35,440	(= c / lifespan)
g. Annualized invertor cost	Ksh./year	13,714	36,571	11,714	28,857	6,000	(= d / lifespan)
h. Annualized CC cost	Ksh./year	14,571	26,571	10,000	21,286	11,286	(= e / lifespan)
2 Regular O&M Cost	**Ksh./year**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**	Estimated by JET
3 Manpower Cost	**Ksh./year**	**48,000**	**48,000**	**42,000**	**42,000**	**42,000**	(= i x j x 12months)
i. Monthly salary per operator	Ksh./month	4,000	4,000	3,500	3,500	3,500	
j. Number of operator	persons	1	1	1	1	1	
4 Miscellaneous	**Ksh./year**	**18,648**	**33,596**	**13,591**	**25,396**	**14,618**	(= b. x 0.01)
B Income from Charging Service	**Ksh./year**	**105,600**	**124,800**	**158,400**	**124,800**	**158,400**	(= e x 12months)
a. Charging Fee							
i). Mobil phone & Lantern	Ksh.	20	20	30	20	30	Market price
ii). Hair cut - Adult	Ksh.	N.A.	N.A.	N.A.	N.A.	N.A.	
iii). Hair cut - Child	Ksh.	N.A.	N.A.	N.A.	N.A.	N.A.	
b. Daily demand							
i). Mobil phone & Lantern	phone	20	20	20	20	20	Estimated by JET
ii). Hair cut - Adult	head	N.A.	N.A.	N.A.	N.A.	N.A.	
iii). Hair cut - Child	head	N.A.	N.A.	N.A.	N.A.	N.A.	
c. Daily income	Ksh./day	400	400	600	400	600	(= a x b)
d. Expected operation days	days/month	22	26	22	26	22	Estimated by JET
e. Monthly income	Ksh./month	8,800	10,400	13,200	10,400	13,200	(= c x d)
C Profit and Loss	**Ksh./year**	**(73,373)**	**(148,079)**	**15,955**	**(98,039)**	**13,056**	(= B - A)
Breakeven Point							
By Charging Fee	**Ksh.**	**33.9**	**43.7**	**27.4**	**35.7**	**27.5**	Daily demand fixed.
By Daily Demand	**phone**	**33.9**	**43.7**	**18.0**	**35.7**	**18.4**	Charging fee fixed.

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

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As seen in the above table, the results of the simulation indicated some profits in two (2) dispensaries and substantial losses in others. In case of two (2) primary schools (Iltumtum and Olemoncho) and one dispensary (Ilkilnyeti), 1.7 to 2.2 times of charging fee or customers against the projected value are required.

(2) Projection of Financial Balance of Lot 2

Implementation of Lot 2 was delayed from the original schedule because the selection of the target facilities took a long time. Therefore, actual financial conditions of Lot 1 facilities became available, and the actual income from charging service in all four (4) facilities in Lot 1 was lower than projected one.

Therefore, JET updated the basic conditions to minimize the expenditure and to reduce the income as summarized in the table below, through the review of actual financial condition of Lot 1, system design and baseline survey in October 2013 for Lot 2 facilities:

Table 2.3.4 Conditions for the Financial Planning of Lot 2

Items	Specified Condition
1. Life Span of Solar PV System	20 years
2. Financial Resource	Income from charging service
3. Expenditure	1). Replacement cost : As same as Lot 1 except unit prices. Market prices as of February 2013 were applied for the estimation.
	2). Regular O&M cost : KSh 3,000 /month (as same as Lot 1)
	3). Salary for operator : Excluded It was identified that salary condition for operators is one of the main causes for the big deficit from the charging service in Lot 1. Therefore, JET planned to appoint only one operator from the engaged personnel for the primary duty in order to avoid additional overhead cost.
	4). Miscellaneous cost : 1% of the initial cost (as same as Lot 1)
4. Charging Service	1). Operating days : 24 to 28 days/month
	2). Number of customers : 5 to 8 persons/day
	3). Charging fee : KSh 20 or 30/charging (market price) As network of mobile telephone is not sufficient and weaker in Samburu County, haircut service seems more potential than mobile phone charging. Therefore, different charging fees for mobile phone and haircut were set based on market price.

Prepared by JET

On the basis of the above conditions and estimations, the financial balance for Lot 2 was projected in March 2014 as shown in the table below.

Table 2.3.5 Projection of Financial Balance of Lot 2

Description	Unit	Latakweny Dispensary	Marti Primary School	Tuum Primary School	Illaut Primary School	South Horr Dispensary	Angata Nanyukei Dispensary	Notes
Given Condition (Designed & estimated by JET)								
a. System Capacity	kW	2.40	6.36	4.92	4.20	0.48	0.92	
b. System Initial Cost	Ksh.	1,684,139	3,467,199	2,654,987	2,584,399	1,133,241	1,114,531	Contract Price
c. Batterie's cost per replacement	Ksh.	235,000	640,000	478,000	408,000	57,000	95,000	5 year of lifespan
d. Invertor's cost per replaceemnt	Ksh.	165,000	510,000	405,000	360,000	50,000	75,000	7 year of lifespan
e. CC's cost per replacement	Ksh.	55,000	135,000	102,000	89,000	20,000	29,000	7 year of lifespan
A Expenditure	**Ksh./year**	**131,270**	**290,815**	**230,578**	**207,587**	**68,732**	**81,002**	(= 1+2+3+4)
1 Replacement Cost	**Ksh./year**	**78,429**	**220,143**	**168,029**	**145,743**	**21,400**	**33,857**	(= f + g + h)
f. Annualized battery cost	Ksh./year	47,000	128,000	95,600	81,600	11,400	19,000	(= c / lifespan)
g. Annualized invertor cost	Ksh./year	23,571	72,857	57,857	51,429	7,143	10,714	(= d / lifespan)
h. Annualized CC cost	Ksh./year	7,857	19,286	14,571	12,714	2,857	4,143	(= e / lifespan)
2 Regular O&M Cost	**Ksh./year**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**	**36,000**	Estimated by JET
3 Manpower Cost	**Ksh./year**	**0**	**0**	**0**	**0**	**0**	**0**	(= i x j x 12months)
i. Monthly salary per operator	Ksh./month	0	0	0	0	0	0	
j. Number of operator	persons	1	1	1	1	1	1	
4 Miscellaneous	**Ksh./year**	**16,841**	**34,672**	**26,550**	**25,844**	**11,332**	**11,145**	(= b. x 0.01)
B Income from Charging Service	**Ksh./year**	**31,680**	**51,840**	**60,480**	**51,840**	**31,680**	**31,680**	(= e x 12months)
a. Charging Fee								
i). Mobil phone & Lantern	Ksh.	20	20	20	20	20	20	Market price
ii). Hair cut - Adult	Ksh.	30	30	30	30	30	30	
iii). Hair cut - Child	Ksh.	20	20	20	20	20	20	
b. Daily demand		5	8	8	8	5	5	
i). Mobil phone & Lantern	phone	2	3	3	3	2	2	Estimated by JET
ii). Hair cut - Adult	head	1	2	2	2	1	1	
iii). Hair cut - Child	head	2	3	3	3	2	2	
c. Daily income	Ksh./day	110	180	180	180	110	110	(= a x b)
d. Expected operation days	days/month	24	24	28	24	24	24	Estimated by JET
e. Monthly income	Ksh./month	2,640	4,320	5,040	4,320	2,640	2,640	(= c x d)
C Profit and Loss	**Ksh./year**	**(99,590)**	**(238,975)**	**(170,098)**	**(155,747)**	**(37,052)**	**(49,322)**	(= B - A)
Breakeven Point								
By Charging Fee	**Ksh.**	**89.2**	**123.7**	**83.3**	**87.6**	**45.7**	**54.3**	Daily demand fixed.
By Daily Demand	**phone**	**19.8**	**43.6**	**29.7**	**31.2**	**10.5**	**12.3**	Charging fee fixed.

Prepared by JET

As seen in the above table, the results of the simulation indicated substantial losses in all Lot 2 facilities. 2.3 to 6.2 times of charging fee or 2.1 to 5.4 times of customers against the projected value were required.

Reviewing the results of the projection both of Lot 1 and Lot 2, JET considered studying the following issues in order to establish rural electrification model:

- To identify the range of the expenditures covered by the charging income.
- To identify any available funds to eliminate the deficits.

(3) Framework of Accounting Procedure at Public Facilities

In order to manage financial condition of the charging service by the pilot project properly, JET prepared the following accounting procedure. And, the required accounting formats for the pilot project were prepared on the basis of the accounting procedure and proper theory of accounting such as Double-Entry Bookkeeping, Main Ledger, Trial Balance, Profit and Loss Statement, Balance Sheet and Cash Flow Statement.

Table 2.3.6 Original Plan of Accounting Procedure

Procedure	Expectations
a) Service & Transaction (Daily Business Record)	The operator enters details of every customer in the Daily Business Record. If any transaction is not entered, the history for the transaction will also be lost and therefore the loss of cash may occur.
b) Cash & Receipt/ Voucher (Cash Book)	Each customer is given a receipt whenever payment for service is made. For recording the cash in and out, the Cash Book is to be recorded the total income from charging service and the total expenditure every day, e.g. purchase of items like distilled water, bulbs or repairs, with vouchers as evidence of payment. The difference between the incomes versus expenditure is also shown as the profit/loss.
c) Transfer to Bank (Bank Account/ Statement)	Every facility is advised to have a separate bank account for the PV system charging service for cash transferred. The cash collected from charging service should never be kept by anyone for too long. At the same time, it must be managed individually separated from the other functions such as health care and education activities. It may be used for other purpose if it is not banked in time. A deposit slip will always be given whenever cash is banked. A copy should be retained by the treasurer or kept in a file by the secretary.
d) Report (Monthly Report and Income & Expenditure Statement)	MC will prepare monthly statement, i.e. Monthly Report of the finances of the PV system, showing the total amount collected from the charging service, the total amount spent, the total amount deposited to the bank account-cumulative and the amount remaining as cash. The cash balance should be carried forward to the following month.
e) Plan & Forecast (Budget Summaries)	MC will be able to get a general overview of all the payments related to O&M and replacements. The MC, for example, will be able to monitor the record of income and expenditure and keep record of those values for the future transaction and budgeting.

Prepared by JET

In order to implement the accounting procedure, JET planned to utilize the existing structure of the management committee (MC) in public facilities, and to be operated the charging service by the following key persons:

- Chairman of MC
- Secretary of MC (Head nurse/ Head teacher)
- Treasurer of MC
- Operator(s) to be appointed by MC.

Then, JET planned the roles/key responsibilities for accounting of the MC and operator(s) as follows:

Table 2.3.7 Responsibilities of Key Persons for Financial Operation

Key Persons	Responsibilities
a) Chairman of MC	✓ Prepares Monthly Report together with the secretary and/or the treasurer.
b) Secretary of MC	✓ To check and keep record of the charging service (Daily Business Record, Cash Book, Bank Statement, Monthly Report), ✓ To prepare Monthly Report together with the chairman and/or the treasurer, ✓ To prepare and/or assist the operator for accounting processing in Daily Business Record, Cash Book.
c) Treasurer of MC	✓ To receive cash from the operator (or makes arrangement with the secretary), ✓ To deposit the cash collected (or makes arrangement for the cash to be deposited by the secretary), ✓ To prepare monthly report together with the chairman and/or the secretary, ✓ To give a report to the stakeholders and users of the PV system about the financial status of the charging service.
d) Operator	✓ To serve customers who come to charge mobile phones, torches, lanterns and hair cutting, ✓ To collect daily cash from the charging service and hair cutting, ✓ To enter the detail and amount for each customer in the Daily Business Record, ✓ To record in the Cash Book, ✓ To hand over the cash collected together with the record to the treasurer or the secretary, ✓ To inform the secretary of the expected expenditure items e.g. distilled water, bulbs and minor repairs to the PV systems.

Prepared by JET

JET explained to each MC regarding the above accounting procedures and the responsibilities of key persons in the first users training, and assists the charging service operation with adjustment of these plans to suit their circumstances.

2.4 Implementation of the Pilot Projects

2.4.1 Assistance on the Environmental License

In support of taking necessary procedures on environmental license (permission) which are generally required by the Kenyan environmental management system (See Section 2.13.4 and Section 2.13.5), field surveys (See Section 2.2.5), assessment of possible impacts, public meetings, actions for the procedures and recommendations on environmental and social considerations on implementations of the pilot projects (Lot 1 and Lot 2) were conducted as part of the technical cooperation to REA.

(1) Lot 1 Pilot Project

1) Project Components (Lot 1)

A brief description of the initially proposed Lot 1 Pilot Project components is provided in Table 2.4.1.

Table 2.4.1 Lot 1 Pilot Project Components

Lot1 Sites			Basic Systems			
County	Community	Facility	PV Size* (kW)	Inverter	Battery	Lamps
Kajiado	Ilkilnyeti	Dispensary	1.4	DC/AC	Lead-acid	Fluorescent & LED
	Meto**	Dispensary	1.4	DC/AC	Lead-acid	Fluorescent & LED
Narok	Iltumtum	Primary School	4.2	DC/AC	Lead-acid	Fluorescent
	Olkinyei	Dispensary	1.1	DC/AC	Lead-acid	Fluorescent
	Olemoncho	Primary School	3.0	DC/AC	Lead-acid	Fluorescent

* The capacities of solar PV system in above table were the initial designs as of Project Description Report submitted to NEMA. After then, due to engineering consideration, the capacities have been modified as appropriately, of which modification application to NEMA have been made as summarized in the item (5) of this Section 2.4. The definitive capacity of each Lot 1 project is as shown in Table 2.4.24.

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

Prepared by JET

2) Prediction of Environmental and Social Impacts Caused by Lot 1 Pilot Project

Possible impacts on the physical and social environment which may be caused by the implementation of Lot 1 pilot projects were assessed in accordance with the reviews of the natural and social environment features of Kenya (See Section 2.13.1 and Section 2.13.2), Lot 1 pilot project components (See Table 2.4.1), site perambulates surveys' results (See Section 2.2.5) and discussions with relevant officials of National Environmental Management Authority (NEMA) Head Quarters, NEMA Country Offices of Kajiado and Narok.

Additional items taken into consideration for the prediction were the following:

- ✓ Especially due to the fact that each Lot 1 project consists of small solar PV panels, related apparatuses (See Table 2.4.1) and necessary wiring, resettlement and evacuation, large scale excavations, heavy equipment and vehicles are not necessary for the construction.
- ✓ In addition, each construction period is about 7-10 days, with adequate human resources for construction/installation.
- ✓ "Solar PV" is inherently a very silent technology, therefore noise, vibration, exhaust gas and dust will not be discharged to the surrounding environment during system operation.

As a result, significant or critical impacts on the natural and social environment have not been identified. These conclusions are summarized in Table 2.4.2.

Table 2.4.2 Assessment of Possible Environmental and Social Impacts (Lot 1)

Environmental Items		Project Stage	Possible Environmental Impacts on Lot 1 Sites				
			Ilkilnyeti D.	Meto D.***	Iltumtum P.S.	Olkinyei D.	Olemoncho P.S.
Natural	Noise/ Vibration	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No
	Air pollution (Exhaust, Dust)	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No
	Solid Waste	Construction	No*	No*	No*	No*	No*
		Operation	No**	No**	No**	No**	No**
Social	Resettlement/ Evacuation	Construction	No	No	No	No	No
		Operation	No	No	No	No	No
	Educational/ Medical Activities	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No
	Living and Traffic Accident	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No

Note; D.; Dispensary P.S.; Primary School

* Trash and packaging materials during the construction shall be taken away by contractor(s) to be disposed in compliance with the Environmental Management and Coordination (Waste Management) Regulations 2006.

** Excluding replacement of used batteries, fluorescent tubes and other electrical appliances, which shall be controlled by each facility in compliance with the Environmental Management and Coordination (Waste Management) Regulations 2006 and the Guidelines for E-Waste Management in Kenya

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

Prepared by JET

3) Public Meetings and Consultations (Lot 1)

i. Meetings and Consultations at Site Selection Stage

Meetings and consultations with relevant stakeholders were carried out at the initial stage (site selection for Lot 1 pilot project) of the project. These are summarized in the following tables (Table 2.4.3 to 2.4.8).

Subsequent to the selection of pilot project sites for Lot 1, several site visits and surveys were conducted, which included establishing contacts with the relevant stakeholders and convening roundtable discussions on project implementation.

Table 2.4.3 Meetings/Consultations on Site Selection for Lot 1

Date	County	Sites	PAP & Focus Group/ Local People	JICA Expert Team	Total
5/6/2012	Kajiado	Ilkilnyeti Dispensary	3	2	5
7/6/2012	Kajiado	Meto Dispensary*	3	2	5
4/6/2012	Narok	Iltumtum Primary School	9	2	11
8/6/2012	Narok	Olkinyei Dispensary	10	2	12
3/7/2012	Narok	Olemoncho Primary School	1	2	3

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

Prepared by JET

Table 2.4.4 Discussion points at Ilkilnyeti Dispensary/Kajiado County (Date: 5/6/2012) (Lot1)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1.	Mr. Mabela	Assistant chief	The project is welcomed	Appreciative of the cooperation
2.	Mr. Mbaabu	Nurse In charge	Improvement of delivery of health care services	Fast track the project
3.	Mrs. Mary	Assisting Nursing Officer	Improvement of security	Positive comment

Prepared by JET

Table 2.4.5 Discussion points at Meto Dispensary*/Kajiado County (Date: 7/6/2012)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1.	Rev. Moses Meeli	Member-Dispensary committee	The project is timely	Ensure timely implementation
2.	Alex Deley	Nurse In charge	Patients should not be inconvenienced	Separate layout
3.	Patrick Achuka	Nurse	Enhance vaccine storage	Positive comment

* Meto Dispensary was cancelled in July 2013, just before the installation works, due to grid extension.

Prepared by JET

Table 2.4.6 Discussion points at Iltumtum Primary School/Narok County (Date: 4/6/2012) (Lot1)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1.	Stephen Sankok	Head teacher	Proper installation	Installation works to be to standard
2.	Mr. Lempaka	Chief	Improved access to cell phone charging	Positive comments
3.	John Malit	Community leader	Improved learning condition	Positive comments
4.	Marik Kingetu	Community member	Improved pupil performance	Positive comments
5.	Wilson Kendaki	Community member	Solution to problem of insecurity	Positive comments
6.	Mary Soit	Community member	Greater access to mobile communication	Positive comments
7.	Vincent Kedoki	Community member	Ensure adequacy	Installation to be as adequate as budget allows
8.	Gladys Normejole	Community member	Durability of the gadgets	The gadgets to meet minimum standard requirements
9.	Susan Nabora	Community member	Teachers motivation	Positive comment

Prepared by JET

Table 2.4.7 Discussion points at Olkinyei Dispensary/Narok County (Date: 8/6/2012) (Lot1)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1.	Tomas Njeru	Clinical Officer	Sustainability of the project	Incorporate business component
2.	Bosco Kiptanui	Lab Technician	Improvement of lab services	Positive comment
3.	Joram Leteto	Community health worker	Improvement of community livelihood	Positive comment
4.	David Letoluo	Chief	Community sensitization	Provide timely and adequate information
5.	Moses Mohonga	Community member	Community support	Positive comment
6.	Santo Letoluo	Community member	Benefit to community	Positive comment
7.	Kikanae Letoluo	Community member	Community savings	Positive comment
8.	John Moonga	Community member	Improved security	Positive comment
9.	Gabriel Minis	Community member	Enhanced access to cell phone charging	Positive comment
10.	Francis Rakwa	Community member	Better health care	Positive comment

Prepared by JET

Table 2.4.8 Discussion points at Olkinyei Dispensary/Narok County (Date: 8/6/2012) (Lot1)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1.	Wilson Nkoyo	Head teacher	Improved study time due to lighting	Positive comment

Prepared by JET

Overall, negative opinions or objections to the implementation of Lot 1 pilot project have not been expressed by any of the relevant stakeholders or community members. However, the following points of concern have been raised for consideration by the project:

- ✓ Construction stage: Construction management to consider educational/medical activities which will be ongoing.
- ✓ Operation stage: Application of regulations on battery charging services to consider the needs of students and patients.

To address these concerns, the JICA Expert Team could introduce construction and operation guidelines (e.g. time restriction), in addition to considering the layout and location of battery charging service facilities as follows:

- ➢ The construction period of each site is about 10 days and therefore each construction can be scheduled to avoid inconveniencing educational/medical activities. For instance, heavy work can be scheduled for the weekends as much as possible.
- ➢ The regular school hours are generally 8:00 am to 15:10 while regular dispensary consultation hours are generally 8:00 to 17:00. To avoid inconveniencing the facilities, the project/contractor could consider determining the most appropriate times for construction in consultation with the facilities.
- ➢ The layouts and locations of battery charging facilities have been determined in consideration of least interference and physical inconvenience to students and patients.

ii. Other Plans for Public Consultations

Several public consultations had been planned to take place prior to and after implementation of Lot 1 pilot projects. These were scheduled to take place during construction and implementation stages. Public opinions were to be collected to inform the smooth implementation of the Lo1 pilot projects. (Details of relevant stakeholders meetings at the pilot project implementation and monitoring of the pilot project, See Section 2.4 and 2.5). The details for public consultation as of 2012 are summarized in Table 2.4.9.

Table 2.4.9 Public Consultations for Lot 1 Pilot Projects

Item	Brief Description
1. Stakeholders (differ in each meeting plan)	a. Target facilities as responsible institution b. Chiefs and/or of assistant chiefs of the concerned locations/sub-locations as local authority c. Elders of surrounding communities as traditional community leaders d. Community people of the surrounding communities as users of the target facilities and potential customers of the power provision service e. District officers of education and health as supervisor of the facilities
2. Purposes (differ in each meeting plan)	a. Determination/confirmation of the Pilot Project management: management structure, financial management, power provision service regulation etc. b. Information sharing among all local stakeholders on the Pilot Project: plan, construction schedule, power provision service *(as advertisement)* and management structure c. Collection of stakeholder's opinion on construction/installation d. Explanation of power provision service e. Dissemination of further electricity use by LED lantern (to chiefs/assistant chiefs and communities) f. Result of monitoring, recommendation of sustainable system use, and so on.
3. Meeting Plans	3.1 Meeting with facility staff a. Schedule: Before the 1st public consultation meeting b. Participants: Facility staff, REA, JICA experts
	3.2 First (1st) public consultation a. Schedule: Before the start of construction/installation b. Participants: Local authority, community elder, community inhabitants, REA, JICA experts
	3.3 Second (2nd) public consultation (and/or Kick off ceremony) a. Schedule: At the time of starting PV system use b. Participants: Facility staff, REA, JICA experts
	3.4 Evaluation workshop or pilot project termination ceremony a. Schedule: At the time of termination of the pilot project b. Participant: Facility staff, Local authorities, Community elders, Community people (customers)

Prepared by JET

4) EIA Procedures and Environmental Licenses for Lot 1 Pilot Project

In compliance with the following relevant laws and regulations, all development projects in Kenya are generally subject to the EIA review processes and approved by NEMA to receive environmental licenses (More details are provided in Section 2.13.4 and Section 2.13.5).

- ✓ Environmental Management and Coordination Act of 1999 (EMCA)
- ✓ Environmental (Impact Assessment and Audit) Regulation 2003 (EIA/EA Regulation)

However, feedback from NEMA indicates that such procedures and licenses are not required due to the nature and magnitude of Lot 1 pilot projects.

i. Necessity of EIA Procedures for Lot 1 Pilot Projects

The basic components of Lot 1 pilot projects are to install small scale solar PV systems in existing public facilities (primary schools and dispensaries) in non -electrified communities.

In order to determine and confirm the requirements to be met by the project, REA sent an official letter attaching the "Project Description Report for Lot 1" (See Attachment N-3) to NEMA HQ on 31 October 2012. The purpose of the letter was to determine whether EIA procedures were required for Lot 1 pilot project. (See Attachment N-2 Figure N-2.1.1 and Figure N-2.1.2)

In this regard, NEMA provided an official response to REA on 14 November 2012 (See Attachment N-2 Figure N-2.1.3 and N-2.1.4), the excerpts of which are shown in the subsequent sections.

> We acknowledge receipt of your letter dated 31st October 2012 on the above mentioned subject. Your request was reviewed and it has been established that you are not required an Environmental Impact Assessment (EIA) for the proposed wiring and installation of solar panels in the listed dispensaries and primary schools given that the project will have minimum/insignificant environmental impacts.

The above therefore officially confirms that EIA procedures and licenses are not required for Lot 1 pilot project.

ii. Supplementary Conditions (Lot 1)

However, some appended conditions were explicitly stated in the letter (See Figure 2.4.3 and 2.4.4) as follows;

> However, you are required to:
>
> 1. Ensure that you obtain the requisite approvals from the Olkejuado/Narok county Council before commencement of the projects
> 2. Comply with the relevant principal laws, By-laws and guidelines issued for development of such a project within the jurisdiction of Olkejuado/Narok County Council, Ministry of Energy, Ministry of Lands, Ministry of public works and other relevant Authorities.
> 3. The proponent shall ensure that all waste material and debris is collected, reused and where need be disposed off as per the Environmental Management and Coordination (Waste Management) Regulations 2006.
> 4. The proponent shall ensure strict adherence to the provisions of Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations 2009.
> 5. The proponent shall ensure strict adherence to the Occupational Safety and Health Act (OSHA), 2007.
> 6. The proponent shall ensure that construction workers are provided with adequate personal protection equipment (PPE) , sanitary facilities as well as adequate training
> 7. Emphasis must be given to control of dust, noise, vibration, occupational hazards and provision of sanitary facilities to the construction workforce.

(2) Lot 2 Pilot Projects

1) Project Components (Lot 2)

A brief description of the initially proposed Lot 2 Pilot Project components is provided in Table 2.4.10.

Table 2.4.10 Lot 2 Pilot Project Components

Lot 2 Sites			Basic Systems			
County	Community	Facility	PV Size* (kW)	Inverter	Battery	Lamps
Samburu	Tuum	Primary (Boarding) School	4.92 kW	DC/AC	Lead-acid	LED
	Illaut	Primary (Boarding) School	4.2 kW	DC/AC	Lead-acid	LED
	Marti	Primary (Boarding) School	6.36 kW	DC/AC	Lead-acid	LED
	Latakweny	Dispensary	2.4 kW	DC/AC	Lead-acid	LED
	South Horr	Dispensary	0.48 kW	DC/AC	Lead-acid	Fluorescent & LED
	Angata Nanyokei	Dispensary	0.72 kW	DC/AC	Lead-acid	Fluorescent & LED

* The capacities of solar PV system in above table were the initial designs as of Project Description Report submitted to NEMA. After then, due to engineering consideration, the capacities have been modified as appropriately, of which modification application to NEMA have been made as summarized in the item (5) of this Section 2.4. The definitive capacity of each Lot 2 project is as shown in Table 2.4.25.

Prepared by JET

2) Prediction of Environmental and Social Impacts Caused by Lot 2 Pilot Project

Possible impacts on the natural (physical) and social environment which may be caused by the implementation of Lot 2 pilot project were assessed in accordance with the reviews of the natural and social environment features of Kenya (See Section 2.13.4 and Section 2.13.5), Lot 2 pilot project components (See Table 2.4.10), site perambulates surveys' results (See Section 2.2.5) and discussions with relevant officials of National Environment Management Authority (NEMA) HQ and the NEMA Samburu County office.

Additional items taken into consideration for the prediction were as follows:

- ✓ Especially due to the fact that each Lot 2 project consists of small solar PV panels, related apparatuses (See Table 2.4.12) and necessary wiring, resettlement and evacuation, large scale excavations, heavy equipment and vehicles are not necessary for the construction.
- ✓ In addition, each construction period is about 7-10 days, with adequate human resources for construction/installation.
- ✓ "Solar PV" is inherently a very silent technology, therefore noise, vibration, exhaust gas and dust will not be discharged to the surrounding environment during system operation.

As a result, significant or critical impacts on the natural and social environment have not been identified. These conclusions are summarized in Table 2.4.11.

Table 2.4.11 Assessment of Possible Environmental and Social Impacts (Lot 2)

Environmental Items		Project Stage	Lot 2 Sites					
			Tuum P.S.	Illaut P.S.	Marti P.S.	Latakweny D.	South Horr D.	Angata Nanyokei D.
Natural	Noise/ Vibration	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No	No
	Air pollution (Exhaust, Dust)	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No	No
	Solid Waste	Construction	No*	No*	No*	No*	No*	No*
		Operation	No**	No**	No**	No**	No**	No**
Social	Resettlement/ Evacuation	Construction	No	No	No	No	No	No
		Operation	No	No	No	No	No	No
	Educational/ Medical Activities	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No	No
	Living and Traffic Accident	Construction	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree	In slight degree
		Operation	No	No	No	No	No	No

Note: P.S. (Primary School) D. (Dispensary)

* Trash and packaging materials during the construction shall be taken away by contractor(s) to be disposed in compliance with the Environmental Management and Coordination (Waste Management) Regulations 2006.

** Excluding replacement of used batteries, fluorescent tubes and other electrical appliances, which shall be controlled by each facility in compliance with the Environmental Management and Coordination (Waste Management) Regulations 2006 and the Guidelines for E-Waste Management in Kenya

Prepared by JET

3) Public Meetings and Consultations (Lot 2)

i. Meetings and Consultations at Site Selection Stage

Meetings and consultations with relevant stakeholders were carried out at the initial stage (site selection for Lot 2 pilot project) of the project as summarized in the following tables (Table 2.4.12 to 2.4.18)

Subsequent to the selection of pilot project sites for Lot 2, several site visits and surveys were conducted, which included establishing contacts with the relevant stakeholders and convening roundtable discussions on project implementation.

Table 2.4.12 Meetings/Consultations on Site Selection for Lot 2

Date	Venue	PAP & Focus Group/ Local People	JICA Expert Team	Total
15/10/2013	Tuum Primary School	2	2	4
16/10/2013	Illaut Primary School	1	2	5
17/10/2013	South Horr Dispensary	3	2	5
22/10/2013	Latakweny Dispensary	1	2	3
23/10/2013	Angata Nanyokei Dispensary	2	2	4
24/10/2013	Marti Primary School	3	2	5

Prepared by JET

Table 2.4.13 Discussion points at Tuum Primary School (Date: 15/10/2013) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Gabriel Letipila	Head teacher	Lighting will highly improve the academic performance of the pupils	Urgent need for PV system
2	Nkestinten Lengorien	Member-school management committee	Reduce burden on parents in providing lighting to pupils	The project will be appreciated well.

Table 2.4.14 Discussion points at Illaut Primary School (Date: 16/10/2013) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Alex Lesamachale	Head teacher	High welcome for the project	Appreciation of Solar PV attribute

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Table 2.4.15 Discussion points at South Horr Dispensary (Date: 17/10/2013) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Mike Lenkak	Nurse In charge	The project will solve energy demand for refrigeration of vaccine storage	Positive comment
2	Josphine Lenkak	Community Health Worker	Clean and healthy energy solution	Positive comment
3	Irene	Nurse	Tribute to the REA/JICA project	Positive comment

Prepared by JET

Table 2.4.16 Discussion points at Latakweny Dispensary (Date: 22/10/2013) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Harrison	Nurse in charge	Revenue from the charging system will help in maintaining the system	Positive comment

Prepared by JET

Table 2.4.17 Discussion points at Angata Nanyokei Dispensary (Date: 23/10/2012) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Longiro	Chairman-management committee	Welcomed the move to train the users on maintenance of the already installed PV system	Positive comment
2	Jacob Lekupe	Community health worker	Charging system will highly help in financing of maintenance of the system	Positive comment

Prepared by JET

Table 2.4.18 Discussion points at Marti Primary School (Date: 24/10/2013) (Lot 2)

No.	Name of Key Informants	Profession	Issues Discussed/ Suggestion	REA/JICA Team Response
1	Samuel Akuwan	Head teacher	PV lighting system to improve quality of study among pupils	Positive comment
2	Philip Lousiye	Deputy head teacher	Solar power is clean and almost free	Cognizance to the importance of solar power
3	Petro Echuka	Chairman-School management committee	Lighting of the school will also improve security	Stressed on the advantage of solar PV system

Prepared by JET

Overall, negative opinions or objections to the implementation of Lot 2 pilot project have not been expressed by any of the relevant stakeholders or community members. However, the following points were concerns to be considered by the project:

- ✓ Construction stage: Construction management to consider educational/medical activities which will be ongoing.
- ✓ Operation stage: Application of regulations on battery charging services to consider the needs of students and patients.

To address these concerns, the JICA Expert Team could introduce construction and operation guidelines (e.g. time restriction), in addition to considering the layout and location of battery charging service facilities as follows:

- ➢ The construction period of each site is about 10 days and therefore each construction can be scheduled to avoid inconveniencing educational/medical activities. For instance, heavy work can be scheduled for the weekends as much as possible.
- ➢ The regular school hours are generally 8:00 am to 15:10 while regular dispensary consultation hours are generally 8:00 to 17:00. To avoid inconveniencing the facilities, the project/contractor could consider determining the most appropriate times for construction in consultation with the facilities.
- ➢ The layouts and locations of battery charging facilities have been determined in consideration of least interference and physical inconvenience to students and patients.

ii. Other Plans for Public Consultations (Lot 2)

Several public consultations had been planned to take place prior to and after implementation of Lot 2 pilot project. These were scheduled to take place during construction and implementation stages. Public opinions were to be collected to inform the smooth implementation of the Lo1 pilot projects. (Details of relevant stakeholders meetings at the pilot project implementation and monitoring of the pilot project, See Section 2.4 and 2.5)

The details for public consultation as of 2013 are summarized in Table 2.4.19.

Table 2.4.19 Details for Public Consultations for Lot 2 Pilot Project

Item	Brief Description
4. Stakeholders (differ in each meeting plan)	a. Target facilities as responsible institution b. Chiefs and/or of assistant chiefs of the concerned locations/sub-locations as local authority c. Elders of surrounding communities as traditional community leaders d. Community people of the surrounding communities as users of the target facilities and potential customers of the power provision service e. District officers of education and health as supervisor of the facilities
5. Purposes (differ in each meeting plan)	a. Determination/confirmation of the Pilot Project management: management structure, financial management, power provision service regulation etc b. Information sharing among all local stakeholders on the Pilot Project: plan, construction schedule, power provision service *(as advertisement)* and management structure c. Collection of stakeholder's opinion on construction/installation d. Explanation of power provision service e. Dissemination of further electricity use by LED lantern (to chiefs/assistant chiefs and communities) f. Result of monitoring, recommendation of sustainable system use, and so on.
6. Meeting Plans	3.1 Meeting with facility staff a. Schedule: Before the 1st public consultation meeting b. Participants: Facility staff, REA, JICA experts
	3.2 First (1st) public consultation a. Schedule: Before the start of construction/installation b. Participants: Local authority, community elder, community inhabitants, REA, JICA experts
	3.3 Second (2nd) public consultation (and/or Kick off ceremony) a. Schedule: At the time of starting PV system use b. Participants: Facility staff, REA, JICA experts
	3.4 Evaluation workshop or pilot project termination ceremony a. Schedule: At the time of termination of the pilot project b. Participant: Facility staff, Local authorities, Community elders, Community people (customers)

Prepared by JET

4) EIA Procedures and Environmental Licenses for Lot 2 Pilot Project

In compliance with the following relevant laws and regulations, all development projects in Kenya are generally subject to the EIA review processes and approved by NEMA to receive environmental licenses (More details are provided in Section 2.13.4 and Section 2.13.5).

- ✓ Environmental Management and Coordination Act of 1999 (EMCA)
- ✓ Environmental (Impact Assessment and Audit) Regulation 2003 (EIA/EA Regulation)

However, feedback from NEMA indicates that such procedures and licenses are not required due to the nature and magnitude of Lot 2 pilot project.

i. Necessity of EIA Procedures for Lot 2 Pilot Project

The basic components of Lot 2 pilot projects are to install small scale solar PV systems in existing public facilities (primary schools and dispensaries) in non- electrified communities.

In order to determine and confirm the requirements to be met by the project, REA sent an official letter attaching the "Project Description Report for Lot 2" (See Attachment N-3) to NEMA HQ on 18 December 2013. The purpose of the letter was to determine whether EIA procedures were required for Lot 2 pilot project (See Attachment N-2 Figure N-2.1.5 and Figure N-2.1.6).

In this regard, NEMA HQ provided an official response to REA on 27 January2014 (See Attachment N-2 Figure N-2.1.7 and Figure N-2.1.8), the excerpts of which are shown in below and the subsequent section.

We acknowledge receipt of your letter Ref No. REA/RE/PP/EIA/PK/6 dated 18th December 2013 on the above mentioned subject. The National Environment Management Authority has studied your request and advises that you do no need to carry out and an Environmental Impact Assessment (EIA) for this particular project comprising Lots 2 solar PV systems in the following locations.

County	Community	Type	PV size
Samburu	Tuum	Primary (Boarding) School	4.92kW
Samburu	Illaut	Primary (Boarding) School	4.2kW
Samburu	Marti	Primary (Boarding) School	6.36kW
Samburu	Latakweny	Dispensary	2.4kW
Samburu	South Horr	Dispensary	0.48kW
Samburu	Angata Nanyokie	Dispensary	0.72kW

The above therefore officially confirms that EIA procedures and licenses are not required for Lot 2 pilot project.

ii. Supplementary Conditions (Lot 2)

Some supplemental conditions have been explicitly stated in the letter.

1. Ensure that you obtain the requisite approvals from the Samburu County Government before commencement of the projects
2. Comply with the relevant principal laws, By-laws and guidelines issued for development of such a project within the jurisdiction of Samburu County Government, Ministry of Energy and Petroleum, Ministry of Lands, Housing and Urban Development and Ministry of Transport and Infrastructure and other relevant Authorities.
3. Ensure that all waste material and debris is collected, re used and where need be disposed off as per the Environmental Management and Coordination (Waste Management) Regulations 2006.
4. Ensure strict adherence to the provisions of Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations 2009.
5. Ensure strict adherence to the Occupational Safety and Health Act (OSHA), 2007.
6. Ensure that construction workers are provided with adequate personal protection equipment (PPE) , sanitary facilities as well as adequate training.
7. Emphasis must be given to control of dust, noise, vibration, occupational hazards and provision of sanitary facilities to the construction workforce.

(3) JICA Guidelines for Environmental and Social Considerations (Both Lot 1 and Lot 2)

Based on JICA's Environmental Policy and JICA Guidelines for Environmental and Social Considerations (April 2004 version) which have been applied to Lot 1 pilot project and Lot 2 pilot project, REA in collaboration with the JICA expert prepared a "screening format" for each Lot 1 and Lot 2 pilot project component as part of the technical assistance as follows.

- ✓ All "Screening formats" for Lot 1 were acknowledged and signed by REA on 28 November 2012
- ✓ All "Screening Formats" for Lot 2 were acknowledged and signed by REA on 24 February 2014

Those Screening Formats are attached in Attachment N-1.

(4) Recommendations on Environmental and Social Considerations (Both Lot 1 and Lot 2)

Due to the same pilot project concepts and components of Lot 1 and Lot 2 as well as nature of Solar PV in small scale and local communities, recommendations on environmental and social considerations for both Lot 1 pilot project and Lot 2 pilot project were made to REA and/ or Contractors as follow.

1) Traffic Management/Safety

Even though the construction period will be short (about 10days) and the project scale is small for each Lot 1 and 2 pilot project, traffic management/safety is still a priority. In order to avoid traffic accidents, necessary education and instruction on safe driving shall be provided to drivers as so on. In this regard, the following shows recommendations for the safe traffic.

- REA and/or contractor(s) are required to conduct such an education and instruction in compliance with relevant local traffic rules and regulations.
- REA and/or contractor(s) are required to disclose the construction schedule for each Lot 1 and Lot 2 project as well as the utilization of some vehicles to relevant local community members and other parties in order to ensure road safety considerations in advance.

2) Signboards, Warning Boards and Safe Guards

During construction, preparation of signboards, warning boards and deployment of safe guards (if necessary) required for each site shall be addressed by the contractor(s).

In this regard, the following shows recommendation for the preparation for construction.

✓ REA is required to instruct the contractor(s) to ensure that these requirements are met and materials to be prepared in accordance with and referring to the following act, rules and bill.

- Occupational Safety and Health Act (OSHA) 2007
- Sign Board Rules on Construction Sites (will be enforced by the government)
- Construction bill (not yet law, but in the process of legislation)

3) Solid Waste Management

Solid waste management issues (as stated in the NEMA letter for Lot 1 and Lot 2 respectively as one of the supplementary conditions) shall be addressed by REA and/or contractor(s) in compliance with EMCA, the Environmental Management and Coordination (Waste Management) Regulations 2006 and other relevant rules.

i. Construction Stage:

Large excavations are not proposed in Lot 1 and Lot 2. All trash and packaging materials which might result from the construction process shall be collected by the contractor(s) for adequate disposal.

In this regard, the following shows recommendation for solid waste management during construction stage.

✓ REA is required to instruct contractor(s) to make sure the solid waste management.

ii. Operation Stage:

As noted in Table 2.4.2 and Table 2.4.21, replacement of used batteries, fluorescent tubes and other electrical appliances shall be managed by each Lot 1 and Lot 2 pilot project facility. In this regard, the following shows recommendations for solid waste management during operation stage.

✓ REA is required to have discussions with each facility, and/or initiate stakeholder meetings in each site to discuss and find solutions for management of used batteries, fluorescent tubes and other electrical appliances.

4) Noise and Vibration

Noise and vibration (as stated in the NEMA letter for Lot 1 and Lot 2 respectively as one of the supplementary conditions) shall be addressed by REA and/or constructor(s) in compliance

with the Environmental Management and Coordination (Noise and Excessive Vibrations Pollution Control) Regulations 2009.

Table 2.4.20 and Table 2.4.21 indicate the national noise standards and limits.

Table 2.4.20 Maximum Permissible Noise Levels

Zone		*Sound Level Limits dB(A) (Leq,14 h)*		*Noise Rating Level (NR) dB(A) (Leq,14 h)*	
		Day	Night	Day	Night
A.	Silent Zone	40	35	30	25
B.	Places of worship	40	35	30	25
C.	Residential : Indoor : Outdoor	45 50	35 35	35 40	25 25
D.	Mixed residential(with some commercial and places of entertainment)	55	35	50	25
E.	Commercial	60	35	55	25

Time Frame: Day 6.01 a.m. – 8.00 p.m. (Leq, 14 h), Night 8.01 p.m. – 6.00 a.m. (Leq, 10h)

Source: Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

Table 2.4.21 Maximum Permissible Noise Levels for Constructions Sites

Facility		*Maximum Noise Level Permitted (Leq) in dB(A)*	
		Day	Night
(i)	Health facilities, educational institutions, homes for disabled etc.	60	35
(ii)	Residential	60	35
(iii)	Areas other than those prescribed in (i) and (ii)	75	65

Note: Measurement taken within the facility,
Time Frame: Day 6.01 a.m. – 6.00 p.m. (Leq, 14 h),Night 6.01 p.m. – 6.00 a.m. (Leq, 14 h)

Source: Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009

i. Construction Stage:

No impacts are expected during the construction stage. This is due to the fact that the construction period will be 7-10 days with adequate human resources and will not include large-scale excavations (as summarized in item 2.8.4 and Table 2.8.7). Heavy equipment and vehicles will also not be necessary for the construction of Lot 2 projects. However, in order to comply with the maximum permissible noise levels (shown in Table 2.8.20 and Table 2.8.21) the following will be done by contractor(s) under the instruction of REA. In this regard, the following shows recommendations for noise and vibration management during construction stage.

- ✓ REA is required to instruct the following points to contractor(s);
  - Vehicle(s) used for the construction shall be well maintained and equipped with an adequate silencer.
  - Driver education and instruction shall be provided to prevent reckless driving.
  - Tools such as electric drills and electric generators which emit high levels of noise and vibration shall be used in limited (designated) times and days which shall be discussed and determined with the responsible personnel(s) of each facility in advance.

ii. Operation Stage;

As previously discussed (See (1) and (2) of Section 2.4.1), “Solar PV” is inherently a very silent technology and therefore when the system becomes operational, there will be no noise or vibration emitted to the surrounding environment.

5) Occupational Safety

The working environment, work place conditions and sanitary facilities for the workers may collectively be stated in the NEMA letter for Lot 1 and Lot 2 respectively as one of the supplementary conditions. These aspects shall be addressed by contractor (s) in compliance with the Occupational Safety and Health Act (OSHA) 2007.

In this regard, the following shows recommendations during construction stage.

✓ REA is required to instruct the following points to contractor(s);

- Personal Protective Equipment (PPE) such as protective clothing, earplugs, helmets, shoes and accessories and so on) shall be provided to the workers, labourers and drivers who may be subjected to adverse safety situation.
- Adverse impacts on workers’ safety shall be minimized by implementing an occupational health and safety training program.
- Dust shall be controlled by water spraying (if necessary, especially in dry season)
- Public health and sanitation education to workers, labourers and drivers shall be done especially against HIV/AIDS issues.
- Sanitary and ablution facilities (washrooms) shall be provided in each Lot project site

As far as the sanitary and ablution facilities are concerned (See Section 2.2.5), each site of Lot 1 and Lot 2 has one and more such facilities. These facilities can therefore be used during construction, due to the short period of the construction schedule (7-10 days).

In this regard, the following shows recommendation for occupational safety during construction stage.

✓ REA is required to instruct to contractor(s) to ensure adherence to the occupational safety measures shown in the following of which conditions shall be applied by the contractor(s):

- Discussions shall be held between each facility and contractor(s) regarding the use of each facility’s sanitary and ablution facilities.
- Workers and labourers shall take responsibility for maintaining appropriate hygienic standards when using the facilities.

6) Introduction of Construction and Operation Guidelines

The following construction and operation guidelines (e.g. time restriction) shall be introduced in accordance with outcomes of discussions amongst stakeholders and contractor(s).

- The construction period of each site is about 10 days and therefore each construction can be scheduled to avoid inconveniencing educational/medical activities. For instance, heavy work can be scheduled for the weekends as much as possible.
- The regular school hours are generally 8:00 am to 15:10 while regular dispensary consultation hours are generally 8:00 to 17:00.
- To avoid inconveniencing for the facilities, the project/contractor could consider determining the most appropriate times for construction in consultation with the facilities.

In this regard, the following shows recommendations during construction stage.

✓ REA is required to instruct to contractor(s) to ensure adherence to the measures

mentioned above.

(5) Additional Actions taken for Environmental and Social Considerations (Both Lot 1 and Lot 2)

1) Lot 1 PV Size Modification

Due to engineering works, the capacity (size) of the PV's of Lot 1 have slightly changed with four sites having been adjusted downwards and only one site has had an upward adjustment as follows and summarized in Table 2.4.22.

- ✓ The PV capacity of Ilkilnyeti Dispensary has been increased from 1.4 kW to 1.68 kW.
- ✓ The Capacities of other Sites of Lot 1 Pilot Project have slightly been decreased.

Table 2.4.22 Lot 1 PV Size Changes

Site (Lot 1)	County	PV Capacity		Difference
		(1) Initial (W)	(2)Revised (W)	(2)-(1) (W)
Ilkilnyeti	Kajiado	1,400	1,680	280
Meto Dispensary	Kajiado	1,400	1,320	-80
Iltumtum Primary School	Narok	4,200	3,360	-840
Olkinyei Dispensary	Narok	1,100	800	-300
Olemoncho Primary School	Narok	3,000	2,640	-360

Note: - A negative difference shows that the revised capacity is smaller than the initial size proportion
- A positive difference shows that the capacity of the revised system is bigger than the initial capacity
- Meto Dispensary was cancelled in July 2013, just before the installation works, due to decision of grid extension.

Prepared by JET

In this regard, as a result of discussions and consultations between REA and the JICA Expert Team, REA prepared and sent an official letter to NEMA dated 26 June 2013 asking further necessary actions with regard to environmental procedures to be taken for the modifications of Lot 1 (See Attachment N-2 Figure N-2.1.9 and Figure N-2.1.10).

NEMA provided an official response letter to REA, No. NEMA/5/23/Vol. V, dated 27June 2013 (See Attachment N-2 Figure N-2.1.11) of which excerpt is shown below;

RE: SPECIFICATION REVISIONS FOR LOT 1 PILOT PROJECTS FOR ESTABLISHMENT OF RURA ELECTRIFICATION MODEL USING RENEWABLE ENERGY

We acknowledge receipt of your letter dated 26th June 2013 on the above mentioned subject.

After evaluation the changes made to the specifications of the Solar PVs for lot 1 pilot projects, we feel that the conditions given for the project through our letter NEMA/5/23/VOL V dated 14thNovember 2012 will suffice for the time being.

Thanking you as you continue to comply with the environmental requirements

The above therefore officially confirms that any other procedures on EIA and licenses are not required for the modifications of Lot 1 pilot project.

2) Actions for Environmental and Social Considerations to be taken for Constructions of Lot

In order to ensure a steady implementation of environmental and social considerations for the construction period of Lot 1 pilot projects, which have been requested by NEMA as well as recommendations by the JICA Expert Team (See PR 2), REA in corporation with the JICA expert prepared a REA official letter asking commitment to adhere to environmental and social considerations. The letter, No., REA/REN/MRE/jm dated 2 July 2013 was sent to the contractor (supplier) for Lot 1 pilot projects (See Attachment N-2 Figure N-2.1.12).

The contractor (supplier) provided a response letter to REA, dated 3rd July 2013 (See Attachment N-2 Figure N-2.1.13) of which excerpt is shown below;

RE: COMMITMENT TO ADHERE TO
ENVIRONMENTAL AND SOCIAL CONSIDERATIONS MASURES

We hereby confirm that we will adhere to environmental and social considerations as per the attachment in your letter dated 2/07/2013 ref: REA/REN/MRE/jm.

Go Solar System Ltd has undertaken numerous projects with the Ministry of Energy, international NGOs and private companies and always adheres to rules and regulations set out by NEMA.

3) Lot 2 PV Size Modification

Due to engineering works, the capacity (size) of the PV's of Lot 2 have slightly changed with all the sites having had upward adjustments as summarized in Table 2.4.23.

Table 2.4.23 Lot 2 PV Size Changes

Site (Lot 2)	County	PV Capacity		Difference
		(1) Initial (W)	(2)Revised (W)	(2)-(1) (W)
Tuum Primary School	Samburu	4,920	5,250	+330
Illaut Primary School	Samburu	4,200	5,000	+800
Marti Primary School	Samburu	6.360	6,750	+390
Latakweny Dispensary	Samburu	2,400	2,500	+100
South Horr Dispensary	Samburu	480	500	+20
Angata Nanyokei	Samburu	720	750	+30

Note: - A positive (+) difference shows that the capacity of the revised system is bigger than the initial capacity

Prepared by JET

In this regard, REA and JICA Expert Team contacted NEMA HQ asking further necessary actions with regard to environmental procedures to be taken for the modifications of each PV size of Lot 2.

An official-in charge of NEMA HQ sent an e-mail dated 25 February 2014 to JICA Expert Team saying as summarized below.

- ✓ No need for a fresh request to be made for the changes made in the capacity of the Lot 2 project.
- ✓ NEMA proposal is that REA can go ahead and implement with the NEMA letter dated 27 January 2014 (See Attachment N-2 Figure 2.1.11)

4) Actions for Environmental and Social Considerations to be taken for Constructions of Lot 2

In order to ensure a steady implementation of environmental and social considerations for the construction period of Lot 2 pilot project, which have been requested by NEMA as well as the recommendations made by the JICA Expert Team (See (4) of this Section), REA in corporation with the JICA expert prepared a REA official letter asking commitment to adhere to environmental and social considerations. The letter dated 24 March 2014 was sent to the contractor (supplier) for Lot 2 pilot project (See Attachment N-2 Figure N-2.1.14, Figure N-2.1.15 and Figure N-2.1.16).

The contractor (supplier) provided a response letter to REA dated 31 March 2014 (See Attachment N-2 Figure N-2.1.17 and Figure N-2.1.18) of which excerpt is shown below;

ENVIRONMENTAL POLICY STATEMENT

PowerPoint Systems E.A. accepts its responsibilities in environmental matters and recognizes environmental management must be an integral and fundamental part of our business.

In this regard, PowerPoint System wish to confirm that it will observe the conditions and measures set out in the Environmental and Social Considerations document as it implements the JICA project for supply and installation of solar PV systems in Samburu county dated 31st March 2014.

2.4.2 Assistance on the Procurement

Lot 1

JET assisted in the procurement of equipment and components to be used for the Lot 1 PV system installation.

The overall schedule from the tender distribution to completion of Lot 1 work was as summarized in Table 2.4.24.

Table 2.4.24 Schedule for Assistance in the Procurement for Lot 1

Work schedule	Contents	Responsibility
12 April 2013	Distribution of tender document	JICA office, Kenya
8 and 9 May 2013	Technical evaluation of Lot 1 offer	MoE&P, REA and JET
14 June 2013	Signing of Contract	Contractor/supplier and JICA office, Kenya
Beginning of July 2013	Site inspection and confirmation of installation work	Contractor/Supplier and JET
From 19 July 2013	Installation work at site, operation & maintenance training to local operator	Contractor/Supplier (Inspection by JET and REA)
End of July 2013	Final inspection of system installation and operation	REA and JET

JET confirmed that flooded batteries should be used in order to educate users on adding distilled water to batteries when necessary. JET also showed an example of training kit to the contractor/supplier.

The contractor/supplier used 120 W and 80 W panels instead of 110 W and 75 W panels. The contractor/supplier used 800VA inverters instead of 500 W inverters because the production of 500 W model was recently stopped. Due to these changes, the original Bills of Quantity (BOQ) was revised.

Lot 2

JET assisted in the procurement of equipment and components to be used for the Lot 2 PV system installation. Considering the sustainability of system components and installation works, the site locations and installation capacity, it was decided to provide more time for the procurement and installation work for Lot 2 compared to Lot 1. Considering the project site area, the schedule for procurement and installation works of equipment is arranged avoiding raining seasons.

The overall schedule from finalizing the tender document to completion of Lot 2 work was as summarized in Table 2.2.25.

Table 2.2.25 Schedule for Assistance in the Procurement for Lot 2

Work schedule	Contents	Responsibility
Beginning of Dec. 2013	Submission of tender document to JICA Kenya office	JET
2nd week of Dec. 2013	Distribution of tender document	JICA office, Kenya
4 week of Dec. 2013	Submission of tender offer by bidders	Local Contractor/Supplier
14 and 15 Jan. 2014	Technical evaluation of Lot 2 offer	MoE&P, REA and JET

Work schedule	Contents	Responsibility
4 week of Jan. 2014	Overall evaluation of Lot 2	JICA office, Kenya
Last week of Jan. 2014	Announcement of evaluation result	JICA office, Kenya
End of Jan. to beginning of Feb. 2014	Negotiation between JICA and selected Contractor/Supplier	JICA office, Kenya
From 1st week of Feb. 2014	Procurement Starts	Bid winner (Contractor/Supplier)
1st week of Feb. 2014	Site inspection and confirmation of installation work	Contractor/Supplier and JET
Middle of Mar. 2014	Inspection of procurements before dispatching to the sites	JET and REA
From middle of Mar. 2014	Installation work at site, operation & maintenance training to local operator	Contractor/Supplier (Inspection by JET and REA)
End of April. 2014	Final inspection of system installation and operation	REA and JET

Prepared by JET

Although the above schedule was made for procurement and installation works, it was noted afterwards that the equipment such as Charge Controller (CC) and battery specified in the tender document would not be arriving in time for installation work. Hence it was agreed, with a series of discussion, to install different types of CC and battery temporarily and replace them after arrival of procured CC and batteries.

2.4.3 1st Stakeholders Meetings

(1) Plan of Public Consultation Meeting

The stakeholders meeting is one of the pilot project components for institutional setting up and ensuring participation of various stakeholders in the project and sustainable management of the solar PV system. JET planned to hold stakeholder meetings three times throughout the pilot project period: before installation of the system, after installation, and at the termination of the pilot project to evaluate the pilot project (evaluation meeting). Also, a consultation meeting was planned to exchange information and opinion with community people.

(2) Subjects of the Public Consultation Meeting

The consultation meeting was planned to involve community people in the pilot project and held at the same time of the 1st stakeholder meeting. As JET considered community people as facility users and potential customers of the charging service. It is necessary that they understand the pilot project contents and be encouraged to use the charging service.

- Explanation of the pilot project (design, schedule and management structure)
- Explanation of the charging service
- Discussion and collection of participants' opinion, Q&A

(3) Subject of the 1st Stakeholder Meeting

1) Information Sharing Among All Local Stakeholders on the Pilot Project

REA and JICA Expert Team explained the contents of the pilot project to the MC members.

2) Determination/Confirmation of the Pilot Project Management Body

JET identified that MC was an appropriate responsible organization to manage the solar PV system and charging service. For ensuring the management system, the JICA expert recommended the target MCs to make a bylaw including the role and duties of the committee and members as well as the way of charging service implementation. Also, she advised the MC to employ one person who would work for operation, maintenance and management of the PV system and charging service.

3) Explanation and Facilitation of the Charging Service

REA and JET explained that the target facilities would start power charging service addressed to community people to get income and that the project design included charging service unit in the school compound or dispensary building. Regarding this, REA and JET requested the MC to manage money correctly for the use of future expenses and to decide unit charging price.

4) Collection of Stakeholders' Opinion and Q&A about the Construction/Installation

REA, JET and MC members exchanged opinions and Q&A about operation, maintenance and administrative financial management.

(4) Result of the First Stakeholders Meeting

1) Date of the 1st Stakeholder Meetings and Public Consultation Meetings

JET held the stakeholders meeting at all ten pilot project sites with one or two REA officers who accompanied JET members. The officer explained the pilot project on site. The dates of these meetings are shown in Table 2.4.26.

Table 2.4.26 Dates of the 1st Stakeholder Meeting and Pubic Consultation Meeting

Lot 1 sites

Facility	Ilkilnyeti dispensary	Meto[6] dispensary	Iltumtum primary school	Olkinyei dispensary	Olemoncho primary school
Date	03-06-2013	06-06-2013	31-05-2013	30-05-2013	28-05-2013

Lot 2 sites

Facility	Tuum primary school	South Horr dispensary	Illaut primary school	Latakweny dispensary	Marti primary school	Angata Nanyokei dispensary
Date	22-01-2014	21-01-2014	12-02-2014; Meeting with teachers on 23-01-2014	23-01-2014	13-02- 2014	11-02- 2014

Prepared by JET

2) Result of the Stakeholder Meetings at Lot 1 sites

REA and JET discussed with stakeholders and got following results at Lot 1 site.

a. JET confirmed MC took responsibility of management of the solar PV system to be installed by the pilot project.
b. Members of MCs changed in all sites except Meto just after the accounting training (April to May 2013) following the instruction from the relevant ministries. Under this condition, MCs of Olemoncho Primary School and Olkinyei Dispensary selected new groups that would be exclusively in charge of the JICA project.
c. Construction of a new dispensary building of Ilkilnyeti was not completed.
d. MC and community people did not start construction of charging huts at two school sites at the time of the stakeholder meeting.
E. MC gave REA officer and JET expert their answer of unit charging fee and names of operators at all sites. All MCs decided charging fee and service time as well as an operator though no requirement was applied. The charging fee was same or below the market price or less (KSh. 20-30 at this moment but it rapidly decreased to KSh. 20 per phone).

[6] The pilot project for Meto Dispensary was canceled in July 2013 due to decision of grid extension.

3) Result of the Stakeholder Meetings at Lot 2 sites

JET got following information and opinions during the discussion.

a. All facility staff of Lot 2 sites answered that they appreciated the pilot project and would do O&M after installation.
b. All target facilities except South Horr do not have stable phone network.
c All four facilities said the appropriate charging fee was KSh20 per phone (market price).
d. A person of South Horr said KSh 15 was better for advertisement to inhabitants.

The result of the stakeholders meetings and discussion with facility staff is summarized in Attachment B-5.

2.4.4 Users Training before the Installation

JET held the users trainings for each target facility of the pilot project in order to build the capacity both of the MCs and the operator to conduct proper accounting procedure of the charging service. The users training was been held by the financial expert twice before and after the installation of the PV system. Features of the trainings are attached at Attachment H-1.

The first trainings were conducted in May 2013 in Lot 1 sites and in April and May 2014 in Lot 2 sites, respectively. The training composed of two days. The main topics of the first training were:

1) Explanation of the outline of PV system and necessity of replacement of the major equipment,
2) The importance of the accumulation of the required funds for the future replacement of the major equipment,
3) Installation of additional system for charging service as one of the measures to obtain some amount of O&M cost,
4) Explanation of accounting procedures and responsibilities of key persons for the charging service,
5) Selection of the key persons, and
6) Practical training of the double entry book-keeping system.

First, the MCs agreed to take the overall responsibility of managing the solar PV systems including the charging service.

Then, the expert requested each MC to discuss and conclude the unit price of charging service, appointing one or two operator(s) and his/her salary, and opening an individual bank account by the first stakeholder meeting. He added that charging fee should not be less than but higher or equivalent to the existing charging business price to protect the private business. But also it is desirable to be fixed as high as possible to cover the O&M cost of the systems[7].

JET found through the practical training that it almost impossible for MC members to fill the double-entry book-keeping system. Therefore, the accounting formats were simplified, and the new format was introduced and all MCs trained on the new format.

2.4.5 Inspection of the Installation Works

Lot 1

The installation work for Lot 1 was delayed primarily due to slow process of importing some components. Although there was a delay, JET confirmed all the systems were in good working condition after inspection of the installed PV systems. The certificates of inspection were signed by

[7] The financial expert explained in the Lot 1 sites that the income should cover all necessary cost including replacement of batteries, inverters and controllers but he explained it should cover only daily O&M cost for Lot 2 sites in conformity according to the result of monitoring.

JET and the contractor/supplier at the end of July 2013, and submitted to JICA. The actual schedule for installation work and operators training is as shown in Table 2.4.27.

Table 2.4.27 Actual Schedule for Installation Work and Operators Training

NO	Name of Institution	Activity	Date
	NAROK		
1.	Iltumtum Primary School	Delivery of materials, installation and training	19/July/2013 - 23/July/2013 28/July/2013 & 29/July/2013
2.	Olkinyei Dispensary	Delivery of materials, installation and training	24/July/2013 & 29/July/2013
3.	Olemoncho Primary School	Delivery of materials, installation and training	25/July/2013 - 27/July/2013
	KAJIADO		
4.	Ilkilnyeti Dispensary	Delivery of materials, installation and training	30/July/2013 & 31/July/2013

Prepared by JET

The user raining is one of the most important subjects in achieving sustainable operation of PV systems installed in rural areas. The training was conducted at all the Lot 1 sites by the contractor/supplier. The PV kit shown in Figure 2.4.1 and Table 2.4.28 was used to demonstrate how each component works.

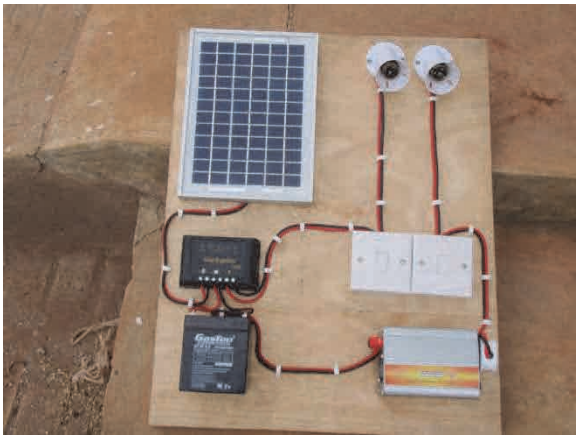


Photo Taken by JET

Figure 2.4.1 PV Training Kit

Table 2.4.28 Materials Used for the PV Kit

PV panel	12 V type, around 5 W
Charge controller	12 V, 5 A
Battery	Sealed lead acid, 12 V, around 4.5 Ah
Inverter	12 V DC to 220 V AC, 100-300 W
Power socket, adaptor	AC extension cord, mobile phone charge adaptor
Lamp	12 V DC small lamp, 220 V AC small lamp
Cable	2.5mm^2 (red, black), AC cable
Switch	Switches for lamps
Cable clip or trunking	
Screw	
Board	Wooden board

Prepared by JET

Unfortunately, the contractor/supplier could not allocate adequate time for the training in Lot 1. This was due to a significant delay in procurement and the contractor/supplier was trying to complete the work before the deadline. Therefore, although the training was conducted and meaningful sessions were shared, it still provided only basic ideas of PV to participants.

Below are some of the photos which were taken during supervision of the PV system installation.

Photo 1 Installation of Solar Panels

Photo 2 Installation of PV System

Photo 3 Installation of Charging System

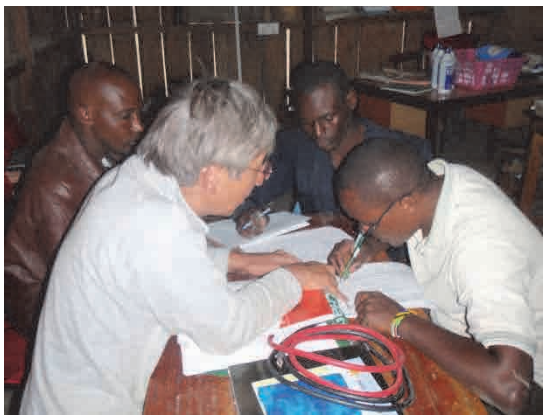


Photo 4 Signing of Handing Over Certificates

All Photos Taken by JET

Lot 2

The initially planned schedule for Lot 2 installation works at the time of procurement was from middle of March 2014. There was a delay on the work schedule due to late arrival of equipment. Although there was a delay on procurement of equipment such as Charge Controller (CC) and storage battery, it was decided to install the system with temporary equipment (CC and battery) since the installation work was already behind the schedule. The contractor agreed to replace the temporary equipment when procured CC and batteries arrives without any additional cost.

To compensate for the delay of installation works with temporary equipment, the installation sites were divided into two groups and technicians were arranged accordingly. The revised schedule for installation work together with operators training is as summarized in Table 2.4.29.

Table 2.4.29 Revised Schedule for Installation Work and Operators Training

Technical Team (Group 1)		
Tuum Primary School 4 to 15 April, 2014	Illaut Primary School 13 to 23 April, 2014	South Horr Dispensary 21 to 25 April, 2014
Technical Team (Group 2)		
Marti Primary School 4 to 17 April, 2014	Latakweny Dispensary 15 to 24 April, 2014	Angata Nanyokei Dispensary 22 to 29 April, 2014

Prepared by JET

Due to lack of proper arrangement of materials and guidance/supervision of technicians' work progress from contractor/supplier side, there was some confusion in conducting installation works in the beginning.

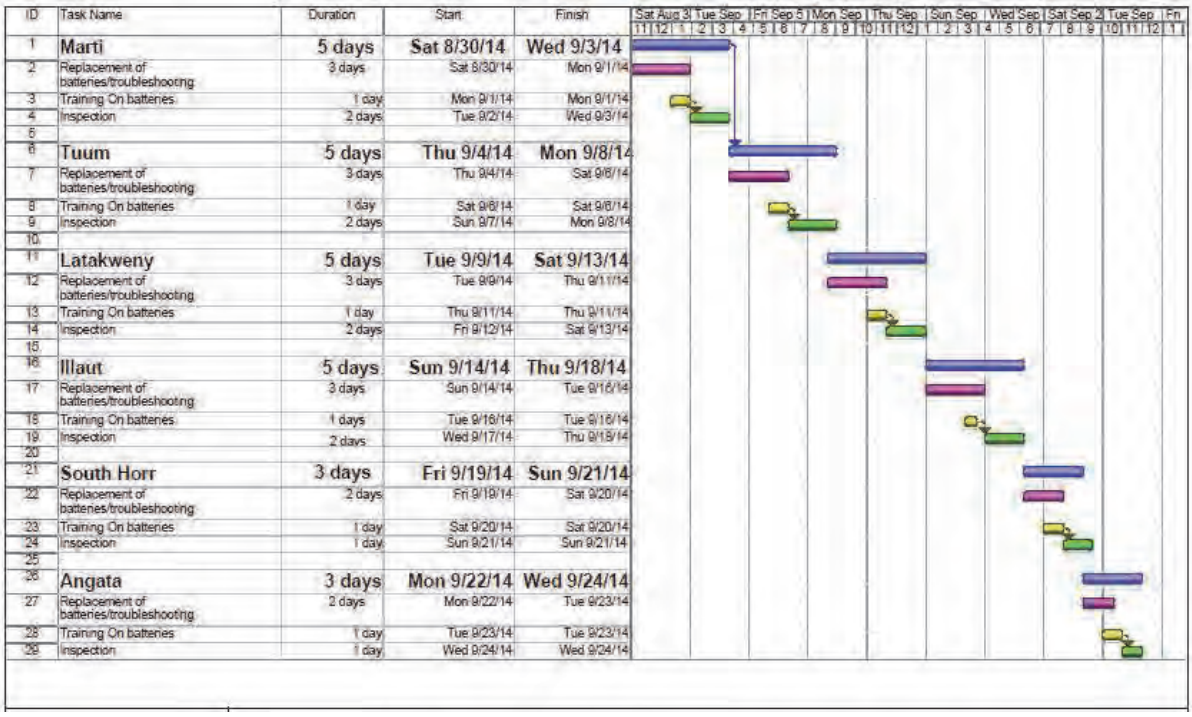
Although there were some differences in proceeding installation works and operators training from the schedule, the installation work with temporary equipment (CC and batteries) and operators training at all six sites were completed on 1 May 2014. As the installation of equipment such as CC and batteries was only temporary, it was agreed to provide trainings once again to the operators at the time of replacement.

The few days delay in the above mentioned schedule was mainly due to:

(1) Lack of management and supervision of installation works by contractor/supplier in the beginning.
(2) Communication problem (No network around project sites area) for timely arrangements of materials.
(3) Transportation difficulties for smooth distribution of arrived materials to each site.
(4) Trainer's absence due to illness, preventing from conducting operators training according to the initial schedule.
(5) Regular break-ups of continuous work over the roof due to strong wind or sun.
(6) Halts of work at class rooms and over the roof in day hours of week days due to the school operation.
(7) Difficulties on smooth arrangement of logistics.

To complete the system installation, the replacement works of CC and battery were planned to be carried out from last week of August 2014 and completion of system installation with all other related works by the end of September 2014. Although replacement work was planned from last week of August 2014, due to the few days delay on arrival of batteries and delay on arrangement of transportation to distribute the materials at each site, the replacement works were started from Marti Primary School from 2nd September 2014. Table 2.4.30 summarizes the submitted planned work schedule of contractor/supplier for replacement and related works.

Table 2.4.30 Submitted Replacement Work Schedule of Contractor for Lot 2



ID	Task Name	Duration	Start	Finish
1	**Marti**	**5 days**	**Sat 8/30/14**	**Wed 9/3/14**
2	Replacement of batteries/troubleshooting	3 days	Sat 8/30/14	Mon 9/1/14
3	Training On batteries	1 day	Mon 9/1/14	Mon 9/1/14
4	Inspection	2 days	Tue 9/2/14	Wed 9/3/14
5				
6	**Tuum**	**5 days**	**Thu 9/4/14**	**Mon 9/8/14**
7	Replacement of batteries/troubleshooting	3 days	Thu 9/4/14	Sat 9/6/14
8	Training On batteries	1 day	Sat 9/6/14	Sat 9/6/14
9	Inspection	2 days	Sun 9/7/14	Mon 9/8/14
10				
11	**Latakweny**	**5 days**	**Tue 9/9/14**	**Sat 9/13/14**
12	Replacement of batteries/troubleshooting	3 days	Tue 9/9/14	Thu 9/11/14
13	Training On batteries	1 day	Thu 9/11/14	Thu 9/11/14
14	Inspection	2 days	Fri 9/12/14	Sat 9/13/14
15				
16	**Illaut**	**5 days**	**Sun 9/14/14**	**Thu 9/18/14**
17	Replacement of batteries/troubleshooting	3 days	Sun 9/14/14	Tue 9/16/14
18	Training On batteries	1 days	Tue 9/16/14	Tue 9/16/14
19	Inspection	2 days	Wed 9/17/14	Thu 9/18/14
20				
21	**South Horr**	**3 days**	**Fri 9/19/14**	**Sun 9/21/14**
22	Replacement of batteries/troubleshooting	2 days	Fri 9/19/14	Sat 9/20/14
23	Training On batteries	1 day	Sat 9/20/14	Sat 9/20/14
24	Inspection	1 day	Sun 9/21/14	Sun 9/21/14
25				
26	**Angata**	**3 days**	**Mon 9/22/14**	**Wed 9/24/14**
27	Replacement of batteries/troubleshooting	2 days	Mon 9/22/14	Tue 9/23/14
28	Training On batteries	1 day	Tue 9/23/14	Tue 9/23/14
29	Inspection	1 day	Wed 9/24/14	Wed 9/24/14

Source: PowerPoint Systems Ltd. (Contractor/supplier)

The schedule for replacement and troubleshooting was made as shown above. However, the replacement and related troubleshooting works, together with additional operators trainings were carried out randomly at each site without following the submitted schedule. This was due to the lack of required materials. To complete the work as per schedule, additional technicians were deployed. With deployment of technicians with required materials the replacement and other related works were completed on 26 September, 2014.

The pictures of installation works, operators trainings, replacement works, and so on are as shown below. Other pictures are attached in Attachment I-1.

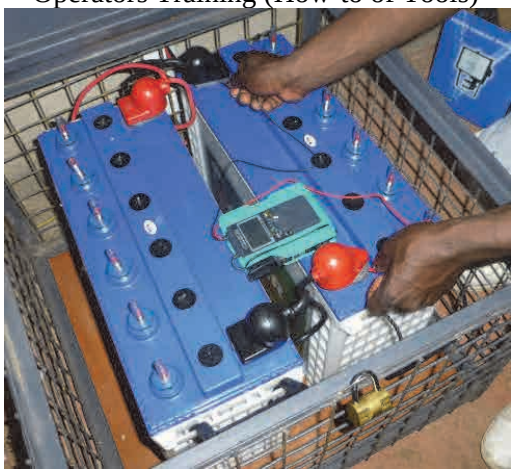
Pictures of Installation Works and Status of Installed System -4

Installation Work
Illaut Primary School

Solar Drive Vaccination Fridge (MKS 044)

Operators Training (How-to of Tools)

Operators Training (Hands-on Training)



Operation Test of Battery and Measurement

Operation Test of Lamps (Marti Pry School)

Source: Taken by JET

2.4.6 2nd Stakeholders Meetings

(1) Subject of the 2nd Stakeholder Meeting

JET held the second stakeholder meeting at the pilot project sites when system installation finished and just before the target facilities started to use the solar PV system as shown in Table 2.4.31. JET members explained to and discussed with facility staff members (head teacher, nurse), MC members, and local authorities. The subjects of the meeting were as follows.

a. Explanation of the contents of the project (PV system in the facility)
b. Declaration of the start of use
c. Explanation of regulations of power provision service: time, unit price, management structure
d. Promotion of charging mobile phone, LED lantern and hair shaving
e. Explanation of monitoring and monitoring schedule
f. Q&A and discussion and collection of participants' opinion

Table 2.4.31 Dates of the 2nd Stakeholder Meeting

Lot 1 sites

Facility	Ilkilnyeti dispensary	Iltumtum primary school	Olkinyei dispensary	Olemoncho primary school
Date	08-07-2013	05-08-2013	07-08-2013	14-08-2013

Lot 2 sites

Facility	Tuum primary school	South Horr dispensary	Illaut primary school	Latakweny dispensary	Marti primary school	Angata Nanyokei dispensary
Date	20-05-2014	15-05-2014	16-05-2014	13-05-2014	12-05-2014	19-05-2014

Prepared by JET

(2) Result of Discussion

a. Facility staff (head teacher or nurse) appreciated the effort of JICA and REA.
b. They have selected an operator and got trainings before the meeting and said they would manage and protect the solar PV system and charging service business.
c. Participants of some sites asked the possibility of grid extension to the site.
d. Participants asked for solution of problems regarding installation that each facility had, such as, direction of socket, replacement of vaccine refrigerator[8]).

2.5 Monitoring of the Pilot Projects

2.5.1 Users Training after the Installation

(1) Technical Training

For sustainable operation of solar PV system, it is necessary to consider following technical trainings.

1) To understand the characteristics of installed solar PV system
2) To understand the Demand Side Management at each facility

[8] Under responsibility of MoH

For the sustainable operation of installed solar PV system, during and after the installation of solar PV system, concerned personal of each institution and selected system operator have to be trained to take care of the system.

The recommended technical training period was at least two days. In some cases, it was not sufficient. An additional training was conducted in those cases.

As a technical training, contents listed below covered to transfer minimum requirements and adequate knowledge for daily system operation.

- ✓ Basic concept of Solar PV
- ✓ Purpose/function of each component
- ✓ System performance expectation and limitation
- ✓ How to use inverter, isolator and fuse/breakers
- ✓ How to operate and maintain the systems
- ✓ Lifespan of each component and supply source of components
- ✓ Hands-on training using PV kit
- ✓ How to replace batteries including wiring
- ✓ Practice of distilled water filling in the batteries, information on timing of filling and supply source of distilled water
- ✓ Meaning of indicator lights of charge controller and daily load (demand side) management base on display indicator
- ✓ How to deal with breakdown (simple trouble shooting)
- ✓ Purpose/function of Consumer Unit and practice of breaker ON/OFF
- ✓ Practice of fuse/breaker replacement
- ✓ Practice of using multi-meter and record keeping
- ✓ Warranty period of the system and each component

Even though above mentioned points was transferred systematically, it seems difficult to imagine actual daily operation and required inspection only by the explanation. Therefore, in case of Lot 2, following trainings were conducted additionally.

1) The selected trainees are requested to observe the installation works, to understand the construction works and types of component/equipment are installed
2) The trainees were requested to assist/help the installation works under the guidance/supervision of trainer.
3) The training were conducted practically for daily system operation several times to understand the procedure of operation and maintenance.
4) Transferred knowledge by the trainees was confirmed through routine operation works.

In Lot 2, 3 to 4 personnel from each school and at least 2 people from each dispensary are attended at the training. The additional training/support shall be conducted when requested/required after some period of system operation.

In the case of schools, one responsible person from facility or management committee of school, one person from teachers and one system operator especially responsible for charging business got trained.

In the case of dispensaries one responsible person from facility or management committee and one system operator especially responsible for charging business got trained.

After the installation and training in all sites, JET team explained the basic points of installed system including how to conduct demand side management of the system once again.

Even though the equipment such as charge controller (CC) and battery is only temporary installation, the training was conducted after installation in April 2014 and once again users training were conducted after replacement of CC and battery at each side in September 2014.

(2) Financial Training

JET held the second users training after the installation of PV system. The trainings were conducted as one day training in August 2013 for Lot 1 and September 2014 for Lot 2 sites. The summary of the trainings are attached at Attachment H-1.

Through the monitoring of each facility after the installation of PV system, it was observed that almost all MC did not submit the monthly report to each county office. Therefore, JET concentrated to train the persons in charge of the monthly report aiming to assist for the correct submission to each county office, after the review how to fill out the simplified formats.

It is noted that key persons in some facilities had been replaced with new ones without proper handover of the works of O&M and accounting of the charging service. In this case, it was necessary to have a special consideration for proper handover of the works of O&M and accounting.

2.5.2 Monitoring of O&M Conditions

(1) Monitoring of the Pilot Project

1) Objectives

Community development and monitoring expert prepared monitoring plan for the pilot project. Monitoring is not described as an activity in the PDM version 3.1 but it is described as Activity 1.8 and 2.8 in the TOR and basis of other activities. Monitoring is the key activity of any project in the project cycle to keep the direction of sustainability.

Monitoring and evaluation of the pilot project was undertaken jointly by REA and the JET to ensure the desired outputs are derived in order to achieve the goal of the pilot project and contribute to the goal of the entire Project. The goal of the pilot project is to ensure that the target facilities can generate electric power using PV systems continuously and sustainably while the project goal of the project is to prepare an effective electrification model of public facilities using solar PV system (the model will be elaborated based on the lessons learnt from the pilot project).

The community development and monitoring expert prepared a plan of monitoring and follow-up on the operation, maintenance and management of PV system. In consistency with Output 1 and Output 2 of the PDM ver. 2.1, it focused on checking whether the PV system installed in the pilot project would function well technically and financially as well as managerial point of view. If problems or stagnation were found, the monitoring team planed to give advices to the MC.

2) Outline of Monitoring

JICA expert planed that the monitoring was to start after the commencement of the use of PV system and was done at every two months till the end of the pilot project in October 2014.

3) Contents of the Monitoring

Monitoring will confirm the actual situation of the following issues. REA and JICA Expert Team will give advice if they find any problem and will modify the pilot project implementation plan if necessary.

i) Organizational management issues: monitor whether the concerned MC works functionally as expected or not;
ii) Technical issues: whether the operator operates and maintains PV system properly or not;
iii) Financial issues: whether the MC gets enough income as planned and manages income and expenditure;
iv) Behaviour change: whether the users change their behaviour in medical treatment and studying;
v) Satisfaction of stakeholders: whether the facility staff, MC, user of the facility, and customer of the charging service are satisfied with the system or not, and;
vi) Behaviour change of concerned government organizations: whether they manage PV system management and give support or not.

The monitoring plan and monitoring sheet are attached at Attachment G-3.1 and G-3.2 respectively.

4) Record of Monitoring

JET implemented monitoring of the pilot project five times for Lot 1 sites and twice for Lot 2 sites, using the above mentioned monitoring sheet. REA officer and county/sub-county officers accompanied JET to some sites. The date of monitoring is summarized in Table 2.5.1 and summary of monitoring result is attached at Attachment G-3.3.

Table 2.5.1 Date of Monitoring

Lot 1 sites

Facility	Ilkilnyeti dispensary	Iltumtum primary school	Olkinyei dispensary	Olemoncho primary school
Monitoring 1	01-10-2013	12-09-2013	16-09-2013	17-09-2013
Monitoring 2	28-11-2013	20-11-2013	12-11-2013	14-11-2013
Monitoring 3	27-01-2014	03-02-2014	17-03-2014	18-03-2014
Monitoring 4	10-06-2014	28-05-2014	31-05-2014	30-05-2014
Monitoring 5	29-08-2014	25-08-2014	26-08-2014	27-08-2014

Lot 2 sites

Facility	Tuum primary school	South Horr dispensary	Illaut primary school	Latakweny dispensary	Marti primary school	Angata Nanyokei dispensary
Monitoring 1	15-08-2014	13-08-2014	14&16-08- 2014	31-07-2014	28-07-2014	30-07-2014
Monitoring 2	17-10-2014	17-10-2014	21-10-2014	15-10-2014	24-10-2014	13-10-2014

Prepared by JET

(2) Financial Management

1) Bookkeeping

Financial management was conducted through bookkeeping of the three revised accounting forms: (i) Daily Business Record (ii) Receipt (iii) Cash book, which are summarized and reported as the official outputs, i.e. Bank Account and Monthly Report.

JET adjusted the accounting procedure and simplified the accounting formats, which were prepared prior to the operation of the charging service, depending on the actual ability of each

MC. The adjustment of accounting procedures are summarized in Table 2.5.2 and the accounting formats used for the pilot project are attached in Attachment H-2.

JET supported MCs in the preparation of the monthly report to submit to the county offices through the monitoring period. As the results of continuous adjustment and assistance, all target facilities prepared account book based on the daily records in principle. Furthermore, the monthly reports prepared on the basis of the account book were submitted to the county offices. Copies of monthly reports submitted to the county offices are at Attachment H-3.

Table 2.5.2 Adjustment of the Accounting Procedure Plan and Result

Original Plan of Procedure	Adjustment
a) Service & Transaction (Daily Business Record)	The Daily Business Record was used by all facilities consistently except Olemoncho where daily record was not available more than six months, then no record for some month, then some record available at end of 2014. Some facilities use an exercise book to record the daily sales whenever they run out of the Daily sheets.
b) Cash & Receipt/ Voucher (Cash Book)	Initially, operator issued receipts to customers. But with time, the latest monitoring results show that no receipts are issued. The customers are well known to the operator and MC and customers prefer not to be issued with receipts. The details of the customers appear in the Daily Business Record. The cash book is used occasionally by some facilities. Expenditure is noted and recorded but vouchers are not usually used.
c) Transfer to Bank (Bank Account/ Statement)	JET recommended MC to open a bank account for the charging service. However, they found it was difficult for dispensaries because of one-account instruction by the MoH. All the facilities in Lot 1 have some deposits to the bank account and deposits slips are available. Health facilities use one bank account. Copies of deposits slips are kept in files. In Lot 2 only Tuum Primary School had opened a bank account by the end of the monitoring period.
d) Report (Monthly Report and Income & Expenditure Statement)	From the latest information, all facilities in Lot 1 have prepared and submitted monthly report twice and in lot 2, at least once
e) Plan & Forecast (Budget Summaries)	MCs are monitoring the income generated from the charging service. All the facilities have carried out operation and maintenance e.g. water topping using income from charging service. The MCs are aware of the cost for repairs and replacement but cannot adequately prepare a budget for facility accounting because their income source is limited.

Prepared by JET

2) Charging service

One of the important analyses at the monitoring was to examine to which extent the charging service can cover. The projection and actual amount of the proceeds from charging service is summarized in the table below. As shown in the table, some target facilities did not carry out the charging service continuously, especially at Olkinyei dispensary and Olemoncho primary school due to absenteeism or replacement of the operator and low capacity of MC members[9].

[9] Even secretaries of some MCs (head teachers) could not quickly understand how to fill the accounting format.

Table 2.5.3 Comparison between Projection and Actual Amount of Charging Income

Public Facility	Monthly Average Income (Ksh./month)			Monthly Average Expenditure (Ksh./month)			Balance (Ksh./month)		Daily Average Customer (person)	
	Projection	Actual	Ratio	Projection	Actual	Ratio	Projection	Actual	Projection	Actual
Lot 1										
Ilkilnyeti Dispensary	8,800	4,698	(53%)	7,000	3,430	(49%)	1,800	1,268	20	10.7
Iltumtum Primary School	10,400	7,732	(74%)	7,000	5,029	(72%)	3,400	2,703	20	16.1
Olkinyei Dispensary	13,200	303	(2%)	6,500	19	(0%)	6,700	284	20	0.5
Olemoncho Primary School	10,400	1,480	(14%)	6,500	810	(12%)	3,900	670	20	3.1
Lot 2										
Tuum Primary School	5,040	323	(6%)	3,000	0	(0%)	2,040	323	8	0.5
South Horr Dispensary	2,640	1,116	(42%)	3,000	642	(21%)	-360	474	5	1.9
Illaut Primary School	4,320	437	(10%)	3,000	0	(0%)	1,320	437	8	0.7
Latakweny Dispensary	2,640	653	(25%)	3,000	0	(0%)	-360	653	5	1.1
Marti Primary School	4,320	1,679	(39%)	3,000	64	(2%)	1,320	1,615	8	2.8
Angata Nanyokei Dispensary	2,640	312	(12%)	3,000	0	(0%)	-360	312	5	0.5

Note: Projected amount of the expenditure not include reserve amount for replacement due to comparison purpose.

Prepared by JET

As seen in the table, both income and expenditure amounts were less than the projected one in all facilities and the balance surplus is quite small. The reason is that the number of customers was less than estimated.

Regarding Lot 2 facilities, the reason being that regular O&M cost did not occur in four (4) facilities because 24 bottles of distilled water were provided by the contractor. O&M cost occurred in two (2) facilities which consisted of purchasing of electric devices for charging service.

All target facilities could avoid the deficit as of the end of the monitoring period. However, the financial situation that can be a reserve for future replacement of major equipment could not be achieved. Countermeasures for the financial deficit are described in Chapter 2.6.3.

3) Support to MCs

JET also supported MCs to improve their capacity in financial management.

i) Assistance for accounting activities: Some of target facilities are far away from the copying shop, and the need paying transportation fee for copying the accounting formats. JET advised the MCs to record the account information in notebooks instead of payment for copying formats.

ii) Assistance for financial balance: As JET found that the salary of the operator oppresses account of the charging service; they recommended the MCs to employ facility workers as operator. It improved balance of the charging service but reduced the service time due to the normal duty of the operator.

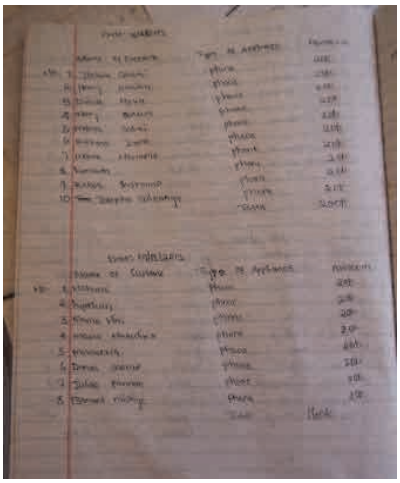


Figure 2.5.1 Daily Income Record on notebook, Ilkilnyeti Dispensary

With regard to the summary of MC performance for charging service operation and accounting activities, the summary is attached at Attachment H-4.

4) Other Findings Relating to Financial Management

- Chairman and secretary were capable to manage accounting procedures including assisting the operators to a certain extent.

- Head nurse secretary and head teacher did not effectively manage the solar PV systems especially when they were replaced.
- One time training is not sufficient for secretaries to prepare the Monthly Report, (head nurses and head teachers). MCs need to receive more training.

(3) O&M and Management

1) Findings from the Lot 1 Monitoring

Three facilities except Olkinyei dispensary drafted up the bylaw of solar PV utilization and got approval by the MC. It is difficult to hold committee meetings for Olkinyei dispensary on whole dispensary management issues due to the indifference of the members. PV committees established at Olkinyei and Olemoncho at the time of the first stakeholder meeting were dissolved because of their poor performance and the management committee gained control. JET learnt that the separate management system is not effective.

Operators were replaced at Ilkilnyeti and Olemoncho. Operator of Olemoncho does not work every day while that of Iltumtum does O&M and recording well.

JET expected that the facility received sufficient income for the O&M of the solar PV system but it was still difficult. First, there are competitors inside and near to the surrounding communities and secondly, the number of individual/private power generation is increasing (grid extension and solar PV system).

Grid electricity line reached Iltumtum early in 2014 and REA will connect cable to one classroom of Iltumtum Primary School. Some inhabitants who can afford to connect to the line will get power and charge appliances at home.

All facilities except Olemoncho make O&M and financial report of charging service and submit to the sub-county office. At Olemoncho no business was ongoing during the progress period and MC did not submit since the head teacher and operator were replaced.

Key problems regarding O&M are lack of commitment by MCs and operators to the management and inactive business of charging service. Especially increased use of individual solar PV systems reduces the number of customers.

2) Findings from the Lot 2 Monitoring

Performance of MC is relatively better than Lot 1 sites. JET supposes that Samburu County has been isolated from other areas and competent people must remain in their place.

(i) Five facilities drafted up bylaw on the solar PV utilization and got approval by the management committee, while MC of South Horr Dispensary drew up the bylaw but MC has not approved yet.
(ii) Operators do operation relatively better than Lot 1 sites. They do record sales daily; treasurers (or secretaries) check daily sales in all six sites even though it is not always the case. They make O&M record in all six sites and all the O&M records except for Tuum are good.
(iii) They make monthly report including system condition and charging service situation and submitted the report to the county offices at least once by the end of the pilot project.
(iv) Only one site (Tuum) opened a bank account exclusively for the charging service. As is the case with Lot 1 sites, MoH forbids dispensaries to have more than one bank account but MoH county officer said if MCs request to the office, it might be possible for them to open the second bank account.
(v) Charging service is not active due to absence of mobile phone network and relatively heavy poverty. MC of Marti was planning to open weekend hair salon in the PC room to increase the sales but anxious to know if it is permitted. MCs explain the situation

of charging service to MC and all MCs advertise charging service to surrounding communities; and they discuss how to increase the sales.

(vi) MC of Illaut and South Horr think they lack technical and financial knowledge and request monitoring team to give additional trainings.

2.5.3 Information Sharing Meetings with Users

Apart from the stakeholder meeting, training and monitoring, JET implemented information sharing meetings with facility staff members and MC members: subjects were (i) plan of the pilot project, (ii) supplementary support and advice on operation and maintenance as well as book keeping and charging service. The list and minutes of the meetings is attached at Attachment B-5.

2.5.4 Progress and Information Sharing Meetings at National and County/sub-county levels

(1) National Level

JET organized the Progress and Information Sharing Meetings together with REA, MoE&P and the relevant ministries in March 2014 on the progress of the Lot 1 Pilot Project and second meeting in January 2015 on the result of the Lot 1 and Lot 2 Pilot Project. In addition to these meetings, JET held three meetings with ministry HQs to discuss the ownership and responsibility for O&M supervision. JET also had meetings with these ministries several times without participation from REA and MoE&P.

(2) County/Sub-county Level

JET members together with REA and MoE&P counterpart personnel held information sharing meetings with the relevant county offices. They completed meetings twice for each county: the first meetings in June 2014 and the second ones in November 2014 and January 2015. In addition to these meetings, JET and REA counterpart personnel explained on the project progress and shared information about the operation and maintenance system with county and sub-county MoH and MoEST offices. Minutes are attached in Attachment B-4.

2.5.5 Evaluation Meetings

JET held the evaluation meeting for each of three counties at the end of the pilot project. The main purposes of the evaluation meeting were that REA and JET declared termination of the pilot project and they gave opportunity to the target facilities and management committees to reflect their activities and performance during the pilot project and to strengthen their recognition of sustainable solar PV system use.

Table 2.5.4 shows the date and Table 2.5.5 shows the agenda of the meeting. Minutes of evaluation meeting is attached at Attachment B-6.

Table 2.5.4 Date of Evaluation Meeting

County	Kajiado	Narok	Samburu
Date	06-11-2014	11-11-2014	14-11-2014
Venue	Ilkilnyeti Dispensary	Park Villa Hotel, Narok	Four Seasons Hotel, Maralal

Prepared by JET

Table 2.5.5 Agenda of Evaluation Meeting

Contents	Presenter
1. Declaration of termination of the pilot project	1. REA, JET
2. Self evaluation of the pilot project (lessons learnt from pilot project)	2. MC members
3. Explanation of the responsibility and tasks of facilities	3. REA, JET
4. Expression of intension of solar PV system	4. MC members, relevant

Contents	Presenter
management from stakeholders	ministries (MoH, MoEST)
5. Others: handover schedule of ownership, e-waste	5. Others: handover schedule of ownership, e-waste

Prepared by JET

The Secretaries and the chairpersons of all the facilities showed their continued commitment for proper PV system use in all sites. However, they evaluated themselves not well capable for O&M and management due to their low capacity and external conditions. In Samburu County, MoH officer assured that the office would prepare financial and technical support to them while MoEST Sub-county officer instructed MCs that they should manage by themselves.

Boxes on the next pages show the key issues that MC members of target facilities evaluated themselves and ministry officers mentioned in the meeting and the Minutes of meetings is attached at Attachment B-6.

<Lot 1 sites>

- The achievements realized are more than the obstacles. For example, the number of boarding pupils has increased, pupils shave frequently and thus remain clean, fuel usage has reduced, evening study is frequent and reliable and the retention rate of teachers in the school has become high (Narok).
- The following challenges have been noted: regular breakdowns/replacement of bulbs, lack of a technical person for consultation and the anticipated cost for battery replacement is very high (Narok)
- The head teacher of Iltumtum where the school will be connected to the main grid assured that she would insist on the school to use solar PV system all the time and the main grid when the PV systems are down (Iltumtum).
- Substitutes for phone charging service have been introduced in Lot 1 site, which make the charging service of the public facilities reduced: an initiative by Safaricom and other partners to provide lanterns called M-Kopa Solar (Olkinyei) and a conservancy group gave out solar PV systems and this has affected the charging business (Olemoncho).
- The county officers for health, both Kajiado and Narok, assured to prepare for future replacement of batteries, inverters and controllers. The county office will identify problems mentioned in the reports, carry out inspection on the condition of the PV systems and address issues raised by the management committee. The schools, however, will have to wait for the results of the discussion between REA and the MoEST. Meanwhile, the schools need to continue saving for any repairs or minor replacements to the PV systems.
- Income from charging service is not bad in Ilkilnyeti and Iltumtum.

<Lot 2 sites>

- The Secretaries and the chairpersons of all the facilities showed their continued commitment for proper PV system use (all sites).
- Performance of facilities was improved since installation of the PV systems: night treatment in dispensaries and evening and morning study are now possible, and security at night enhanced by the security lights.
- However, some challenges remain: employment of competent and honest operator is difficult: trained operator quitted (Tuum), weak in O&M and need more training (South Horr), .
- They are faced with competition from the M-Kopa solar PV products like Lot 1 site (South Horr).
- Income from charging service is still low (except Marti).

<Comments from County Chief Health Officer>

- HSSF funds can be used for O&M of the PV systems
- If a special request can be made by the management committee of the dispensary through the CoH, to the County Executive Committee (CEC), opening of a new account can be legalized.
- The County Government of Samburu has set aside a budget for the maintenance officer. The officer is to begin working in December 2014. He will go round all the dispensaries and carry out replacements and repair to the solar PV systems. Also, emergency cases regarding PV systems can be handled by the County Government.
- Facilities should be able to pay for the usage of the PV systems just as they would pay for electricity bills.

<Comments from Education Officer of Samburu North Sub-county (DEO)>

- Facilities should own the solar PV systems. Solution for challenges faced by the committee members should come from within and not outside.
- MC of every facility should ensure sustainability of their solar PV systems.
- Charging income is public money and reporting is necessary. Each facility should seek better ways of marketing the charging service.
- Boarding schools like Marti can use funds for boarding to maintain and operate the PV system

2.5.6 Handover of the Ownership

The monitoring so far conducted by JET officially came to an end with the ownership handover of the PV systems in 10 pilot project sites from JICA to REA. A symbolic ceremony was planned and held in Iltumtum Primary School on 4 February, 2015. In the ceremony, with the remarks by Mr. Ogawa representing JICA, JICA officially handed over the ownership to REA.

Photo taken by JET

Figure 2.5.2 Photos of Handover Ceremony

2.6 Formulation of Rural Electrification Model Using Solar PV

2.6.1 Update of Capacity and Needs Assessment

JET continued capacity and needs assessment of stakeholders throughout the implementation of the pilot project and updated the results of the assessment at the end of the Project.

(1) Results of Capacity and Needs Assessment and Financial Sources for the Target Facilities

1) Financial Status

Each facility receives a budget allocation from the central government in the form of HSSF or FPEF, which they use to manage facility activities. However, the allocations are significantly smaller than that required for the facility management. To strengthen the facilities' management capability, more sources of funds are needed, especially in remote rural areas where usually little investment is done.

2) Staff Members of Target Facilities

Head teachers or nurses are assigned as the secretaries to the MC in the case of schools and health institutions respectively. Ministries provided training in management and book keeping to these key personnel. They therefore keep accounts of HSSF or FPEF, make periodic reports and submit them to sub-county offices. However, they do not have adequate time to manage the solar PV system due to the burden of their normal duties.

3) Management Committee (MC)

MCs are not adequately equipped with requisite experience and knowledge of management. Members are chosen from the community residents and are expected make decisions, sign bank transactions, and raise funds. However, the level of training they have received is critically low in regards to facility management, and do not receive a salary for their work[10]. Furthermore, they are not permanent members of the MC and are scheduled to be replaced every two (2) to three (3) years. Due to limited opportunities for income generation in the remote rural areas, committee members are eager to generate income from charging services, for O&M and management. Thus, JET's appraisal is that MCs in remote rural areas need more

[10] They receive a token contribution for lunch while they are required to work every day and provide for their families' upkeep.

capacity building in techniques, administration and finance for effective management of the solar PV systems.

4) Operators

Operators are the key human capital for sustainability of the solar PV system and charging services as most other inhabitants of the community have limited knowledge and techniques of O&M and book keeping. Operators are in charge of constant operation and maintenance of the installed solar PV system and conduct charging services safely.

JET obtained several findings from the monitoring of the Project. First, the project planned that operators would be paid from the income generated by the charging services. However, they found that the operator's salary put a strain on the balance of the charging services business. Secondly, the capacity of operators was lower than expected. Many of the operators shortly forgot the contents of the training that JET provided as their level of education was low and they had little experience of abstract thinking. Additionally, initial operators were replaced in some facilities and the new ones had not taken over their predecessor's responsibilities for O&M of the solar PV system.

In conclusion, the capacity of stakeholders at facility level seems inadequate to fulfill necessary works for solar PV system management. They (including operators where they are facility staff) are generally busy with their normal duties and cannot commit adequate time for O&M and management of the PV system. All stakeholders at the facilities lack technical knowledge of PV systems even though they have received technical and financial training. Thus, JET recommends that county offices of MoH and MoEST who are the owners of the systems, support facilities in terms of trouble shooting of technical problems and providing advice on managerial problems. JET also recommends that MCs apply the manual that JET will submit to REA for daily O&M and financial management. Lastly, JET advised Lot 2 sites to employ operators using "labour fee" included in the HSSF or FPEF to reduce expenditure.

5) Sub-County MoH and MoEST Offices

It is important to continuously share information on solar PV systems management with MoH and MoEST offices at sub-county level so that they can manage and monitor facilities. As a normal duty, the offices directly supervise schools and dispensaries and have therefore engaged with the facilities longer and know them better than most other government institutions. Officers receive periodic work reports from facilities, visit facilities often, and give advices when necessary. They generally show intention and responsibility to supervise PV system management as the system is a part of facility properties. MoH county offices in the three target counties expressed their support of solar PV system management to the dispensaries, while MoEST county offices did not express their support due to lack of human and financial resources as they have limited knowledge of PV systems[11].

6) County MoH and MoEST Offices

Transition to the county governments system is still underway but county officers of MoH and MoEST are the principal actors who are responsible for facility management.

The county offices have a certain amount of budget allocated for their governance as the central government disburses an equitable share of revenue to them. Table 2.6.1 shows the disbursement amount, balance in county bank account and per capita disbursed amount; and Figure 2.6.1 shows the flow of the funds to county governments. It can be seen that almost half of disbursed funds have been used for public affairs and KSh. 4,606 was disbursed per capita nationally. This per capita allocation is larger for Samburu than Kajiado, Narok and the national average because government pays special attention to counties where public

[11] JET introduced technical training on solar PV systems, at JKUAT in 2014, for the relevant ministries. Technical officers from County Health Offices participated in the training while none participated from the County Education Offices.

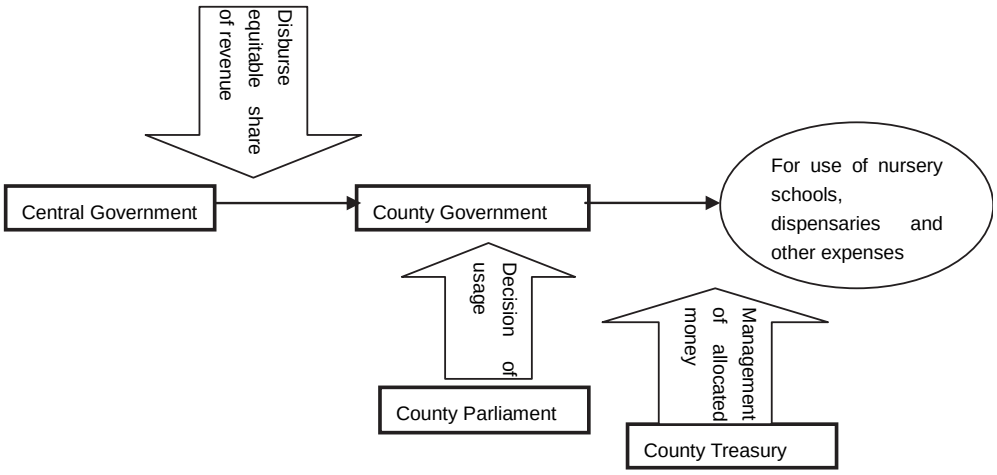
investment is relatively low. If county offices want to obtain funds, they are required to submit proposals (budget demands) to the county parliament.

Table 2.6.1 Disbursement of Revenue to County Governments for the 4th and 5th Tranches, FY2014/5

County Government	Releases to County Government as at 21-01-2015	Total Bank Balances Note (i)	% in Kenya of cumulative disbursement	Population (ii)	Total Disbursement per capita
Unit	KSh.	KSh.	%	Person	KSh.
Kajiado	1,778,596,101.00	1,011,168,622.25	1.7%	687,312	2,587.8
Narok	2,130,075,421.00	703,410,212.60	2.0%	850,920	2,503.3
Samburu	1,429,779,005.00	841,916,558.85	1.4%	223,947	6,384.5
Kenya	105,563,212,212.00	43,229,012,879.40	100.0%	38,610,097	2,734.1

Notes: (i) Bank balances include the equitable share of the revenue raised nationally and the county governments' own revenues, collected and banked in the County Revenue Fund bank accounts, and other county governments' bank accounts maintained at the CBK.
(ii) Kenya Population and Housing Census 2009 was the 5th Census in post-independence Kenya. The geographical unit used in the census is the district which is not exactly the same area as a county. The above figures should therefore be considered only as a reference and for comparison of counties.

Source: The National Treasury on 23 January 2015 and arranged by JET



Source: County Treasury, Samburu and arranged by JET

Figure 2.6.1 Flow of Revenue Distribution

Considering the vulnerable social and economic conditions of the target area for implementation of the rural electrification model, and weak management capacity of MCs, it is indispensable that O&M and replacement of equipment are under the responsibility and supervision of county ministries; and the public facility staff and MC are the managers on site. Ministries should strengthen MC's capacity so that the committee can secure more funds by promoting charging services and submitting proposals to the CDF offices.

MoH head office confirmed that county MoH takes responsibility of infrastructure development of facilities under their supervision. In their budget, Kajiado County did not include the component related to PV systems, and the health administrator informed JET that they may include it in the next budget. Samburu County MoH confirmed after explanation and discussions with JET that they would give financial support for O&M and replacement of equipment to the dispensaries having solar PV systems. Additionally they guaranteed that the technical officers who work for O&M and maintenance of hospital equipment would visit

facilities in the area to give advice, and take a role of trouble shooting if solar PV systems have problems. To strengthen technical capacity of MoH officers, JET proposed that the concerned MoH county offices attend the technical training to be held at JKUAT under the BRIGHT Project (refer to Chapter 2.14 of this report).

MoEST, on the other hand, has not confirmed their responsibility for infrastructure management of the schools under their supervision. There are several reasons: both MoEST HQ and county offices do not receive allocations from the Treasury to budget for infrastructure management including procurement of school equipment and electricity fees[12]; no education budget was disbursed to the county government except the one for nursery schools; and MoEST county offices have very small human resources (one director, a few officers and a secretary). These facts make it difficult to conduct supervision of infrastructure management. REA and JET suggested to MoEST HQ that they needed to include the component of maintenance of the solar PV systems in their budget for the coming fiscal year to ensure long term sustainability of the Laptop Programme. JET will therefore continue to negotiate with them.

County offices were making budgets for the coming fiscal year at the time of the 2nd information sharing meeting at county level. JET explained that they develop the budget by estimating necessary amounts based on the experiences of the previous year. Ministry county offices should consider the fact that replacement of batteries, inverters and controllers is not a fixed annual cost but occurs when their life time finishes, and prepare the budgets at appropriate times referring to the Financial Guidelines of this Project

7) MoH and MoEST Head Offices

Although both MoH and MoEST HQs function as policy making institutions instead of program implementation bodies, attitudes to the electrification of their facilities are different. MoH agrees to witness the Memorandum of Understanding (MoU) that REA and the county health offices will conclude on the ownership and responsibility of the solar PV systems installed/ to be installed at dispensaries. MoEST HQ indicate that they have neither budget nor personnel for school infrastructure management, but MoEST county officers pointed out that HQ keeps governance of overall school management. JET continues discussions with MoEST HQ on the O&M and replacement costs of all solar PV systems installed/ to be installed at public schools. Further, REA started official discussions with MoEST HQ about the O&M and replacement costs of the solar PV systems installed within the framework of the Laptop Programme.

8) REA

Technical transfer of the “soft component issues” from JET to REA is one of the main purposes of the Project but not enough techniques and knowhow have been transferred so far in the soft-component issues due to lack of human resources in this field. During the pilot project implementation, JET identified following matters:

- REA’s mission is construction and installation but does not include O&M after handover of the systems. Thus, they have no personnel, budget or experience on O&M of installed electric systems. This situation is the same for MoE&P.
- REA has a number of technical staff but no officers who are competent in socio-economic analysis and participatory development, setting up institutions, and project monitoring, either for renewable energy or for general electrification activities[13].

[12] MoEST expects MC pays for electric fee and other expenses using FPEF directly coming from the national treasury. Officers of MoEST HQ understand the amount of FEPF is not enough, but the Parliament did not decide to increase it.

[13] A staff member of the Communication Department accompanied JET for Lot 2 stakeholders meeting but was was not a specialist in participatory development and monitoring.

- At the beginning, REA was less keen on supporting other institutions in sustainable O&M. However, they have increasingly become more involved in this matter throughout the trial technical transfer to staff in the Project.

In conclusion, capacity of stakeholders at government institutions does not seem quite high because (i) supervision of O&M of electrification systems after handover is not the duty of REA or MoE&P, and (ii) MoEST has neither budget nor officers for supervision of O&M, but (iii) MoH confirmed preparation of a certain amount of fund from their county budget and dedication of some technical officers. At the second information sharing meeting at county level, JET and REA requested MoH and MoEST to prepare the necessary budget for the next financial year, and ensure officers get training because of electrification of public facilities, a national policy. In addition, the Laptop Programme by the president and MoEST is developing in 2014 will not be sustainable without an appropriate framework for O&M and equipment replacement. JET also recommended that MoEST applies the model that JET is developing.

At the time of the Project termination (January 2015), JET learnt that REA was planning to sign a service contract with the private sector for O&M of solar PV systems. REA expects that private companies will monitor and do O&M of installed solar PV systems at public facilities in each county. REA also made a budget according to the contract and requested the National Government to implement these activities. However, the details of this contract were not disclosed to JET by the end of January, 2015. Thus, JET recommends that REA seriously considers the goal of O&M; sustainable use of solar PV systems and to apply the JICA model consisting of technical, financial and institutional frameworks to their activities.

9) Others

The capacity of contractors (private companies who install solar PV systems) is not high. The construction work is not appropriately done, which resulted in inconveniences in the system use. One contractor of the pilot project installed batteries that are not specified in the TOR. REA should quickly establish a quality maintenance system to enhance installers' quality.

2.6.2 Analysis of Effective Charging Services

(1) Background of the Charging Service

The TOR of the Project instructed JET to apply the combined solar PV system or community solar system (tentative name) as the base concept for the technical and financial design of the pilot project. The idea of a combined solar PV system was first proposed in the JICA report "Preparatory study for the promotion program of renewable energy in non-electrified villages (electrification of public facilities)" in 2009. It means that public facilities have a solar PV system offering charging services to the communities in addition to the basic systems necessary for the general power requirement. The report explained that this service could improve not only the quality of service at the facility but also the quality of inhabitants' life by providing a place to charge mobile phones and rechargeable lanterns. The report estimated number of users, income and expenditure of a typical charging service as: number of mobile phones charged would be 100 phones per day[14]; and income from charging service would be US$750 per month[15]. Expenditure was not estimated. The report made reference to private service providers and indicated that public facilities should coexist with these providers by developing new service demand such as rechargeable lanterns.

The Project is the first application of the idea of combined solar PV system in Kenya. JET followed the instruction and started system design including charging system and meetings with stakeholders focusing that facility and MC would operate and maintain the system and replace machines using income from the charging service. After the idea was proposed, there was no F/S, the pilot project had

[14] The report describes that the combined solar PV system can be applied to the core communities (large population size) in the area and supposes there are 300 phones at a site, two times charging per week. The report also explains the cases of rechargeable lantern and car battery.
[15] Unit charging price was set at US$0.25 (equivalent to KSh 58,005 as of the end of April 2009.)

the role to examine its feasibility though it was not instructed. The most challengeable matter was that the 2009 report did mention the supply side expectation but did not mention the demand side situation.

(2) Activities Challenged and lessons learnt in the Pilot Project

JET implemented the pilot project to monitor and examine if the components are feasible and applicable to the rural electrification model. As the F/S had not been applied to the charging service and the idea was made from supply side, JICA expert tried to examine its feasibility by focusing on its demand side using marketing frameworks.

1) Estimate of Required Income and Necessary Number of Customers

Using the result of the baseline survey and the 1st stakeholder meetings in Lot 1 site, JICA expert set the direction of the charging service. At this moment JET tried to maximize income from the charging service to satisfy the requirement of all the cost including replacement of batteries, inverters, and controllers in consistency with the idea of combined solar PV system.

Power charging service was considered as the key activity for stable system condition because in that it generates funds for O&M and replacement of PV equipment. Even though the target facilities are public, support from community people is indispensable contributing in the form of payment of charging fee. From the view point of participatory development, responsibility should not be called from communities since they have no ownership over the objects (PV system possession). In this regard, it seems appropriate that they pay money to the facility as a form of compensation for charging service. Thus, it is needed to promote local inhabitants to use the service.

Prior to the commencement of the pilot project, the JICA expert made a trial estimate to find the necessary minimum number of mobile phones to be charged at each Lot 1 facility that will cover all the necessary cost. This is a comparison of supply side (necessary cost) and demand side (unit price x number of phones and frequency of charging).

- Because lifetime of any machine has long range and depends on the manner of use, an average according to the experience was applied here: 4.5 years for battery, 7.5 years for both charge controller and inverter for this estimate[16].
- Solar panel's cost was not included because its lifetime was more than a cycle of the project.
- The result of the baseline survey and stakeholder meeting was used for the average phone number that a household owns at each site, frequency of charging, number of service day in a week at each site.
- The supposed consumers are "constantly charging households" who charge phones only at the facility. The calculation was made for the number of mobile phones only because it was considered as the most popular appliance to charge at rural areas. The result of trial calculation is shown in Table 2.6.2.

Table 2.6.2 Necessary Number of Charging Appliances and Customer Households

Facility	Ilkilnyeti*	Iltumtum	Olkinyei	Olemoncho
Minimum number of phones/day	29 phones	35 phones	15 phones	34 phones
Minimum number of households who constantly come to charge	34.8 HHs	65.6 HHs	25.0 HHs	42.5 HHs

* As the service day in the week was not decided at the stakeholders meeting, six day service in a week was applied for calculation in Ilkilnyeti.

[16] The basic calculation was done by the financial expert, who tentatively applied this lifetime at that moment. Finally JET applied following life time: battery 5 years, inverter and controller 7 years/

2) Challenges

The estimate indicates that the charging service was not an easily successful business for the target facilities. JICA expert found that the required number of households in school sites probably exceeded the number of existing households in surrounding communities as in the case of Iltumtum and Olemoncho. JET expert guessed following conditions disturb the income from the charging service.

- It is not a new activity even in rural areas of Kenya; rather, it is a kind of common business. It has little comparative advantage in quality of power. This condition makes target facilities face high competition with other service providers, who have already been operating in surrounding communities and nearby markets. Also, it is not easy to raise charging fee if facilities want to get customers because they need to consider current market price.
- Generally, service or product sale is not easy without sufficient needs and wants rather than producer's intention. Location is important but geographical condition of public facilities cannot be changed even if there is mature market or little population.
- Owner's intention is the first step of the successful business, but owners of public facilities (ministries) have not concretely shown intention to manage and take responsibility for the facility electrification by PV system as well as the direction of charging service business.
- At the beginning of the pilot project, some stakeholders expected that communities would contribute a certain amount of funds when the service balance became in red. However, JICA expert thought that communities having no ownership of the facility should not take on the responsibility.

These were challenges to tackle with both REA and JET throughout the pilot project and it was needed to find a breakthrough to sustain the PV system and facility electrification. They adopted possible measures at this stage of the pilot project:

- Promotion of use of charging service to the inhabitants living in the facility service area (demand generation),
- Extension of information on the charging service to the communities bordering the service catchment area (expansion of information),
- Introduction of rechargeable electric appliances at an affordable price (opportunity expansion), and
- Involvement of the PV system owners (MoH and MoEST)

3) Output of the Charging Service

JET learnt a lot of lessons from the monitoring of the pilot project. Charging service was still difficult even after the facility received sufficient income even for the O&M of the solar PV system. First, there are competitors inside and near the surrounding communities and secondly, the number of individual/private power generation was increasing (by grid extension and private solar PV system).

Sales of the charging service in Lot 1 sites differed according to each site at the time of the 5th monitoring. Each facility faces competition with private providers and grid extension that will reduce the needs of charging service.

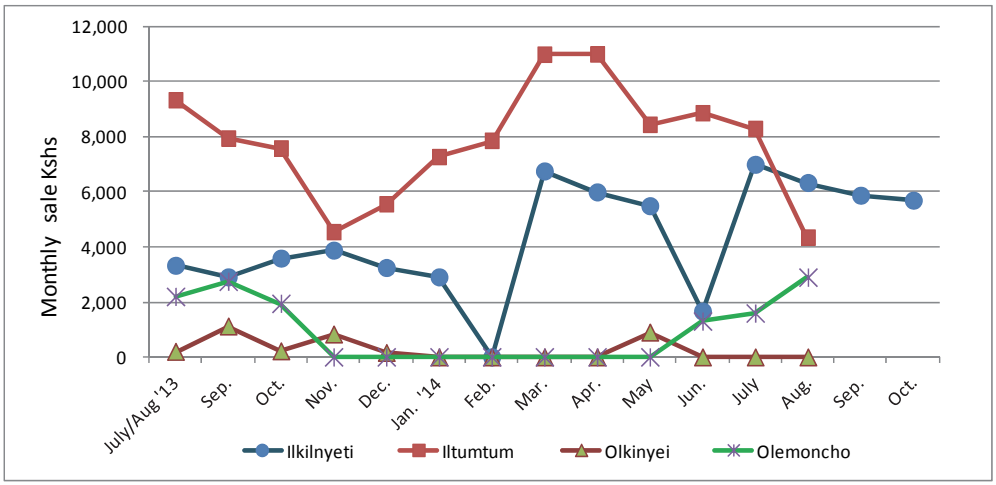
Ilkilnyeti got in total KSh 64,500 up to October 2014.

Iltumtum earned relatively well with KSh 101,800 total sales since the commencement. The MC paid salary of the operator and bank commission fee and purchase distilled water from the sales.

Charging service of Olkinyei functioned only when the operator came to work and had low sales due to existence of competitors. Its total income since commencement is the worst with KSh 3,400.

Olemoncho stopped charging service in November 2013 because of mismanagement of MC secretary and operator, but was restarted in May 2014 by employing a new operator. Also an increase in individual solar PV systems reduced the demand of charging in Olemoncho where the total sales were KSh 12,650.

Figure 2.6.2 shows the monthly income of the charging service in Lot 1 sites.



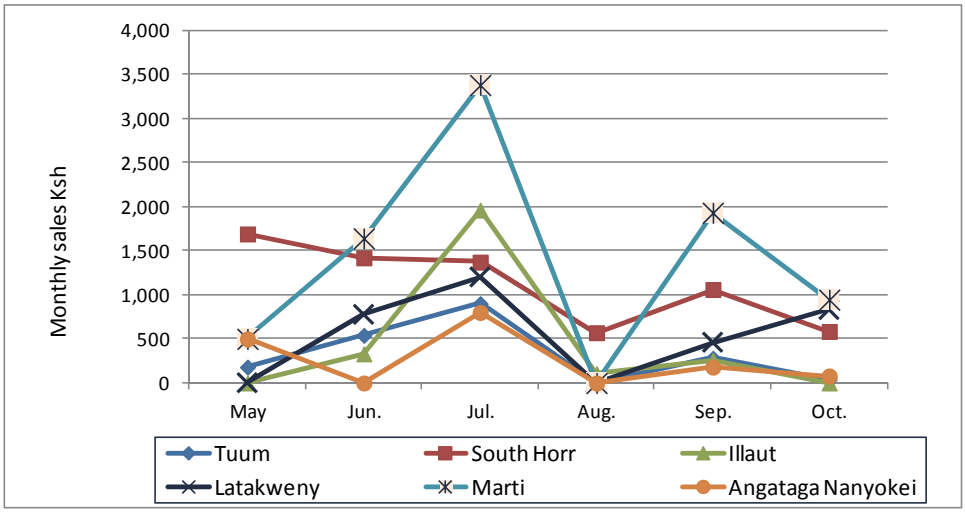
Prepared by JET

Figure 2.6.2 Monthly Income from Charging Service (Lot 1)

At the 2nd monitoring at Lot 2 sites, facilities did not have good income from the charging service because there was no mobile phone network and competition (refer to Figure 2.6.3.

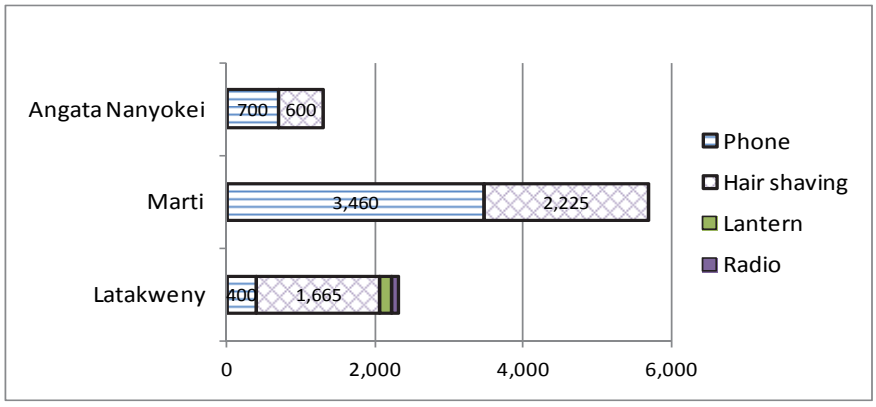
Sales revenue was highest in Marti with KSh 5,685 cumulatively while it was lowest in Illaut with KSh 2,290 cumulatively. Sales data of June were not available in Angata Nanyokei. South Horr MC purchased some additional cable from the sales. Monthly sales revenue was between KSh 500 and KSh 1,960.

Not only mobile phone charging but also hair shaving was the source of income. At the time of 2nd monitoring, South Horr town was the only place where mobile phone network existed, though the network was quite weak at the dispensary. Also Marti located along the trunk road will have network in early 2015. Other four sites had no plan of network extension. Breakdown of sales revenue in three sites (Figure 2.6.4) shows that the network availability has more impact than hair shaving.



Prepared by JET

Figure 2.6.3 Monthly Income from Charging Service (Lot 2)



Prepared by JET

Figure 2.6.4 Breakdown of the Service Sales in Three Lot 2 Sites (May-July 2014)

4) Understanding from the Pilot Project

JICA expert has reached to the understanding that the charging service business will not generate enough income to cover at least O&M cost, which consists of purchase of distilled water and bulbs, and repair of small scale. Needs and wants of power charging are not large. On the other hand, electrification of public facilities is under responsibility of the government. Thus, the owners of the system (MoH, MoEST and their county offices) shall take responsibility for future devise replacement in human and financial capitals. At this stage, JET started discussion with government organizations on the responsibility of the government organizations. Summary of revenue and expenditure of charging service is attached at Attachment G-4-1.

(4) Analysis of the Charging Service Industry

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? Charging service is a business activity where the sales are determined by the relation between demand and supply. Thus, JET examined the factors using a general analytical framework (refer to Attachment G-4-2).

As the charging service is a business, profit or loss is determined by demand and supply relationship like all other businesses. The most important activity of the pilot project concerning this service is to apply this concept because the idea mentioned in the 2009 JICA Report considered only from the supply side (expected amount of income and number of HHs) even though it said it was applicable to relatively large scale communities. Thus, JET starts the analysis with this basis and use the frameworks used for business analysis.

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

Figure 2.6.5 Porter's Five Force Analysis - Framework

First, JET applies Michael Porter's 'five forces analysis', a well-known business analysis tool for examination of the charging service industry (Figure 2.6.5).

Table 2.6.3 Michael Porter's Five Forces

Force	Degree of threats and attractiveness to the charging service
Bargaining power of suppliers	Low
Threats of substitute produces or service	Low-Medium
Barrier to new entrants	Medium
Bargaining power of customers	High
Intensity of competitive rivalry	High

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

Two forces, bargaining power of customers and intensity of competitive rivalry among five forces (factors that effects on the business) are found more important for the charging service (Table 2.6.3).

1) Factors Included in the Bargaining Power of Customers

- Demographic factor: number of households living in neighbourhood of the facility has strong effect on the sales. JET sets a criterion of classification as to whether the facility has more than 50 households in the radius of 5km or not.
- Geographic factor or form of hamlet: if a neighbourhood has concentrated core with a few number of households, there is a high likelihood that some business persons exist comparing with a neighbourhood where houses are dispersed.
- Economic strength: income. Degree of social development including household income in the target counties are regarded as the most vulnerable in Kenya (refer to 2.2 of this report).
- Social or human factor: Customer's preference (qualitative factor). It means why a person with charging demand chooses the private charging shop instead of the charging service of the facility or vice versa.

JET applies the demographic factor and geographic factor as they are the key elements for analysis.

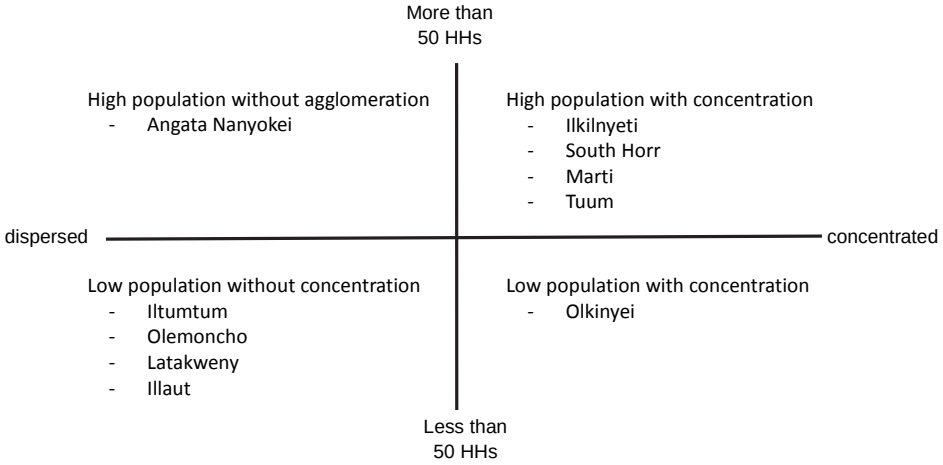
2) Intensity of Competitive Rivalry

- Private service providers are some of the competitors where mobile phone network exists.
- If private service providers start service when the network reaches a place, it is the new entrant force who threatens the charging service of public facility.
- Electric appliances, e.g. solar lantern with charging sockets for mobile phones, are substitute products because many of them have the sockets.

JET applies the existence of private service provider in the neighborhood as an element.

3) Classification and Analysis

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

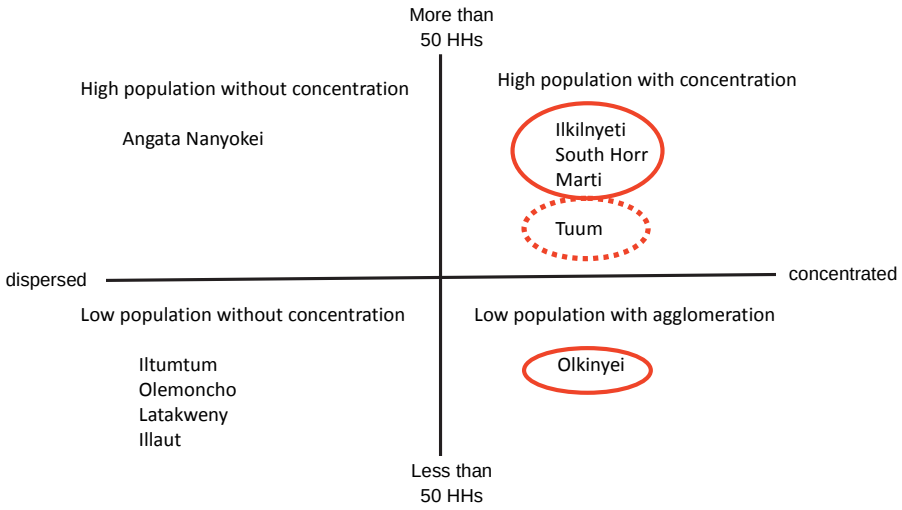


Note: Numerical values are estimates.

Source: JET based on the result of monitoring and observation

Figure 2.6.6 Classification by Demography and Village Form

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 concentration (core) have high potential of competitive rivalry of charging. Also, commercial activity and concentration relate to each other and high rivalry means that there is high potential of demand for charging service. All facilities with more than 50 households in the neighbourhood have competitors. Note that Tuum has no phone network at this moment but inhabitants said that Safaricom would install network tower soon because this community locates at a strategic point for security.

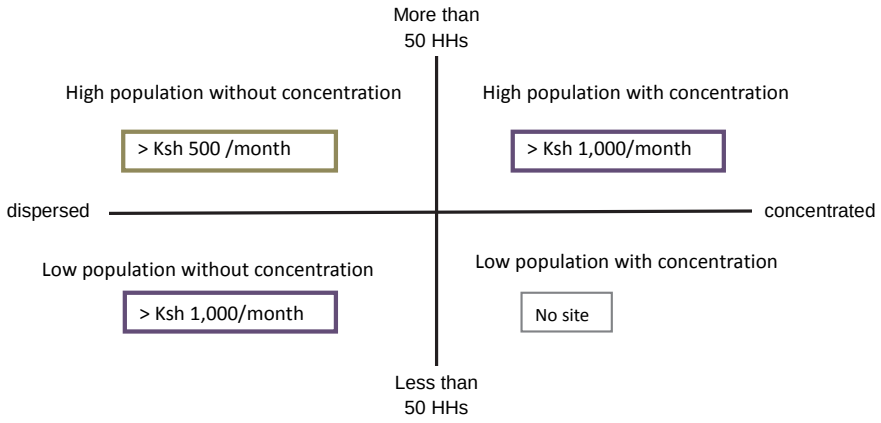


Note: Pilot project sites circled by ◯ have competitor.

Source: JET based on the result of monitoring and observation

Figure 2.6.7 Factor of Competitive Rivalry Added

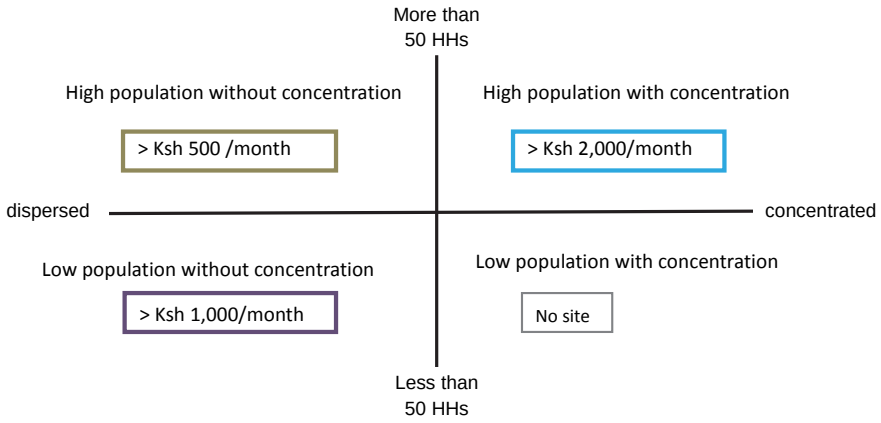
At step 3, sales from charging service are identified for each quadrant by result of the pilot project. As electrification of public facilities using solar PV system targets the remote, less developed counties, only the data of Lot 2 are regarded appropriate and applied here. Some Lot 2 sites started 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 is received, even communities located in dispersed places have potential to earn more than now with the "Blue Ocean" effect. Hair shaving is an important source both for dispensary and primary school.



Source: JET based on the result of monitoring and observation

Figure 2.6.8 Sales of Charging Service in Lot 2 Sites by Location Type (Moderate Case)

Sales exceed KSh 2,000 per month for the sites with concentration at optimal case (largest monthly income). If MC promotes of the charging service it is possible to keep this level.



Source: JET based on the result of monitoring and observation

Figure 2.6.9 Sales of Charging Service in Lot 2 Sites by Location Type (Optimal Case)

No site earns more than KSh 1,000 monthly for the pessimistic case (lowest monthly income) but it is not projected to occur often because this case occurred the first few months when inhabitants did not know the service.

4) Other Factors Found in the Pilot Project

It must be remarked that all the five forces are external conditions that we can observe and measure. However, the monitoring results indicate that each site has internal problems, such as lack of direction of MC and lack of motivation or personal limitation of MC and operator. An extreme example was embezzlement. Management control is indispensable for each facility and facility management committee to ensure the income from charging service. Also, it is found that customers choose the place of charging in order to strengthen social relationship with friends, relatives, and business partners.

(5) Rationales for Charging Service

1) Benefit of the Charging Service

Income from charging is used by the MC exclusively to pay for immediate needs of system O&M and daily administration cost in order that the MC can use the solar PV system without dependence on the fixed budget. Thus, 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 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, JET found it was not enough and the Report did not consider the demand (customer) side. On the other hand, JET thinks 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

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

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 prioritized 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).

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: number of households and population concentration. For understanding more concrete conditions from social and business point of view, JICA expert 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. 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. All these factors mean that:

a) There are a lot of private service providers as rivalries with public facility,
b) When mobile phone network comes, new entrants start their business, and,
c) There are a few substitutes for charging service.

It must be repeated 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 contributing to the meaningful social development.

Now let's move to the question: what strategy is feasible and applicable to this situation? As customers go to charge their phone as their wants, which means that they sometimes want to get additional benefit when they choose particular charging providers; for example tightening relationship with particular relative or starting relationship with particular service provider[17]. It is difficult for public facilities to satisfy this kind of benefit. Thus, the potential facilities are:

Adding to the abovementioned geographical conditions:

a) More than fifty households within a radius of five kilo meters:
b) Concentration of houses near to the facility

More social and business factors should be considered such as:

c) Where mobile phone network will come soon (Safaricom or other companies announced network extension and started construction of network system);
d) M-Kopa and other power generation supported by other donors or NGOs usable for charging service have not or not widely spread yet.

Current situations of Lot 2 sites regarding these conditions are shown Table 2.6.4.

Table 2.6.4 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	No	Yes	No	no	Early 2015	no

[17] The term, 'needs' means the situation that is not fulfilled and customers start actions to improve the situation. 'To charge mobile phone' is the needs in this context. On the other hand, 'wants' means 'intetsion to level up from the least satisfied situation to higher satisfaction.' One does not go to any provider but chooses particular providers to strengthen relationship or to get additional benefit. Chargins service is used as means of strengthening social relationship.

Lot II Site	Tuum	South Horr	Illaut	Latakweny	Marti	Angata Nanyokei
network						
Existing competition	Plan to start charging service	Providers in the South Horr town	No providers nearby	No providers nearby	Started and plan to start charging service.	No providers nearby
Substitutes Solar PV, M-Kopa etc.	-	M-Kopa	-	-	PV systems exists & many private service providers	M-Kopa
Internal problems	No comepetent operator	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

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 sites: monitoring period was six months only, solar PV system of Lot 2 sites was not at 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 favorable condition for the charging service that can cover the initial investment cost is:

a) A facility inside or very near to an agglomeration of houses more,
b) More than 50 households in five kilo meters radius,
c) Mobile phone network will come soon, and
d) 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.

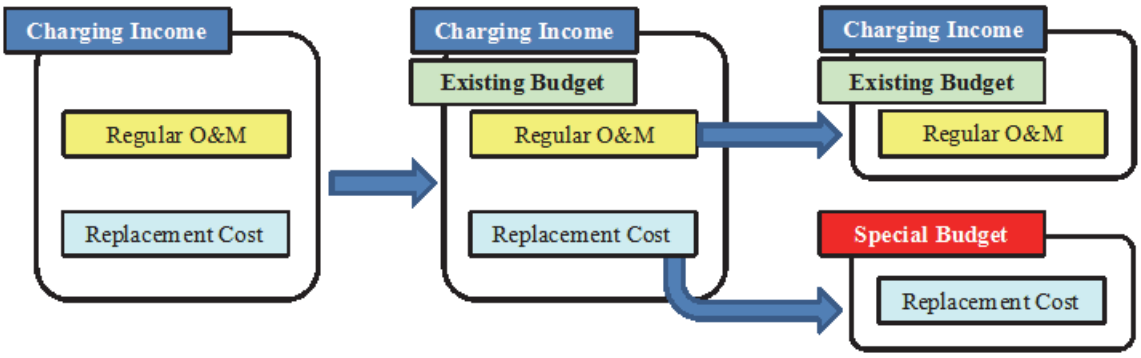
In conclusion, they are the estimated condition of feasible charging service at public facilities where the facility and MC get a certain amount of OM cost and REA will not waste their budget for construction of charging service and the budget will enhance the experience of facility staff and MC members 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.

2.6.3 Study on Countermeasures for Financial Deficit

Considering the results from the pilot project and conditions of existing public budgets as explained in this chapter, JET made a decision to propose “Specific Budget”, i.e. central and or county annual budget as the funding source for replacement cost of major equipment to ensure the sustainable use of solar PV systems at public facilities in off-grid areas.

The following figure shows the process of how JET has reached this financial supporting system, starting from the original idea that the income from charging service would cover all necessary cost”, and through the result of monitoring.



Prepared by JET

Figure 2.6.10 Process to Lead to the Proposal of Government Budget

(1) Review of the Financial Balance of Pilot Project

The income from charging service in public facilities was initially expected as the possible funding source for regular O&M cost and replacement cost of major equipment of the installed solar PV systems. JET updated projection of the financial conditions based on the monthly average amount of the incomes and the expenditures through the monitoring period as follows:

Table 2.6.5 Updated Projection of Financial Balance of Lot 1

Description	Unit	Ilkilnyeti Dispensary	Iltumtum Primary School	Olkinyei Dispensary	Olemoncho Primary School	Meto Dispensary	Notes
a. System Capacity	kW	1.47	2.98	0.74	2.35	Cancelled	
b. System Initial Cost	Ksh.	1,275,420	2,341,160	848,960	1,907,230		Contract Price
A Expenditure	**Ksh./year**	**92,510**	**183,723**	**59,363**	**139,325**		(= 1+2+3)
1 Replacement Cost	Ksh./year	76,326	155,283	50,854	119,443		As same as previous.
2 Regular O&M Cost	Ksh./year	41,160	60,348	228	9,720		(= c x 12months)
c. Monthly average expenditure	Ksh./month	3,430	5,029	19	810		Actual average
3 Miscellaneous	Ksh./year	12,754	23,412	8,490	19,072		As same as previous.
B Income from Charging Service	**Ksh./year**	**56,376**	**92,784**	**3,636**	**17,760**		(= d x 12months)
d. Monthly income	Ksh./month	4,698	7,732	303	1,480		Actual average
e. Daily demand	Person/day	10.7	14.9	0.7	2.8		Back-calculated value
C Profit and Loss	**Ksh./year**	**(36,134)**	**(90,939)**	**(55,727)**	**(121,565)**		(= B - A)
Proportion of Income	**Percent**	**61%**	**51%**	**6%**	**13%**		(= B / A)
Breakeven Point							
By Daily Demand	**Person/day**	**17.5**	**29.4**	**11.2**	**22.3**		Charging fee fixed.

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Table 2.6.6 Updated Projection of Financial Balance of Lot 2

Description	Unit	Latakweny Dispensary	Marti Primary School	Tuum Primary School	Illaut Primary School	South Horr Dispensary	Angata Nanyukei Dispensary	Notes
a. System Capacity	kW	2.40	6.36	4.92	4.20	0.48	0.92	
b. System Initial Cost	Ksh.	1,684,139	3,467,199	2,654,987	2,584,399	1,133,241	1,114,531	Contract Price
A Expenditure	**Ksh./year**	**95,270**	**255,583**	**194,578**	**171,587**	**40,436**	**45,002**	(= 1+2+3)
1 Replacement Cost	Ksh./year	78,429	220,143	168,029	145,743	21,400	33,857	As same as previous.
2 Regular O&M Cost	Ksh./year	0	768	0	0	7,704	0	(= c x 12months)
c. Monthly average expenditure	Ksh/month	0	64	0	0	642	0	Actual average
3 Miscellaneous	Ksh./year	16,841	34,672	26,550	25,844	11,332	11,145	As same as previous.
B Income from Charging Service	**Ksh./year**	**7,836**	**20,148**	**3,876**	**5,244**	**13,392**	**3,744**	(= d x 12months)
d. Monthly income	Ksh./month	653	1,679	323	437	1,116	312	Actual average
e. Daily demand	Person/day	1.4	3.5	0.6	0.9	2.3	0.7	Back-calculated value
C Profit and Loss	**Ksh./year**	**(87,434)**	**(235,435)**	**(190,702)**	**(166,343)**	**(27,044)**	**(41,258)**	(= B - A)
Proportion of Income	**Percent**	**8%**	**8%**	**2%**	**3%**	**33%**	**8%**	(= B / A)
Breakeven Point								
By Daily Demand	**Person/day**	**14.5**	**38.3**	**25.1**	**25.8**	**6.3**	**7.0**	Charging fee fixed.

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The results show that the deficit between income from charging service and expenditure is not balanced at all pilot facilities. The range of the income against the required expenditure was about 61% and 2% of the required expenditure. It has been shown to be impractical that cover all expenditures including the future replacement cost of the major equipment by charging income.

To deal with this issue, JET studied the following measures to fill the gap:

a) To leave out the expense of salary of an operator,
b) To consider to utilize the existing budget as additional fund,
c) To use the fund allocated from the National Government,
d) To use the fund allocated from the County Government,
e) To apply and receive the Constituency Development Fund (CDF), and,
f) To request contribution of community and Parents Association (for primary schools)

(2) Existing Public Budget to be applicable for Solar PV System

JET surveyed the existing public budgets for public facilities (dispensary and primary school), and studied the applicability of those budgets to O&M of the solar PV system at public facility. The results are summarized in Table 2.6.7.

As results of study, JET judged that incorporating the existing public budget into the rural electrification model is inappropriate because of the following reasons:

- Facility that can receive the budget allocated is limited,
- Facility that cannot receive the budget allocation in every yare,
- Budgets are small with respect the necessary expenditures of the PV system.

Table 2.6.7 Summary of the Existing Public Budgets

Fund/Ministry	Amount	Description	Applicability for O&M of PV System
Health Sector Service Fund (HSSF) / MoH	KSh. 110,800 (per annual) = KSh. 27,700 x 4	✓ The objective of this fund is to help improve service delivery to the community. ✓ This fund is applicable for maintenance, payment to support staff, allowances to committee members, communication, fuel, and non-drug supplies, etc. ✓ Dispensaries receive this amount quarterly from the government in their HSSF account. ✓ MC of dispensaries oversees the implementation and controls HSSF and any other income raised by the facility. ✓ Dispensaries can utilize funds for O&M of solar PV systems; however, the amount is not sufficient.	Partially applicable.
Free Primary Education Fund (FPEF) / MoEST	KSh. 1,020 (per pupil per annual and to be increased to KSh.1,400 in 2015)	✓ This is fund to help pupil's expenses in school. ✓ The fund is allocated based on the number of pupils that each primary school report to the MoEST annually. ✓ FPEFs are sent directly to the respective school account. ✓ FPEF is specifying expenses items, and items for "repair, maintenance & improvements" and "electricity, water & conservancy" are applicable for the replacement of major equipment in PV system.	Partially applicable.
Infrastructure Fund / Ministry of Public Works	KSh. 1,000,000 (Annual limit for two schools in each sub-county)	✓ This is provided for infrastructure development like construction of new classrooms, dormitories or improvement of the existing structures. ✓ Priority is only given to two most needy schools in each sub-county. ✓ Schools usually apply to the fund through their sub-county/county offices. The sub/county officers together with the infrastructure committee of the school evaluate all applicants. The Ministry of Public Works makes final approval. ✓ In case that the schools with PV systems are selected as target of the fund, they can use it for the replacement of major equipment in PV system.	Not applicable in general.
Constituency Development Fund (CDF) / Parliament	Not Fixed	✓ The CDF was established by an Act of Parliament. The funds are sent directly to constituencies' CDF accounts from the National Government. ✓ The CDF funds are disbursed in two phases: (i) at the beginning of the financial period, and in (ii) the last half of that period. The amount is not fixed. ✓ Any organization/institution/individual organizations that wish to get funds from the CDF can apply by submitting an application to CDF in their respective constituency. Once the proposal has been submitted, the CDF committee evaluates the proposal.	Not applicable in general.
Rural Electrification Fund/ REA	Not Clear	✓ This is managed by REA, but information related with this fund is not available (REA did not open to JET).	Not clear

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(3) Necessity of New Budget for O&M

The monitoring results of the pilot project conclude that the income from charging service could cover only for regular O&M cost and could not cover the replacement cost of major equipment. On the other hand, JET thinks that the budget of national and county governments should be allocated to

compensate the deficit. However, existing public budgets related with dispensaries and primary schools are limited to allocate to that deficit.

Based on such background, JET initiated the facilitation of negotiation between REA/MoE&P and MoEST and MoH, respectively, to secure the budget for O&M expenditures of the solar PV systems installed at public facilities by the pilot project. Situations of the budget preparation for health service and primary school are mentioned below.

1) Fund for Health Service

The MoH is being devolved and the MoH HQ is only entitled with policy formulation. The operation budget for health service is already transferred to the county health office. The anticipated budget for replacements to the major equipment of solar PV systems of the pilot project sites can be met by MoH of every respective county.

JET has carried out consultations with key persons in the counties that received the pilot projects. The county health offices of the pilot project site positively stated that they are willing and able to pay for the lack of O&M expenditure.

The MC of every facility will save the income collected from charging service and use it for daily O&M of the PV systems. As the requirement by the MoH, the MC should make expense plan of HSFF and submit it to the county health office before HSSF allocation of each quarter. Thus, income from charging service that is banked will require the approval of the County MoH office (cash remaining can be used for regular O&M but evidence is required by the County MoH).

2) Fund for School

The MoEST HQ does not have its own budget for facility infrastructures and it only monitors the funds disbursed to primary schools; above mentioned FPEF.

FPEF specify the amount of each item as shown in the table below. Among them, items for "repairs, maintenance & improvements" and "electricity, water & conservancy" (KSh. 137 per annum per pupil), must cover all cost relating to infrastructure and JET suggest that it is not enough for daily O&M.

Table 2.6.8 Components of the FPEF per Pupil

(Unit: KSh./pupil/year)

Instructional Materials		**General Purpose Account**	
Item	Amount	Item	Amount
i Text books	360	i. Support staff wages	112
ii. Exercise books	210	ii. Repairs, maintenance & improvements	127
iii. Pens & pencils	15	iii. Quality assurance	29
iv. Supplementary & reference books	55	iv. Local travel & transport	21
v. Dusters, white boards, registers,	10	v. Activity	43
vi. charts, & wall maps		vi. Electricity, water & conservancy	10
		vii. Telephone, box rental & postage	22
		viii. Contingency	6
Sub-total 1		Sub-total 2	
		Grand Total (650 + 370 =)	**1,020**

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On the other hands, since the new President was elected in April 2013, the government is implementing the "Laptop Project", that is, providing laptops to all primary schools in Kenya. Accordingly, PV system is currently installing at more than 3,000 public primary schools. Therefore, there is another need for the government to consider the sustainability of the solar PV systems installed at public schools.

Without any financial scheme, solar PV systems installed for laptop project will not survive continuously for the entire lifetime of solar panels. This is an opportunity to discuss together with all the stakeholders, i.e. REA, MoE&P, MoEST, the National Treasury, and the Ministry of Finance. Such discussion will conclude and provide the practical solution for the sustainable use of solar PV systems installed in public educational facilities in off-grid areas.

(4) MOU

Taking into consideration of the limitation of charging income and necessity of the new public budget, JET prepared a draft MOU regarding to prepare the financial source for future replacement of major equipment of the PV system, and shared the draft MOU with REA in July 2014. Then, JET started and initiated the discussion for the sustainability of the solar PV systems.

However, a common ground for the signing of the MOU was not reached during the Project period. The situations as of the end of January 2015 were:

1) MOU between REA and MoH

REA sent a draft MOU to the MoH in November 2014 and the MoH did their internal review of the draft MOU. The draft MOU is under examination of the Attorney General as of the end of January 2015.

2) MOU between REA and MoEST

REA initially prepared a similar draft MOU with MoEST; however, they showed intention to take responsibilities by themselves for O&M of solar PV system at public primary schools in December 2014. REA examines application of the service contract as a means of O&M of solar PV system installed at primary schools. The detail of the service contract has not been documented yet. However REA seems to consider in quarterly periodic inspection by the assignment to private companies. The private company will prepare cost estimation for required equipment and submit to REA when fault is found in solar PV system. At present, REA applies to the Kenyan government for 2,600,000 KSh as budget of O&M for solar PV.

There is the ownership in REA before the MOU is signed and once the service contract is really signed. Therefore, the county offices and sub-county offices of the MoEST conduct necessary maintenances in contact with REA when it was broken down.

At pilot project facilities, JET instructed the facility to contact installer directly when operation trouble happened.

2.6.4 Rural Electrification Model for Health Service Institutions

(1) O&M Model

The purpose of the O&M model is to ensure that dispensaries can utilize the electricity generated by solar PV system in terms of physical and O&M matters during the lifetime of solar panels (20-25 years). It covers all the solar PV systems that REA installed and will install in the health facilities. The target area is mainly ten counties where social and economic investments have not been active due to its remoteness and insecurity.

Operation and Management Model for Dispensary

Main Target area: Dispensaries in West Pokot, Samburu, Turkana, Marsabit, Isiolo, Mandela, Wajir, Garissa, Lamu and Tana River counties

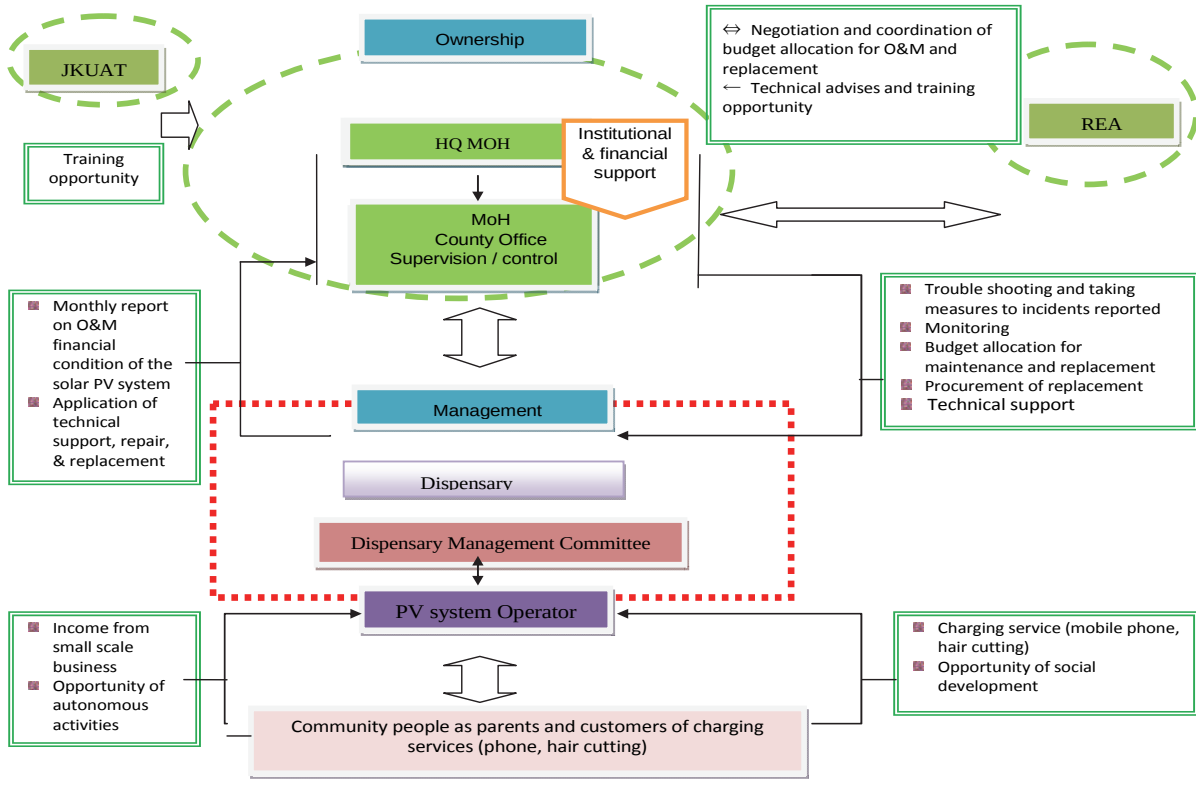

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Figure 2.6.11 O&M Model for Dispensary

1) Roles of Institutions (REA, MoE&P, MoH, County Government)

<REA and MoE&P>

- REA and MoE&P are responsible government organizations for installation of solar PV system at dispensaries. MoH HQ does overall management and county MoH officers do supervision of O&M, responsible for equipment replacement and monitoring/feedback.
- MoE&P formulates policy and REA implements project for installation of solar PV systems at non-electrified dispensaries and then hands over the system to county MoH offices.
- MoE&P and REA need to fulfil conditions for effectively realizing the model. They have no updated information of electrified and non-electrified public facilities, which is an obstacle to efficient electrification and PV system installation by MoE&P and REA. To solve this problem, MoE&P needs to expand their staff in charge of database management.
- REA installs an additional solar PV system and constructs the charging hut at each facility so that each facility starts charging service (mobile phone, hair shaving, lantern, small radio etc.) to earn at least some amount of money for daily operation.

<MoH>

- MoH HQ arranges collaboration with MoE&P and REA for county MoH offices.

- MoH county office is the owner of the solar PV system that is one of the assets of their health facilities. The County Health Director does overall control and prepares its proper budget for the O&M and especially replacement cost. The county technical officers who get training at Kenyan Institution e.g. JKUAT, do regular monitoring of the facilities and do technical trouble shooting. The district health officers do monitoring and check monthly reports from dispensaries and give advices.
- County technical officers enhance their technical capacity for doing trouble shooting of solar PV systems. Training courses are prepared by JKUAT. Also, County MoH office gives training, advices and supports to the dispensary MCs on the financial and managerial issues.
- Dispensary staff members and dispensary MC members are in charge of conducting O&M, charging service, and reporting with the support of the county MoH offices.
- County health officers regularly monitor performance of MCs.

2) Charging Service

- Charging service contributes to obtain revenue for the dispensary MC to be used for their immediate needs such as transportation, distilled water, and salary of operator[18]. It contributes to sustainable use of the solar PV system and self-reliant activity of the management committee.
- Possible charging services are mobile phone charging, hair shaving, lantern charging and other services within the limit of the power capacity.
- The amount of sales of mobile phone sales can be estimated simply by a following formula:

  $n \times \alpha \times p \times f \times K =$ Weekly sales

  Where, n: the number of households in the service area,
  α: the customer percentage,
  p: the number of mobile phones per household,
  f: the number of phone charging per week, and
  K: the unit price of phone charging.

  α is a very important coefficient that is defined by the existence of phone network, number of competitors (private service providers who sometimes have familial, social and business connection with customers) and distance from the facility. In the case of Latakweny Dispensary, where rough estimates show that n= 600, α=1.0, p=0.02, f=0.5 and K=20, the revenue from phone charging becomes KSh. 120 or less per week.
- Charging service performance is analyzed using five force analysis framework and results of the pilot project (refer to 2.6.2 and Attachment G-4-1).

(2) Financial Model

As the results of the pilot project, it has becomes clear that the central and/or county government should prepare not only the initial investment cost but also O&M expenditures for the solar PV system, in case that the solar PV system is installed in the public facilities in off-grid area.

Cost components of a solar PV system consist of (i) initial cost, (ii) recurrent operation expenses, and (iii) replacement cost. The following table summarizes the major items and responsible agency/stakeholder for each component.

[18] MC must pay operator's salary from sales of charging service if MC cannot use the dispensary budget for it.

Table 2.6.9 Cost Components of Solar PV System

Cost Component		Responsible Agency/ Stakeholder	Funding Source
Initial Investment		REA	- REA budget (and/or donor finance)
Operation & Maintenance (O&M)	Regular O&M Cost	Dispensary/ Primary School MC	- Charging service revenue - Operational budget allocated by County Health Office/ MoEST (or School MC)
	Replacement Cost	County Health Office/ MoEST	- County Health Office Budget/ MoEST Budget

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JET considered that to present the required budget scale for installation and O&M of solar PV system is necessary and important information for the respective stakeholder should refer to when formulating their own budget proposal and planning upon implementation of a solar PV project. Therefore, JET prepared the financial model which is calculating required budget scale in accordance with the results of the pilot project.

The conceptual flow of cost estimation for solar PV projects is illustrated in the Figure 2.6.12.

Both initial investment cost and O&M cost are vary depending on the scale of solar PV system to be installed. On the other hands, income from charging service is depending on not the system scale but the social situation surrounding the target facility.

The financial model estimates the scale of solar PV system based on the basic information of the target facility, and calculates the initial investment cost, O&M cost, and charging income. Then, the model provides the cash flow projection of these required expenditures and assumed incomes.

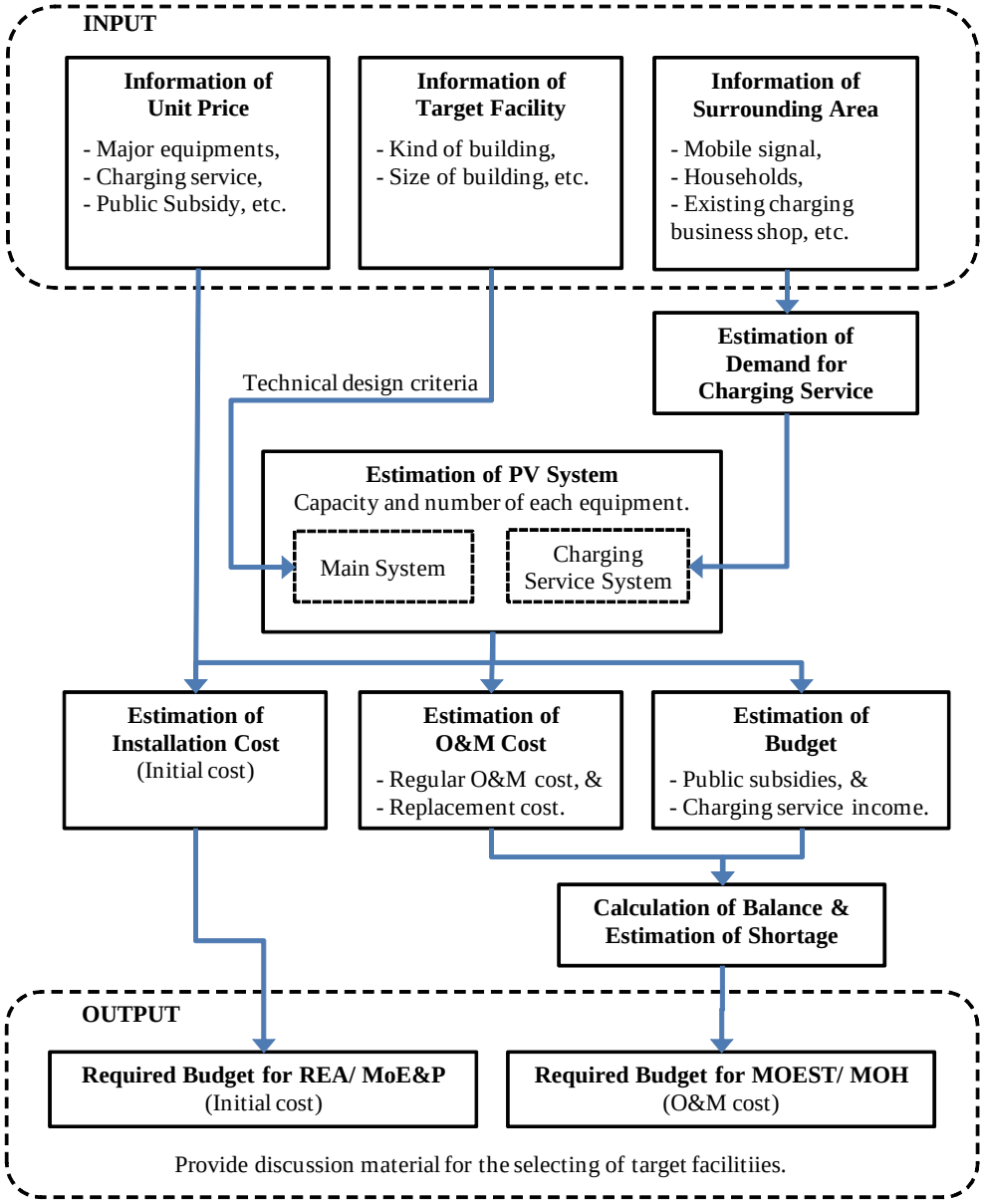

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Figure 2.6.12 Conceptual Diagram of Financial Model of PV System

Contents of the financial model are explained hereinafter.

1) PV System Scale [REA]

The PV system scale required for each facility depends on its electricity demand which is determined by the number and type of rooms in its buildings. Once the demand is estimated, the suitable power package is chosen from lighting model (PP0, PP1 and PP2) and charging model.

Table 2.6.10 shows unit power demand by room type and Table 2.6.11 presents suitable power package by estimated power demand.

Table 2.6.10 Estimated Unit Power Demand of Dispensary

No.	Room Type	Unit Power Demand (Wh/day)
D1	Main building	650
D2	Sub-building (max. 2 rooms)	300
D3	Staff quarter (max. 2 rooms) + TV	600
D4	Kitchen	100
D5	Store	50
D6	Security for each building (10 W x 11 hr.)	110

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Table 2.6.11 Suitable Power Package by Power Demand

No.	Unit Power Demand (Wh/day)	Power Package
PD1	~ 350	PP0
PD2	~ 700	PP1
PD3	~ 1,400	PP2
PD4	~ 700	Charging Model

Prepared by JET

Example: Power Package Selection for Dispensary
One building in a dispensary with one main room and one store room
- Power demand (P) = 500 Wh/day x 1 main room + 100 Wh/day x 1 store room
  = 600 Wh/day
- Power package: 1 unit of PP1 (~ 700 Wh/day)

2) Initial Cost [REA]

The initial cost of PV system is estimated by the following formula based on the actual tender records of the pilot projects:

$$P_{IC} = P_1 + P_2 + P_3 + P_4$$
$$P_2 = P_1 \times 0.25$$
$$P_3 = 130{,}000$$
$$P_4 = (P_1 + P_2 + P_3) \times \alpha$$

Where, P_{IC}: initial cost of PV system
P_1: cost of procurement and installation of major equipment
P_2: cost of procurement and installation of other devices (25% of P_1)
P_3: cost of construction of charging house = 130,000 KSh.
P_4: commission charges
α: rate of commission charges against direct cost
(30% of above for dispensaries / 10% of above for primary schools)

The cost of major equipment of PV system (P_1) is estimated by required number of units of power package and unit price. The required units of each power package are estimated as mentioned above, and unit prices of major equipment in each power package are estimated as per the table below.

Table 2.6.12 Estimated Unit Price of Major Equipment in each Power Package

Major Equipment	Lighting Model			Charging Model
	PP0	PP1	PP2	
1. Solar module (120 W)	12,000 (1 unit)	24,000 (2 units)	48,000 (4 units)	24,000 (2 units)
2. Roof mounting structure	1,800	3,500	7,000	3,500
3. Isolator	5.000	5,000	5,000	5,000
4. Charging controller	9,000	9,000	11,000	11,000
5. Battery	19,000 (1 unit)	38,000 (2 units)	54,000 (2 units)	19,000 (1 units)
6. Inverter	25,000	25,000	35,000	25,000
7. DC fuse/breaker	9,200	9,200	9,200	92,000
8. Consumer units	8,500	8,500	8,500	8,500
Total	89,400	122,100	177,600	105,100

Note: The above unit prices have been specified based on the pilot project in 2014. Therefore, these unit prices are needed to update.

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The cost of other devices (P_2), such as cables, LED, switches, boxes, sockets, security light, maintenance tool box, etc. are estimated to be 25% of the amount of major equipment.

The cost of charging house (P_3) is estimated to be 130,000 KSh./unit.

The commission charges are estimated to be 30% of the total of P_1, P_2, and P_3.

3) Regular Operation Expenses [Dispensary]

The daily operation expenses include distilled water, consumables, transportation, etc., and it is learnt from the pilot project that the most important expenditure is the purchase of distilled water and repair of clippers.

They are estimated by the following formula based on the monitoring results of the pilot projects.

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

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

4) Replacement of Major Equipment [County Health Office]

Useful life of the major equipment (battery, charge controller, and inverter) is shorter than that of PV module, therefore, the major equipment to be replaced during the system life are. The replacement costs are estimated as follows based on the actual tender records of the pilot projects;

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

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

The expected lifetime and unit price of major equipment are estimated as shown in the table below.

The lifetime of equipment may be longer than expected if operators take sufficient care; however, the expected lifetime of equipment is assumed as shown in Table 2.6.13. The unit price of the major equipment is estimated as shown in Table 2.6.13 as well, based on the quotation prices for the tendering of pilot project.

Table 2.6.13 Estimated Unit Price and Useful Life of Major Equipment

Major Equipment	Capacity	Unit Price (KSh./unit)	Equipment Life
Battery			5 years
For lighting model of PP0, 12 V	100 Ah	19,000	
For lighting model of PP1, 12 V x 2 = 24 V	100 Ah	38,000	
For lighting model of PP2, 12 V x 4 = 48 V	200 Ah	54,000	
For charging model, 12 V	100 Ah	19,000	
Charge Controller			7 years
For lighting model of PP0, 12 V	10 A	9,000	
For lighting model of PP1, 12 V x 2 = 24 V	10 A	9,000	
For lighting model of PP2, 12 V x 4 = 48 V	20 A	11,000	
For charging model, 12 V	20 A	11,000	
Inverter			7 years
For lighting model of PP0, 12 V	300 W	25,000	
For lighting model of PP1, 12 V x 2 = 24 V	300 W	25,000	
For lighting model of PP2, 12 V x 4 = 48 V	400 W	35,000	
For charging model, 12 V	300 W	25,000	

Note: The above unit prices have been specified based on the pilot project in 2014. Therefore, these unit prices are needed to update.

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The replacement cost is estimated by unit price and number of major equipment as well as the commission charge of 40% based on the experience of the pilot projects.

5) Existing Budget for Regular O&M [Dispensary]

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

6) Income from Charging Service [Dispensary]

Demand and income from the charging service depends on the surrounding conditions of the target facility. Based on analysis results of the pilot projects monitoring, income from the charging service is estimated for four cases as shown below.

Table 2.6.14 Estimated Charging Service Revenue

Case	Household within 5 km	Village Type	Monthly Revenue (KSh./month)
1	More than 50 HHs	Concentrated or having core area	2,000
2	More than 50 HHs	Dispersed	1,000
3	50 HHs and less than 50 HHs	Concentrated or having core area	1,000
4	50 HHs and less than 50 HHs	Dispersed	1,000

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The financial model provides cash flow of expenditures (b, c, d of the above) and income (e and f of the above) in each year over the specified PV system life of 20 years. The sample calculation of dispensary is attached at Attachment H-5.

(3) Technical Model

Technical model for the health service institutions is prepared considering the power demand and consumption pattern of facilities of that institution. Hence, to adopt different types of demand of facilities adequately, the PV system is basically designed and categorized in three different groups as described below. Furthermore, the total system design factor for model is taken at 60%. However, in Lot 1 and Lot 2 installed PV systems, the total system design factor is taken at 52%. This is because in existing practice, the details of taken value of correction factor were not clear. Therefore, to be more conservative and to make sure that the installed system serves the purpose for a long period, the taken values of correction factors were on the higher side. After the installation of the system, by the

observation of system operation and several technical discussions with the counterparts, the value of each correction factor were verified and decided, hence the total correction factor for the system is decided to be 60%.

The calculation method and the formula for determining PV system capacity is the same as explained in section 2.3 Detailed Planning of the Pilot Project.

1) PV System for Lighting

In actual practice, the PV systems are installed on each building. To determine the capacity for lighting, the below mentioned points are considered.

a) In general, a health service institution consists of some buildings and there are some distances between the buildings.
b) The characteristics of load pattern are different in each building.
c) The existing roof structure might not be strong enough to hold large capacity of PV array over the same roof. In addition, it is necessary to consider appropriate location for installation of PV array on rooftop to avoid shadows throughout the year.
d) Complicated house wirings for connecting all buildings need to be avoided.
e) By installing a system for each building, blackout for all buildings caused by system failure can be avoided.
f) Installing a small PV system at each building is appropriate for health institutions to optimize the replacement cost of the equipment, especially storage battery.

Considering the load pattern and demand of each facility such as staff quarter, Outpatient Department (OPD), pharmacy, delivery room, maternity room, medical wards, and so on, the model for lighting is divided into different Power Packages (PP).

It is possible to combine PPs, if the demand is rather higher than the summarized demand range shown in Table 2.6.15. In addition, it is recommended to conduct demand side management by each facility as a daily practice.

The power package for lighting model is summarized as shown in Table 2.6.15.

Table 2.6.15 The Power Package for Lighting Model according to the Demand

Power Package (PP) Type	PP0	PP1	PP2
Load demand (Wh/day)	Up to 350	350 to 700	700 to 1,400
County minimum average solar irradiation (kWh/day)	5.1	5.1	5.1
Total system design factor	0.6	0.6	0.6
Calculated minimum required PV array capacity (W)	114	229	458
If chosen PV module capacity (W)	120	120	120
DC system voltage (V)	12	24	24
Adjusted PV array capacity (W)	120	240	480
Days of autonomy (days)	3	3	3
Storage battery capacity (Ah)	100	100	200
Charge controller (CC) capacity (A)	10	10	20
Inverter capacity (W)	300	300	400

Prepared by JET

2) PV System for Charging Services

In the areas where electrical equipment has not been utilized, it is very difficult to estimate actual power demand and its future escalation.. Looking at the current tendency of using electricity in Kenya and all over the world, the power demand for information and communication equipment has been increasing steadily.

The charging model is introduced to provide minimum power for charging mobile phones, lanterns and hair clippers for community people. In addition to that, for public institutions with installed PV system, it can support financially for replacement of consumable equipment such as lamps, fuses and distilled water for refilling battery, and so on.

The assumed utilization pattern of charging model is as shown in Table 2.6.16.

Table 2.6.16 Assumed Utilization Pattern of Charging Model

Items	Quantity	Watt (AC)	Use (hr./day)	Total Demand (Wh/day)
Mobile phone	20	2	3	120
Lantern (LED)	20	3	5	300
Hair clipper	1	75	2	150
In House Light (LED)	1	5	4	20
Security Light	1	10	11	110
Total				700

Prepared by JET

From the total demand as shown in the above table, the required PV array capacity is determined to prepare the standard of a charging model. Table 2.6.17 summarizes the technical standard of the charging model.

Table 2.6.17 Size of PV Array for Charging Model

Load demand (Wh/day)	Up to 700
County minimum average solar irradiation (kWh/day)	5.1
Total system design factor	0.6
Calculated minimum required PV array capacity (W)	228
Capacity of each PV module (W)	120
DC system voltage (V)	12
Adjusted PV array capacity (W)	240
Storage battery capacity (Ah)	100
Charge controller (CC) capacity (A)	20
Inverter capacity (W)	300

Prepared by JET

In charging services, the generated power is mostly consumed during the day time; therefore it is not important for system to design storage capacity for several days of autonomy. In this system, the storage battery is considered to be used for voltage stabilization and to balance the power demand of each hour. In addition, battery is necessary to supply power for lighting in charging room and security lights. If only the demand for light in the room and for security is considered, then the days of autonomy will be for more than 3 days if above mentioned capacity of storage battery is installed. If demand of charging is increased after installation or in the future, then an additional charging system is recommended to be installed to satisfy the public demand.

3) PV System for Vaccine Refrigerator

Presently, in health service institutions in off-grid areas, dual power supply system type vaccination fridge is in use, that is PV system with battery and LPG. In most cases where PV system is used, once life of battery ends institutions change operating system from PV power supply to LPG, just because it is difficult to replace the batteries periodically due to the financial burden. However, for LPG only system also, periodical budget for purchasing LPG is indispensable.

Nowadays there is solar vaccine refrigerators approved by World Health Organization (WHO), which is directly driven PV system without any battery backups. A vaccine refrigerator driven directly by PV was installed at Olkinyei dispensary in Narok by MoH for monitoring. The type of PV driven vaccine refrigerator is MKS 044, and the manufacturer recommends to use this product in the temperate climate zone with the ambient temperature of 32°C and below. .

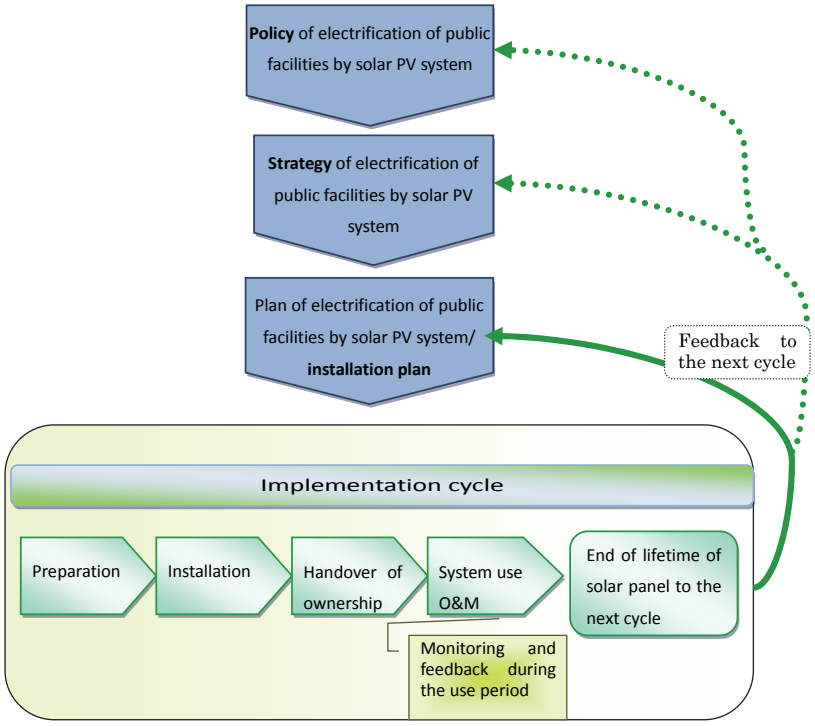
From the result of discussions with MoH, this project' purchased 2 (two) MKS 044 solar direct driven vaccine refrigerators and installed them at two different sites. One at Lot 1 Ilkilnyeti dispensary in Kajiado site, in July 2014 and the other at Lot 2 Latakweny dispensary in North Samburu site in April 2014. The maximum DC input current of the product is 15 A. Therefore in Lot 1, existing two 120 W PV modules of 6.68 A is used. In Lot 2, two 125 W PV modules of 7.0 A were installed to supply the power for the solar direct driven vaccine refrigerator.

Comparing these two installations, the one that was installed in Latakweny dispensary took more time to cool and settle inside temperature. Depending on the area and seasons, the ambient temperature might go higher or near 32°C. Therefore, in those areas where ambient temperature goes nearby 32°C, it is recommended to use the product which can be used in hot climate zones (over 32°C ambient temperature) and the product shall be an approved one by WHO.

(4) Assistance for Users Benefits

The most important tool as assistance for maximizing users' benefit is to understand the project cycle and, then, to apply monitoring and feedback procedure. By applying monitoring and feedback, system owners and management bodies (MCs) can extract the maxim effect from the abovementioned Model consisting of O&M, financial and technical parts (refer to Figure 2.6.13).

Project is the most concrete and final stage of the governmental implementation for development. Generally the proponent implements a project in accordance with the plan and/or program, and a plan is made based on the strategy of the sector or region. The highest level is government policy that defines the nationwide direction of the sector. Electrification of public facilities (program, project) will be implemented under this structure.



Prepared by JET

Figure 2.6.13 Project Cycle of Electrification of Public Facilities by the Solar PV System

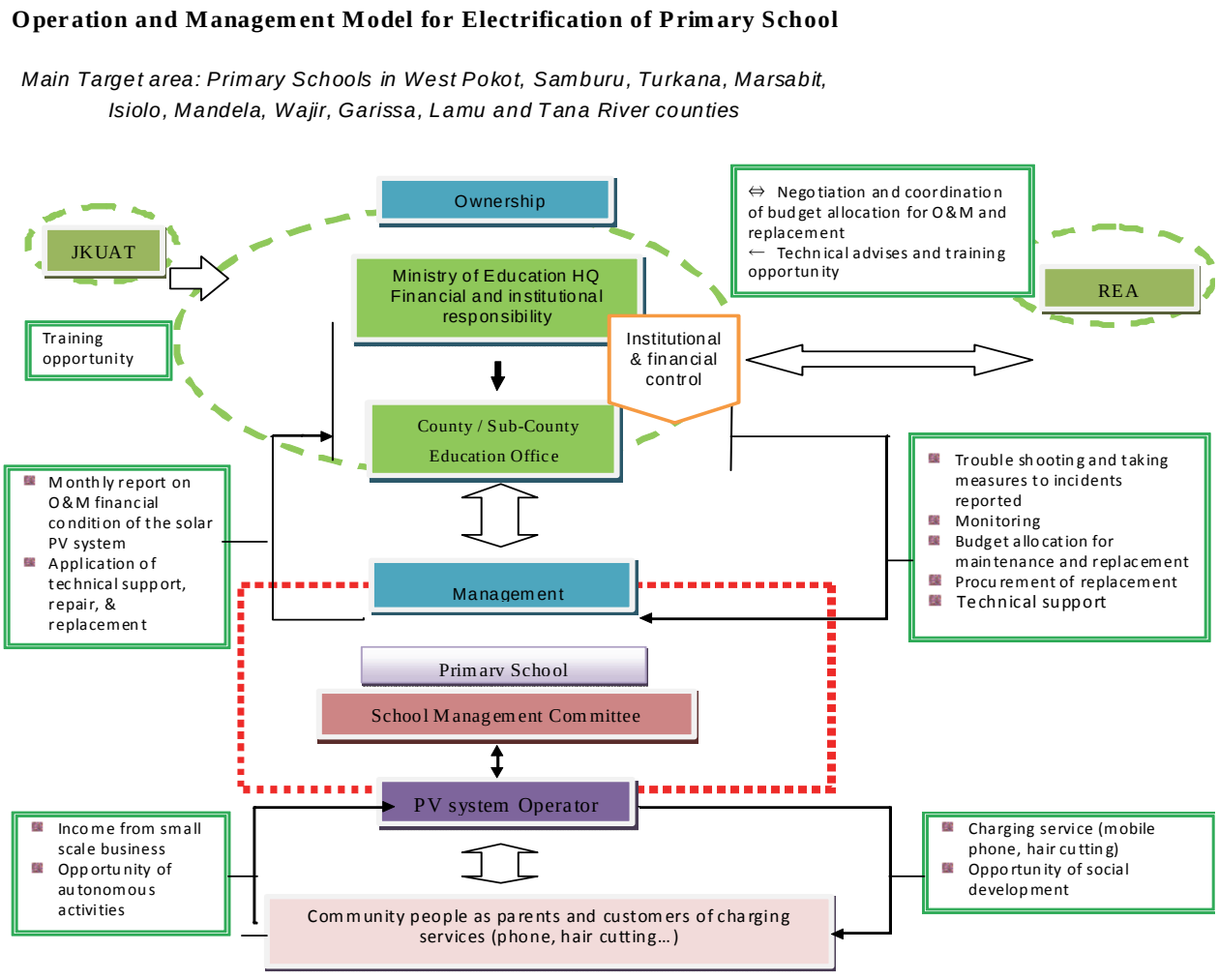
A project has cycles during its lifetime. It does not finish when the project proponent (project owner) constructs or installs facilities or equipment but the project owner and system owner shall continue

periodical monitoring of the system and management and give feedback of the monitoring result to the management organization. Additionally, overall result of evaluation and lessons from the implementation shall be utilized in policies, strategies and planning of next generation. From this assistance, each public facility can use the solar PV system as long as its lifetime in technical, managerial and financial meanings. REA and MoH county offices need to enhance their knowledge and awareness of monitoring and feedback (project cycle), establish the implementing structure and budget for monitoring the project sites.

2.6.5 Rural Electrification Model for Schools

(1) O&M Model

The purpose of the O&M model is to ensure that primary schools can utilize electricity generated by solar PV system in terms of physical and O&M matters during the lifetime of solar panels (20-25 years). It covers all the solar PV systems that REA installed and will install in schools. The target areas are mainly ten counties where social and economic investment has not been active due to their remoteness and insecurity.



Source: Prepared by JET

Figure 2.6.14 O&M Model for Primary School

1) Role of Institutions (REA, MoE&P, MoEST, County Government)

<REA and MoE&P>

- REA and MoE&P are the responsible government organizations for installation of solar PV system in the primary schools in non-electrified areas. MoEST county office is the owner of the solar PV systems as one of the assets of their schools. MoEST HQ does overall control, and county MoEST officers together with sub-county MoEST officers do supervision of O&M and are responsible for equipment replacement and monitoring/feedback.
- MoE&P formulates policy and REA implements projects of solar PV system at non-electrified schools and then hands over the system to MoEST. For effective and efficient O&M, they need to carry out simple social and economic condition survey.
- Electrification of public facilities in rural areas is regarded as social development and MoE&P and REA should consider this aspect at planning and implementation. As MoE&P and REA have no officers in the field of social and economic fields, both organizations need to employ at least one officer who has competent experiences in social and economic development as well as participatory development.
- REA installs an additional solar PV system and constructs the charging hut at each facility in order that each facility starts charging service (mobile phone, hair shaving, lantern, small radio etc.) to earn some money for daily operation.

<MoEST>

- MoEST HQ officers make plans for giving training, advices and supports to the school management committees on the financial and managerial issues. School staff members and school management committee members are in charge of conducting O&M and charging service and reporting with the support of the county and sub-county MoEST offices. The County Education Director does overall supervision and MoEST HQ prepares its proper budget for the O&M and especially replacement cost through budget making and request to the Government. The MoEST HQ takes care of schools through county education offices. The sub-county education officers do monitoring and check monthly reports submitted from schools and give advices.
- The MoEST HQ officers do not have sufficient knowledge and experiences in solar PV system and have little opportunity to do investigation of schools equipped with solar PV system. It is condition of successful management that MoEST HQ prepare opportunity of getting training at JKUAT (refer to Chapter 3.4) and provide its proper budget for investigation of schools in entire non-electrified area. This is the condition for achieving this model.

In addition, the number of officers who have experience in solar PV system is not sufficient in county offices. These technical officers get their training at Kenyan Institutions e.g. JKUAT, and give training to county and sub-county education officers. The sub-county officers do regular monitoring of the solar PV system on site and technical trouble shooting. HQ should assign more competent officers in county offices and give them proper training in order to run the school management efficiently.

- County and sub-county officers regularly monitor the performance of school MC in solar PV O&M by checking monthly report submitted from schools.

2) Charging Service

- Charging service contributes to obtain revenue to the school MCs to be used for their immediate needs such as transportation, distilled water, and operator's salary[19]. It assures sustainable use of the solar PV system and self-reliant activity of the MCs.

[19] MC must pay operator's salary from sales of charging service if MC cannot use the school budget for it.

- Possible charging services are mobile phone charging, hair shaving, lantern charging and other services within the limit of the power capacity.
- The amount of sales of mobile phone sales can be estimated simply by the following formula:

$$n \times \alpha \times p \times f \times K = \text{Weekly sales}$$

Where, n: the number of households in the service area,
α: the customer percentage,
p: the number of mobile phones per household,
f: the number of phone charging per week, and
K: the unit price of phone charging.

α is an important coefficient that is defined by the existence of phone network, number of competitors (private service providers who sometimes have familial, social and business connection with customers) and distance from the facility. In the case of Iltumtum Primary school, n= 27, α=0.9, p=1.6, f=2 and K=20, which results in weekly sales is KSh. 1,555. Adding to it, Iltumtum also gains revenue from hair shaving, the weekly sales becomes around KSh. 2,000.

- Charging service performance is analyzed using five force analysis framework and results of the pilot project (refer to 2.6.2 and Attachment-G-4-1).

(2) Financial Model

The financial model for schools is prepared in order to provide materials for prior and budget allocation among stakeholders, as same as the model for health service institution. In principle, the model was prepared based on the same concept of the model for health service institution.

Deferent points between two models are explained below.

1) PV System Scale [REA]

The procedure of estimation of the PV system scale and the power package (PP0, PP1, PP2 and Charging Model) is same as the model for health service institution. Rooms required in primary school are different from the same in dispensary, and unit power demand of rooms of primary school is specified as shown in the table below.

Table 2.6.18 Estimated Unit Power Demand of Primary School

No.	Room Type	Unit Power Demand (Wh/day)
S1	Class room (each room 40W x 4 hr.)	160
S2	Teacher room (Light: 160 Wh/day + Power socket 300 Wh/day)	450
S3	Dining hall (Light 100W x 4 hr. + TV 100W x 4hr)	800
S4	Dormitory (Light 80W x 4 hr.)	320
S5	Store quarter (max. 2 rooms) + TV	600
S6	Store	50
S7	Security for each building (10 W x 11 hr.)	440

Prepared by JET

2) Initial Cost [REA]

The initial cost of PV system is estimated as same manner as the model for dispensary except commission charge rate. In case of dispensary, the rate is applying as 30%, but rate of 10% applies for primary school. In general, facility scale of school is larger than the same of dispensary, therefore, rate of indirect cost become reduced.

The unit price of major equipment in each power package is same as the model for dispensary.

3) Regular Operation Expenses [Primary School]

As same as the model for dispensary

4) Replacement of Major Equipment [MoEST/REA]

As same as the model for dispensary

5) Existing Budget for Regular O&M [MoEST/REA]

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

6) Income from Charging Service [School]

As same as the model for dispensary

The sample calculation of primary school is attached at Attachment H-5.

(3) Technical Model

Technical model for the public schools is prepared considering the power demand and consumption pattern of facilities of that institution. Hence, to adopt different types of demand of facilities adequately the PV system is basically designed in three different categories as described below. Furthermore, the total system design factor for model is taken at 60%. However, in Lot 1 and Lot 2 installed PV systems, the total system design factor is taken at 52%. This is because in existing practice, the details of correction factor were not so clear. Therefore, to be more conservative and to make sure that the installed system serves the purpose for a long period, the taken values of correction factors were on the higher side. After the installation of the system, by the observation of system operation and several technical discussions with the counterparts, the value of each correction factor were verified and decided, hence the total correction factor for the system is decided to be 60%.

The calculation method and the formula for determining PV system capacity is the same as explained in section 2.3 Detailed Planning of the Pilot Project.

1) PV System for Lighting

The basic terms of lighting system for schools are the same as described in section 2.6.4, for PV electrification of health service institutions. To determine the capacity for lighting the points mentioned below are considered.

a) In general, a school consists of some buildings and there are some distances between the buildings.
b) The characteristics of load pattern are different in each building.
c) The existing roof structure might not be strong enough to hold large capacity of PV array over the same roof. In addition, it is necessary to consider appropriate location for installation of PV array on rooftop to avoid shadows throughout the year.
d) Complicated house wirings for connecting all buildings need to be avoided.
e) By installing a system for each building, blackout for all buildings caused by system failure can be avoided.
f) Installing a small PV system at each building is appropriate for school facilities to optimize the replacement cost of the equipment, especially storage battery.

Considering the load pattern and demand of each facility such as class rooms, teacher’s room, dormitory, staff quarter, office room, dining hall, and so on, the model for lighting is divided into different Power Packages (PP) as shown in Table 2.6.16 of Section 2.6.4.

It is possible to combine PPs, if the demand is rather higher than the summarized demand range in Table 2.6.16. In addition, it is recommended to conduct demand side management by each facility as a daily practice.

2) PV System for Charging Services

In the case of PV system for charging services, it is the same as the one described in Section 2.6.4.

3) PV System for Laptop

To determine the PV capacity, utilization pattern and unit power consumption are essential points that need to be understood correctly. On the basis of the information provided by MoEST, for Laptop system, the PV system for power supply is designed. Table 2.6.19 summarizes the estimated power demand for Laptop model.

Table 2.6.19 Assumed Utilization Pattern of Laptop Model

Items	Quantity	Watt (AC)	Use (hr./day)	Peak Demand (kW)	Total Demand (kWh/day)
Laptop	50	25	3	1.25	3.75
Computer for teacher (Administration)	1	50	3	0.05	0.15
Projector	1	230	1	0.23	0.23
Laser printer	1	600	1	0.60	0.60
Total		905		2.13	4.73

Prepared by JET, based on information provided by MoEST.

The table above shows the peak demand of 2.13 kW and total demand of 4.73 kWh/day. Based on the estimated power demand, the values for system design to determine PV capacity are as summarized in Table 2.6.20.

Table 2.6.20 Size of PV Array for Laptop Model

Load demand (kWh/day)	4.73
County minimum average solar irradiation (kWh/day)	5.1
Total system design factor	0.6
Calculated minimum required PV array capacity (kW)	1.545
Chosen PV module capacity (W)	120
DC system voltage (V)	48
Adjusted PV array capacity (kW)	1.92
Days of autonomy (days)	1.5
Total battery capacity (Ah)	200
Charge controller (CC) capacity (A)	40
Inverter capacity (kW)	3.0

Prepared by JET

From the above table, even though there are differences in actual practice of use pattern, the adjusted PV array can still supply power smoothly in the long run without any problem.

The above table shows the required PV array capacity is 1,545 W, but to establish the system the PV modules need to adopt certain series and parallel connection. In actual practice, the capacity of PV array depends on the calculated required minimum size of PV array due to the series and parallel connection of PV arrays to adopt the pertinent DC system voltage and market availability of the product. Therefore, with this adopted series and parallel connection of PV module the adjusted PV capacity becomes 1,920 W. Hence, the system can supply power up to the demand of 5.8 kWh/day with this capacity.

To determine the storage battery capacity, characteristics of power consumption pattern by laptop users are considered. That is;

1) The laptops are used in the classroom only in day hours of week days. Therefore, longer days of autonomy are not required.
2) The functions of battery are mainly to stabilize voltage and to supply power when PV array may not meet the demand of that particular time.
3) The battery stays idle in weekends and on long vacations.
4) The replacement cost needs to be minimized as much as possible.

To decide the inverter size, the peak demand needs to be considered as reference data. There also is a need to confirm the occurrences of supplying peak demand while system operation. A small battery is included in a laptop. Thus, it is a very rare case that all laptops will be consuming power at exactly the same time at the same rate. Additionally, there is no such big inductance load in the system. Hence the minimum size of 2 kW inverter can also be used in the system if demand side management is conducted well.

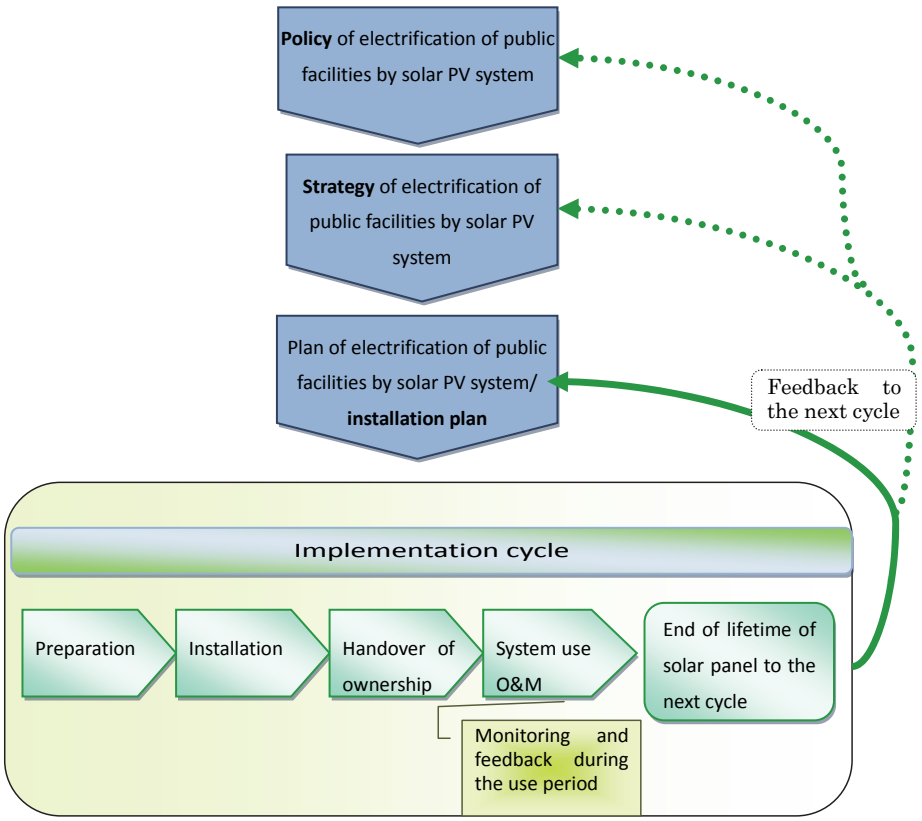
The details on the determination of PV capacity, battery capacity, voltage drop across the cable, cable sizes and applied correction factors for models are summarized in Guideline for Solar PV System in Schools.

(4) Assistance for Users Benefits

The most important tool as assistance for maximizing users' benefit is to understand the project cycle and then, to apply monitoring and feedback procedure. By applying monitoring and feedback, system owners and management bodies (MCs) can extract the maxim effect from the abovementioned Model consisting of O&M, financial and technical parts.

Project is the most concrete and final stage of the governmental implementation for development. Generally the proponent implements a project in accordance with the plan and/or program, and a plan is made based on the strategy of the sector or region. The highest level is government policy that defines the nationwide direction of the sector. Electrification of public facilities (program, project) will be implemented under this structure.

A project has cycles during its lifetime. It does not finish when the project proponent (project owner) constructs or installs facilities or equipment but the project owner and system owner shall continue periodical monitoring of the system and management and give feedback of the monitoring result to the management organization. Additionally, overall result of evaluation and lessons from the implementation shall be utilized in policies, strategies and planning of next generation. From these assistance, each public facility can use the solar PV system as long as its lifetime in technical, managerial and financial meanings. REA and MoH county offices need to enhance their knowledge and awareness of monitoring and feedback (project cycle), establish the implementing structure and budget for monitoring the project sites.



Prepared by JET

Figure 2.6.15 Project Cycle of Electrification of Public Facilities by the Solar PV System

2.6.6 A Quantitative Analysis on Applicability of the Charging Service

There are two different types of application for the Models. One is application for new installation of solar PV system with a battery charging facility the other is installation of only battery charging facility beside the solar PV system.

1) Install a solar PV system for public facility and a battery charging facility.

2) Install a battery charging facility beside the solar PV electrified public facility

For the estimation of the number of the model applicable public facility, number of non-electrified public facility and that of solar PV electrified facilities have to be clarified based on obtained data and information. In the same time, applicability of charging service is estimated. On the basis of the both data and estimation, number of the model applicable facility is estimated.

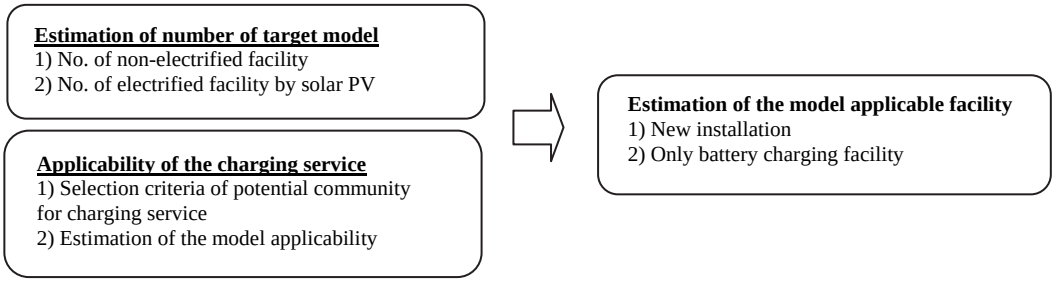


Figure 2.6.16 Workflow of the quantitative analysis

(1) Non-electrified facility

REA summarizes the number of non-electrified public facilities and publishes every fiscal year. JET has compiled the data by each county. However the data of dispensary could not obtained from both of REA and MoH. Therefore, the number of non-electrified dispensary was estimated based on the number of health center. Following table shows number of health facility in Kenya. There are 2954 dispensaries and 682 health centers. The ratio between dispensary and health center becomes 4.33. The number of non-electrified dispensaries was estimated simply multiplying number of non-electrified health center and the ratio.

Table 2.6.21 Distribution of Health Facilities, by ownership and level of care

Key Health Infrastructure	Priority care facilities					County hospitals	National hospitals	Total
	Dispensaries	Health Centers	Medical Clinics	Maternity homes	Nursing homes			
Government	2954	682	35	1	0	268	16	3956
Faith Based	561	166	61	3	11	79		881
NGO's	200	24	73	4	5			306
Private	196	60	2098	32	150	116		2652
Total	3911	932	2267	40	166	463	16	7795

Source: HEALTH SECTOR STRATEGIC AND INVESTMENT PLAN (KHSSP) JULY 2013-JUNE 2017, THE SECOND MEDIUM TERM PLAN FOR HEALTH, p46, MoH

Dispensary / Health Centre = 2954 / 682 = 4.33

The number of non-electrified facility was obtained from REA. The data primary school applied which of FY 2013 because classified data into each county was available. For secondary school and health canter, latest data of FY 2014 was applied. Based on the number of health centre, the number of dispensary was estimated. Number of non-electrified facilities in each County was summarized in Table 2.6.22.

Table 2.6.22 Number of non-electrified public facility

No.	County	Non-electrified Facility			
		Primary Schools (July 2013)	Sec. School / Polytechnics (Sep 2014)	Health Center (Sep 2014)	Dispensary (Estimation)
1	BARINGO	266	44	89	385
2	BOMET	269			
3	BUNGOMA	471	88	45	194
4	BUSIA	144	29	28	121
5	ELGEYO_MARAKWET	259	22	40	173
6	EMBU	170	29	23	99
7	GARISSA	79	13	26	112
8	HOMABAY	493	107	80	346
9	ISIOLO	33			
10	KAJIADO	256	25	38	164
11	KAKAMEGA	237	50	25	108
12	KERICHO	245			
13	KIAMBU	201	59	30	129
14	KILIFI	367	69	56	242
15	KIRINYAGA	184	18	12	51
16	KISII	127			
17	KISUMU	210	29	34	147
18	KITUI	839	63	49	212
19	KWALE	248	25	34	147
20	LAIKIPIA	256			
21	LAMU	50	13	27	116
22	MACHAKOS	553	46	38	164
23	MAKUENI	548	186	173	749
24	MANDERA	98	16	15	64
25	MARSABIT	111			
26	MERU	474			
27	MIGORI	255	13		
28	MOMBASA				
29	MURANGA	181	21	9	38
30	NAIROBI		8	3	12
31	NAKURU	328			
32	NANDI		127	196	848
33	NAROK	372			
34	NYAMIRA	282			
35	NYANDARUA	480	55	26	112
36	NYERI	58	14	6	25
37	SAMBURU	120	14	45	194
38	SIAYA	255	23	25	108
39	TAITA_TAVETA	67	6	1	4
40	TANA_RIVER	129	6	21	90
41	THARAKA	209			
42	TRANS_NZOIA	158	19	8	34
43	TURKANA	251	42	132	571
44	UASIN_GISHU	238			
45	VIHIGA	154			
46	WAJIR	66	21	79	342
47	WEST_POKOT	272	48	74	320
	(N/A)	1			
TOTAL		***11,064***	***1,348***	***1,487***	***6,421***

Prepared by JET

(2) Solar PV electrified facility

The data of electrified public facility was obtained from REA and MoE&P. The number of facility under the laptop program indicates the solar PV system which already installed and determined in the plan. The number of public facility under MoE&P project between 2005/2006 to 2012/2013 was

classified into county. Detailed information of Spanish project could not obtain but in total 667 solar PV systems are installed at public facilities by the Spanish project.

Table 2.6.23 Number of solar PV electrified public facility

No.	County	Electrified by Solar PV				
		REA	MoE&P (2005/2006 - 2012/2013)			
		Solar PV under Laptop Program (19 Jan 2015)	Primary Schools	Secondary Schools	Dispensary	Health Center
1	BARINGO	167	26	8	22	2
2	BOMET					
3	BUNGOMA					
4	BUSIA					
5	ELGEYO_MARAKWET	17		9	3	
6	EMBU	5		5	5	
7	GARISSA	121	17	12	25	3
8	HOMABAY		1		5	
9	ISIOLO	24	6	6	11	
10	KAJIADO	180	3	1	5	1
11	KAKAMEGA					
12	KERICHO					
13	KIAMBU					
14	KILIFI	28	2	3	4	
15	KIRINYAGA					
16	KISII					
17	KISUMU					
18	KITUI	347	3	25	28	4
19	KWALE	41	1	5	9	
20	LAIKIPIA	54	4	9	18	2
21	LAMU	55		3	10	1
22	MACHAKOS	36	1	3	6	
23	MAKUENI	53		30	8	4
24	MANDERA	132	5	10	8	1
25	MARSABIT	79	12	15	24	6
26	MERU		2	1	3	2
27	MIGORI					
28	MOMBASA					
29	MURANGA					
30	NAIROBI					
31	NAKURU	6				
32	NANDI	1		1		
33	NAROK	197	9	9	16	4
34	NYAMIRA					
35	NYANDARUA					
36	NYERI					
37	SAMBURU	107	24	4	17	1
38	SIAYA			1		1
39	TAITA_TAVETA	6		4	1	
40	TANA_RIVER	102	1	6	13	1
41	THARAKA	42	2	6	4	
42	TRANS_NZOIA					
43	TURKANA	264	53	15	30	4
44	UASIN_GISHU					
45	VIHIGA					
46	WAJIR	143	4	8	20	1
47	WEST_POKOT	167	33	12	8	6
	(N/A)					
	TOTAL	***2,374***	***209***	***211***	***303***	***44***

Prepared by JET

(3) Applicability of the charging service

As mentioned in 2.6.2 of this report, JET set the condition of the appropriate site for charging service, that is the expected income exceeds the initial investment[20], and identified several criteria for appropriate public facilities for the charging service.

At first the JICA expert set the time period five years at maximum: JET cannot predict the medium-term and long term prediction of electrification because REA does not have the rural electrification master plan by renewable energy. Then, in order to find the quantitative solution for selecting public facilities which meet the condition. It can be considered three factors among Michael Porter's Five Forces analytical framework, which affect the charging service business: substitute products, bargaining power of customers and intensity of competitive rivalry. Barrier to new entrants relates to the bargaining power of customers because it mainly depends on the existence of mobile phone network.

Using the geographical condition and result of the monitoring of Lot 2 site, the possibility of monthly income over KSh. 1,100 is roughly estimated 7% of target facilities. The result of the pilot project in Lot 2 sites shows, potential of substitute products is 2/3, which is estimated from the fact that four of six sites have potential substitute; that is, introduction of M-Kopa. The potential of bargaining power of customers is 1/3 because four of six sites have more than 50 households and half of six sites have core area. Also, the intensity of competitive rivalry is 2/6, explained by the existence of mobile phone network, two of six sites has or will have it. The possibility of occurrence is calculated by multiply each occurrence rate. Thus, the total is 2/27 ($2/3 \times 4/6 \times 3/6 \times 2/6 = 2/27 = 7\%$). This estimate can be updated if the each assumption is ameliorated.

Table 2.6.24 Tentative Analysis of Potential of Charging Service

Porter' Five Force Factors	Actual situation	Potential of sound business (learning from Pilot Project)
Threats of substitute produces or service	● M-Kopa ● Financial support from the government and NGOs to the community[21]	2/3 (i.e. other than South Horr, Angata Nanyokei)
Bargaining power of customers	● More than 50 HHs within 5km radius ● Having core area just adjacent to the facility	Household 4/6 (i.e. other than Illaut, Latakweny) Core 3/6 (i.e. Illaut, Latakweny, Angata Nanyokei) 4/6 ×3/6 = 1/3
Intensity of competitive rivalry	● Where mobile phone network starts prior to the electrification, lots of private service providers. ● If electrification starts a few years prior to the network, little competitors.	Mobile phone reaching 2/6 (i.e. South Horr, Marti)

Prepared by JET

(4) Estimate Number of the Model Applicable Public Facility

Applicability of the charging service is estimated as 7%. Therefore, number of public facility which applicable for the model both of electrification of existing building and the charging service facility becomes 449 for dispensaries and 104 for health centres as shown in following table. All primary schools will be electrified under the laptop program so that there is no new installation for primary

[20] Monthly income is Ksh 1,120 above.

[21] Government paid compensation to the land owners of Olemoncho, Narok County, whose land the Government use for animal protection. Land owners bought solar PV system by this fund and charge phones of their own, relatives and friends.

schools in the table. In addition, all secondary schools will be also electrified under REA and MoE&P projects. Therefore, number of public facility applicable for the model becomes 553 in total.

Table 2.6.25 Estimated Number of the Model Applicable Facility

(Facility electrification and battery charging hut installation)

Facility	No. of non-electrified facility	Applicable number of facility
Dispensary	6,421	449
Health Center	1,487	104
Total	7,908	**553**

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The table below shows the number of the public facilities which is already and under the installation of solar PV. This model is to install battery charging hut separately from existing building where solar PV system is already installed. Therefore, number of public facility which is applicable for the model both for charging service facility becomes 180 for primary schools, 14 for secondary schools, 21 for dispensary and 3 for health centers as shown in following table. In addition, 280 public facilities was electrified by the Spanish project therefore, number of public facility applicable is around 19. In total, the number of public facility applicable for the charging service model becomes 237 in total.

Table 2.6.26 Estimated Number of the Model Applicable Facility

(Battery charging hut installation only)

Facility	No. of solar PV electrified facility	Applicable number of facility
Primary School	2,583	180
Secondary School	211	14
Dispensary	303	21
Health Center	44	3
Spanish Project	280	19
Total	3,421	**237**

Prepared by JET

2.6.7 Guideline and Manual for Solar PV Systems

(1) Guideline for Solar PV System in Public Institutions

On the basis of the lessons learnt from the installation of Lot 1 and Lot 2 solar PV systems, and also of the inspection of existing PV systems, necessities for appropriate design procedure of solar PV system were found. Therefore, in the “Guideline for Solar PV System for Public Institutions (Health Institutions and Schools)”, details of system designing are described. The guidelines were prepared based on frequent technical discussions with C/P. The main subjects included in the Guideline of Solar PV system are written in below.

“CHAPTER 1 INTRODUCTION” summarizes objectives and contents of each Chapter.

“CHAPTER 2 SOLAR PV SYSTEM” is designed as a technical resource for people interested in learning how to design stand - alone PV systems. The main objective of this chapter is to impart the ability to successfully deal with the many aspects of PV system design. It is also designed to integrate a range of skills required to specify the appropriate electrical components for the system, and select them from a wide variety of products and manufacturers.

The purpose of the “CHAPTER 3 O&M AND MANAGEMENT” is that REA, MoH and MoEST enhance their knowledge on the appropriate and effective action of sustainable PV system, strengthen their attitude towards action and give detail elements of practice. This section of the guideline can be used to ensure that all stakeholders make up an effective management system, in terms of physical and

O&M matters, for electrification of dispensaries and primary schools in the non-electrified areas using solar PV systems. It also can be used to ensure that the facility users can enjoy the power generated by installed PV systems for as long as the lifetime of solar panels (20 years). The section covers all solar PV systems that REA installed and will install.

The purpose of the "CHAPTER 4 FINANCIAL SYSTEM" is to facilitate all the executing agencies, facility owners, concerned ministries and stakeholders to prepare and provide the necessary funding for O&M and replacement of equipment for the solar PV systems for the long run. This chapter includes the introduction of the financial model to provide methodology to estimate the required public funding from the government budget as well as the commercial revenue of each facility.

"CHAPTER 5 ENVIRONMENTAL AND SOCIAL CONSIDERATIONS" describes the systems of environmental managements, reviews of relevant EIA reports and issuances of environmental licenses. Environmental and social impacts caused by solar PV projects on small scales are limited because solar PV is an inherently silent technology.

(2) Solar PV Operation Manual

The Solar PV manual is prepared for distribution to end users, to make them understand about the installed solar PV system. In addition, the manual can be referred whenever O&M is required. In the beginning, Solar PV manual was prepared and distributed at the time of Lot 1 system installation. For Lot 2 the manual is revised to adopt the installed solar PV systems and distributed to the users.

The manual contains basics of standalone PV system technology, installed systems at public facilities and information of charging system. The manual was developed with many illustrations for easier understanding by local system operators. The developed manual is attached at Annex 1 of Attachment F-1 and F-2.

For the operation of charging services, an operator needs to understand not only the technical part of the system but also the method of management and financial recording of the system. For this the management and financial parts are also developed and included in the same manual.

2.7 Technical Transfer of Solar PV

2.7.1 Technical Transfer Method and Output of O&M Section

Technical transfer in the baseline survey, stakeholder meeting, and monitoring was not effectively done because there are no staff members in REA who specialize in social science, especially in social development and project management. Also there are no members who have practical experience in these fields because REA rarely holds stakeholder meeting and monitoring on site and no monitoring after the handover of power generation system to the facility owners.

JICA experts implemented technical transfer to REA staff in the form of on-the-job-training (OJT). JET invited REA officers who were nominated as C/Ps of these fields to the on-site activities, such as stakeholder meetings and evaluation meetings. As a result, total of 5 people attended the 1st stakeholder meetings at Lot 1 sites and 6 people attended at Lot 2 sites together with JICA expert. Additionally, 4 people attended the evaluation meetings of Lot 1 sites and 2 people attended at Lot 2 sites (the number of people includes REA and MoE&P for the evaluation meeting). None of the attendees was an officer in charge of soft component issues, but JET considers that all participants got meaningful experiences in this field and hopes that they will apply them to their duties.

2.7.2 Technical Transfer Method and Output of Financial Section

Technical transfer of the financial section was initially intended for REA personnel will be able to predict O&M cost of PV system, especially replacement cost, and its cash flow during the life time of the PV system. REA nominated counterparts several times; however, they were basically busy for their own permanent roles, and there were not enough staffs/engineers to sit together with JET.

JET request REA to arrange some personnel to attend users training for the target facilities of the pilot project. Upon requisition by JET, REA finally selected the following staffs as the counterpart personnel and for the technical transfer:

(1) May 2013	Two Engineers of Renewable Energy Department
(2) February/ March 2014	Two Officers of Corporate Planning, and
	Two Officers of Communications Departments

The above were the first user trainings before the installation of PV systems. However, the results of technical transfer of financial aspects were not attained because of the inappropriate selection (mismatch of specialities) and unavailability.

2.7.3 Technical Transfer Method and Output of Technical Section

In the planning of Lot 1 pilot projects in 2013, counterparts from REA accompanied JET to the site surveys and JET conducted technical transfer on site selection, capacity assessment, explanation to the users, and so forth. Through preparation of a user manual, JET explained O&M requirements to the counterpart staff, at the time of supervision of Lot 1 installations in July 2013, JET showed REA counterparts the methodology of supervision by regularly checking each system, maintaining close supervision and advising the technicians.

For technical transfer of solar PV systems, a hand out on technical information of Photovoltaic (PV) and PV systems was prepared and shared with counterparts. On the basis of the prepared hand out, details of solar PV systems, characteristics of PV and its systems, method of system design and applied correction factors were explained to counterparts from REA in February 2014.

Based on the explained system design method and other details of the PV system's development, C/Ps visited a site to develop the system for planning the project on electrification of a slum area of Mombasa.

In October 2014, for monitoring and reconfirmation of operation of Lot 1 systems, a counterpart from REA accompanied JET and technical transfer on O&M was carried out. At the sites, counterparts practically found out the problems which can cause system failures by conducted demonstration. In addition, replacement of equipment/components, measurement of battery electrolyte density and refilling, and other technical issues were explained in hands-on training. The counterpart asked JET about technical issues to build their understanding of the system.

2.8 Additional Study on Grid Connection of Off-grid PV

(1) Objective for the Study on Grid Connection of Off-grid PV System

The Government of Kenya has set the target of 100% connectivity by the year 2020. Accordingly, many off-grid PV systems installed by MoE&P and REA are planned to be connected in the near feature, under the rural electrification program. The number of the PV systems is under investigation for grid connection. Some of the Pilot Project sites, where connection to the grid had not been done at the initial stage of the Project, are also planned to be connected to the national grid. The construction of grid is under construction from Narok to connect Iltumtum and Olemoncho, Lot 1 project sites.

There are about 1,000 PV systems that were installed by MoE&P and REA, of which approx. 40% is located in the counties that is not categorized as off-grid counties. Those facilities have the possibility of grid connection.

Following table summarizes the number of facilities that PV system was installed by MoE&P.

Table 2.8.1 Number of Facilities that PV Systems were installed by MoE&P

County	PV Installation by MoE&P			County	PV Installation by MoE&P		
	Facility nos.	Off-grid County	Grid County		Facility nos.	Off-grid County	Grid County
Baringo	58		x	Mandera	45	x	
Elgeiyo Marakwet	12		x	Marsabit	89	x	
Embu	12		x	Meru	18		x
Garissa	78	x		Nandi	1		x
Homabay	6		x	Narok	42		x
Isiolo	31	x		Samburu	49	x	
Kajiado	11		x	Siaya	3		x
Kilifi	11		x	Taita Taveta	5		x
Kitui	70		x	Tana River	29	x	
Kwale	17		x	Tharaka Nithi	12		x
Laikipia	42		x	Turkana	132	x	
Lamu	22	x		Wajir	37	x	
Machakos	12		x	West Pokot	65	x	
Makueni	42		x	**TOTAL**	**951**	**577**	**374**

Source: Facility number data is from MoE&P. On-grid and Off-grid County was categorized based on Rural Electrification Master Plan, 2009.

In addition to the table above, REA installed about 65 PV systems as indicated in Table 2.2.2.

Under this situation, it is necessary to evaluate the method of PV systems utilization after grid connection concerning the off-grid rural electrification model. The objective of the study of grid connection of off-grid PV system is as follows:

- To figure out the benefit of PV system after grid connection.
- To evaluate and find the optimum methods of off-grid PV utilization after grid connection from options of 1) reverse flow without battery, 2) reverse flow with battery, and 3) no-reverse flow.

The case study using the data of Iltumtum and Olemoncho, the sites of Lot 1, was conducted in this chapter based on assumptions.

Here, the case of shifting existing solar PV system to other off-grid institutions after grid connection is not considered.

(2) Policy for Grid Connection of Off-grid PV System

The regulatory framework for grid connection of small PV system with reverse flow has not been settled yet. There are two perspectives for grid connection 1) Feed-in-tariff (FIT) and 2) Net-metering.

1) FIT

For FIT, MoE&P specifies FIT values for small renewable energy projects more than 500 kW (for biogas, more than 200 kW) and less than 10 MW, as shown in the table below.

Table 2.8.2 FIT Values for Small Renewable Energy Projects (<10 MW)

Type	Installed capacity (min-max, MW)	Standard FIT US$/kWh
Wind	0.5-10	0.11
Hydro	0.5	0.105
	10	0.0825
Biomass	0.5-10	0.1
Biogas	0.2-10	0.1
Solar (Grid)	0.5-10	0.12
Solar (Off-grid)	0.5-1	0.2

*For values between 0.5-10MW, interpolation is applied to determine tariff.

Source: FEED-IN-TARIFFS POLICY ON WIND, BIOMASS, SMALL- GEOTHERMAL, BIOGAS AND SOLAR RESOURCE GENERATED ELECTRICITY, 1st Revision: January 2010

Standard FIT value for off-grid PV was US$0.20/kWh (17.3 KSh/kWh, as of July 2014). Meanwhile, the average tariff rate of public facility is at the level of 18-22 KSh/kWh. Accordingly, this FIT value results in negative net worth for electric energy sales.

Furthermore, the minimum installed capacity applicable for FIT is 500 kW, which is much larger than those installed in off-grid PV system for most of public institutions. The general capacity of off-grid PV systems for public institutions is at 1-10 kW level. Inherently, FIT is the system for private independent power producer for megawatt scale electricity generation with power purchase agreement, not for small and dispersed power producers in rural area. Accordingly, FIT is not considered to be applicable for this case in Kenya at present.

2) Net-metering

Net-metering is defined as an independent generation system that operates in parallel with the grid and measures the amount of electrical energy that is supplied/fed from/to the grid by means of one or more meters. Net-metering is considered to be an incentive for consumers of electrical energy who supply renewable energy generated by them to the grid. Currently, Net-metering has not yet been practiced in Kenya. National Energy Policy drafted in June 2014 stipulates the policy to formulate a framework for connection of electricity generated from solar energy to national and isolated grids through direct sale or net metering.

In sum, there is no legal framework to carry out grid-connection of off-grid PV system less than 500 kW. However, there is a possibility that net-metering is applied in the near feature in Kenya, as shown in the Energy Policy.

Accordingly, application of net-metering was assumed in this evaluation for the grid connection method analysis.

(3) Options for Grid-connection of PV Systems

There are three optional types for grid connection; 1)-a) reverse flow without battery, 1)-b) reverse flow with battery back-up, and 1) changeover with inverter charger.

1) Grid connected PV system with reverse flow

The user will pay the tariff for the amount of electric energy supplied from the grid deducted by the generated energy in solar system. When a user does not use electricity in a daytime when PV energy is generated, the generated energy is fed to the grid. In the net metering system, the user will pay electric tariff for the amount of balance of inflow and outflow.

PV panels installed as the off-grid system will be assembled in at the location of grid connection with a connection box. It needs to place PV modules at one place to avoid voltage

drop in a long line. The voltage of PV module needs to meet the requirement of specification of a power conditioner (PCS).

Power conditioner (PCS) is the equipment including inverter and protection relays such as OVR[22], UVR[23], OFR[24], and UFR[25]), which will be newly installed for grid connection. Reverse power protection relay is required at the time of independent operation to avoid reverse flow (depending on PCS).

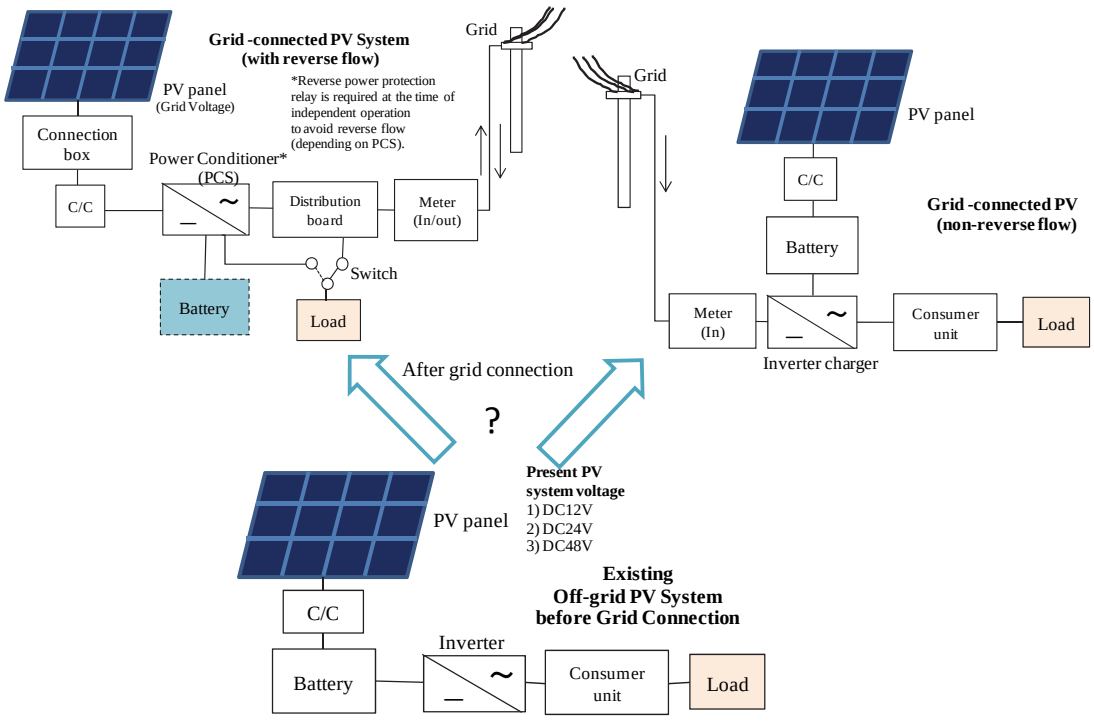
This case was divided into two cases; without battery and with battery back-up.

a) No battery: no battery is installed. Power is not available at the time of power cut. If PV energy is generated in the daytime, the energy can be utilized during power cut as an independent operation.
b) With battery back-up: Battery is installed to supply power during power cut.

2) Grid-connected PV system with inverter charger

The system provides electric energy both from the grid and PV panel to the load of a user. It does not feed any energy from PV system to the grid. The electric energy is charged in a battery with an inverter charger for the energy use when solar energy is not available.

Simplified system figure is shown in the figure below.



Prepared by JET

Figure 2.8.1 Simplified System Structure of Grid Connection of Off-gird PV System

[22] OVR: Over voltage protection relay
[23] UVR: Under voltage protection relay
[24] OFR: Over frequency protection relay
[25] UFR: Under frequency protection relay

(4) Method for Cost and Benefit Analysis

The initial cost and operation cost for equipment and benefit for 1)-a) reverse flow without battery, 1)-b) reverse flow with battery back-up, and 2) changeover is summarized in the table below.

Table 2.8.3 Cost and Benefit Assumption of Grid Connection of PV System Analysis

Item	Reverse Flow		Changeover (non-reverse flow)
	No battery	With battery back-up	
Initial Cost	- Connection box - Power conditioner - Distribution board - Assembling and rewiring	- Connection box - Power conditioner - Distribution board - Battery - Assembling and rewiring	- Inverter charger - Rewiring
Operation Cost	- Equipment replacement	- Equipment replacement - Battery replacement	- Inverter charger and battery replacement
Benefit	- Sales of PV energy to KP grid (by net-metering)	- Sales of PV energy to KP grid (by-net metering) - Energy supply during power cut	- Electricity supply during power cut - Electricity saving by PV

Prepared by JET

The financial benefit from net-metering was determined with tariff rate and generated energy amount by PV system. The benefit of battery was determined with the amount of energy supply from PV system during power cut hours.

There were still uncertainties for conditions since there is no example for small scale PV grid connection. The evaluation was conducted based on assumptions and conditions as follows:

- Samples of two sites were selected from pilot projects for the case study.
- Base condition is existing PV system before grid connection.
- Initial cost of original off-grid PV system was NOT considered. Only the cost for equipment required for PV system utilization after grid connection was considered.
- Cost for grid extension to the facility such as cables, meter, and transformer was NOT considered, since grid connection was assumed to be conducted within general governmental plan regardless of PV system availability in the facility.
- The grid was assumed to be extended to a target facility with three-phase line.
- Original capacity of existing PV modules is assumed to be able to be fully utilized. (Actually, series and parallel arrangement is required so that DC voltage from PV array becomes within allowable range of power conditioner specification in reverse-flow system.)
- Voltage drop in facility wiring was neglected.

(5) Tariff Analysis

Power tariff rate is used to determine financial benefit of grid connection of off-grid PV system. The power tariff rate in Kenya is determined by several factors. There are categories for metered rate such as Domestic, Small Commercial, and Commercial Industries (divided in five types depending on voltage level). It is considered that public institutions with charging business facility in rural areas are generally categorized as Domestic or Small Commercial. The metered rate for Domestic and Small Commercial category is shown in the table below.

Table 2.8.4 Tariff Rate in Kenya

Category	Fixed Charge	Metered Rate		
		0-50 kWh	51-1500 kWh	>1500-15000 kWh
Domestic	120 KSh.	2.5 KSh./kWh	11.62 KSh./kWh	19.57 KSh./kWh
Small Commercial	150 KSh.	12 KSh/kWh		

Source: Energy Regulatory Commission

In addition, fixed charge, fuel cost charge, foreign exchange rate fluctuation adjustment, security support facility, taxes and levies (including rural electrification programme (REP) and Energy regulatory Commission (ERC)) will be added. These charges are determined by economic conditions such as fuel price and currency. Accordingly, accurate tariff rate cannot be predicted with current regulation of ERC. Thus, to determine tariff rate to be used in financial analysis, actual record of revenue and distributed energy by Kenya Power is applied here.

The tariff rate is determined from the data of total energy sold divided by the revenue in Domestic and Small Commercial category in the record of Kenya Power as of 2013.

Table 2.8.5 Average Power Tariff Rate of Kenya Power

Item	Unit	Domestic	Small Commercial	Domestic + Small Commercial	Kenya Total
Energy	GWh	1,670	998	2,668	6,144
Nos of Customer incl. REP	nos	2,000,790	240,359	2,241,149	2,330,942
Revenue	mil KSh	27,771	21,582	49,353	96,097
Average tariff	KSh/kWh	16.63	21.63	18.50	15.64
Average energy usage	kWh/nos/M	69.6	346.0	99.2	219.7

Source: Annual Report 2013, Kenya Power

From the above total average tariff of Domestic and Small Commercial, 18.50 KSh./kWh, was applied as the tariff rate in this financial analysis.

(6) Power Outage

Assumption of power outage hours is required to evaluate the benefits of battery in the grid-connected PV system, since the amount of energy supplied from PV panel and battery is considered to be the benefit.

There are several causes of power outage, such as arcing air break switch, MV jumper break, transformer faulty, transient line fault, earth fault, planned outage for construction or O&M of lines, etc. The power outage data of Central Rift Valley sub-region, where Iltumtum and Olemoncho of the case study areas are located, from July 2013 to January 2014 is used to obtain average power outage hours.

Table 2.8.6 Total and Average Power Outage of Narok Area

Month	Total outage duration (h)	Average outage h/day
Jul-13	4,669	2.59
Aug-13	3,536	1.96
Sep-13	3,749	2.08
Oct-13	5,574	3.10
Nov-13	2,879	1.60
Dec-13	2,963	1.65
Jan-14	3,432	1.91
Total/Ave.	26,802	2.13

Source: Kenya Power

From the above table, average power outage at 2.13 hours/day is applied for the analysis.

(7) Consumption and Energy Supply from PV Module

The consumption of energy supplied from PV module multiplied by tariff rate will be a benefit of PV system. The consumption of energy from PV module in the case study (Iltumtum and Olemoncho) is calculated as shown in the table below. The assumed energy consumption is used to design the PV system.

Table 2.8.7 Assumed Energy Consumption of the First Year

			School Days								Holidays							
	Building	PV	FL 20W	CFL 9W	Light hrs	LED 5-10W	LED hrs	Other W	Other hrs	Total Wh/day	FL 20W	CFL 9W	Light hrs	LED 5-10W	LED hrs	Other W	Other hrs	Total Wh/day
		(W)	(nos)	(nos)		(nos)					(nos)	(nos)		(nos)				
Iltumtum Primary School																		
1)	Classroom 1 to 3	480	18		4	1	12			1,500	18		0	1	12			60
2)	Classroom 4 to 8	480	18		4	3	12			1,620	18		0	3	12			180
3)	Quarter 1 to 4	480		4	4	4	12	60	3	564		4	4	4	12	60	6	744
4)	Quarter 5 to 10	480		6	4	4	12	80	3	696		6	4	4	12	80	6	936
5)	Hall	720	16		4	4	12	60	3	1,700	16		4	4	12	60	0	1,520
6)	Girls dormitory store	240	1	4	4	4	12			464	1	4	0	4	12			240
7)	Boys dormitory	240		8	4	3	12			468		8	0	3	12			180
8)	Charging	240	1		8	2	12	25	8	480	1		8	2	12			280
	TOTAL	**3,360**	**54**	**22**		**25**				**7,492**	**54**	**22**		**25**				**4,140**
Olemoncho Primary School																		
1)	Classroom 3 & 4	480	9		4	3	12			900	9		0	3	12			180
2)	Classroom 5 to 7	480	18		4	2	12			1,560	18		0	2	12			120
3)	Boys dormitory	480	12		4	3	12	60	3	1,320	12		0	3	12	60	6	540
4)	Staff room	480		6	4	3	12	100	3	696		6	4	3	12	100	6	996
5)	Girls dormitory	240		6	4	3	12	60	3	576		6	4	3	12	60	6	756
6)	Class1 & 2, Kindergarden	240	6		4	2	12			600	6		0	2	12			120
7)	Charging	240	1		8	2	12			280	1		8	2	12			280
	TOTAL	**2,640**	**46**	**12**		**18**				**5,932**	**46**	**12**		**18**				**2,992**

Prepared by JET

The amount of energy consumed in facilities is larger in school days and smaller in holidays since the living pattern is different. The annual consumption and possible energy sold to the grid needs to be calculated considering this aspect.

(8) Conditions and Parameters to determine Annual Energy and Benefit

The considerations for determination of parameters for benefit calculation are as follows:

- Energy consumption is assumed to be increased by 5.0% every year (GNP growth rate in Kenya) up to fifth year.
- Up to designed energy generation amount of PV system, the energy is assumed to be supplied from PV module. If consumption is less than the energy produced by PV system, the excess amount of energy is fed to the grid, and all the energy is assumed to be supplied from PV in net-metering system even if there is no battery.
- If the energy consumption exceeds solar energy generation amount, the excess energy is assumed to be supplied from the grid. Thus, the benefit is assumed to be the amount of energy generation of PV system.
- In the both cases of reverse-flow and non-reverse flow, it is assumed that the PV module is connected to make a string in one place with a connection box. PCS or inverter charger covering the installed capacity of existing PV system is selected.
- When PV modules are connected in one place, depending on the facility, roof may not be strong enough to hold large strings. Therefore, additional cost may needs to be added, which is site specific. This aspect is not considered in this estimation.

The amount of energy generated annually in respective site is calculated accordingly.

Table 2.8.8 Parameters to determine Annual Energy and Benefit

Item Description	Unit	Iltumtum	Olemoncho
Assumed energy consumption (School days)	kWh/day	7.49	5.93
Assumed energy consumption (Holidays)	kWh/day	4.14	2.99
Annual energy consumption increase (1-5year)	per year	5.0%	5.0%
Nos of holidays/year	days	96	96
Original output of PV module	kW	3.36	2.64
Output of PV for reverse flow system	kW	3.36	2.64
Solar irradiation	kWh/day	5.0	5.0
Average PV system efficiency		0.60	0.60
Daily energy production for reverse flow	kWh/day	10.08	7.92
Daily energy production, non-reverse flow	kWh/day	10.08	7.92
PV detrioration factor	per year	1%	1%

Prepared by JET

(9) Initial Cost and O&M Cost

Initial cost estimation is conducted for reverse-flow system (with battery and without battery) and non-reverse-flow system. Existing PV module is assumed to be utilized as it is in both reverse-flow and non-reverse flow system after grid connection.

The initial cost for reverse-flow system is estimated in the following table.

The equipment cost for power conditioner is from supplier's estimation. The cost for wiring and earthing, breakers, and miscellaneous items are referred from Lot 1 contract price with adjustment in proportion to the capacity of PV system.

The training, labour, and transportation cost is assumed to be the same as that of Lot 1 contract price, since those items are considered to be almost the same irrespective of the capacity.

Table 2.8.9 Initial Investment Cost for Grid Connection Reverse-Flow System

Item Description	Iltumtum (3.36 kW)			Olemoncho (2.64 kW)			Remarks
	Qty	Unit Price	Price	Qty	Unit Price	Price	
Connection box	1	39,200	39,200	1	30,800	30,800	8% of PV panel
Power conditioner (PCS, 4 kW)	1	392,500	392,500				from supplier's estimation
Power conditioner (PCS, 3 kW)				1	305,000	305,000	from supplier's estimation
Breaker and huses	1	68,300	68,300	1	58,300	58,300	Same as Lot-1 price
Wiring and earthing	1	94,785	94,785	1	76,965	76,965	15% of equipment
Miscellaneous	1	131,900	131,900	1	119,000	119,000	Same as Lot-1 price, propotional to capacity
Training	1	10,000	10,000	1	10,000	10,000	Same as Lot-1 price
Labor	1	50,000	50,000	1	50,000	50,000	Same as Lot-1 price
Transportation	1	60,000	60,000	1	60,000	60,000	Same as Lot-1 price
Administration	1	2,000	2,000	1	2,000	2,000	Same as Lot-1 price
TOTAL			848,685			712,065	

Prepared by JET

In case of reverse-flow system with battery, the benefit of battery is counted from the energy supply during power cut hours. The battery requirement of the system with inverter charger is the same as reverse-flow system with battery. The battery capacity is calculated as shown in the table below.

Table 2.8.10 Determination of Battery Requirement

Item Description	Unit	Iltumtum	Olemoncho
Average consumption	kWh/day	7.49	5.93
Days of autonomy	days	1	1
Inverter efficiency		85%	85%
System voltage	V	24	24
Load current	A	367.25	290.78
Max depth of discharge		0.8	0.8
Batteyr discharge correction factor (columbic eff)		0.9	0.9
Charge controller eff		0.95	0.95
Required battery size	Ah	537	425
Number of Battery (200 Ah)	nos	3	2

Prepared by JET

It is highly possible that the battery used in existing PV systems already deteriorated at the time of grid connection. Thus, battery and related wiring is assumed to be replaced in the cost estimation of reverse-flow system with battery and inverter charger system. The cost of battery is shown in the table below.

Table 2.8.11 Battery Cost for Grid Connection Reverse-Flow System

Item Description	Iltumtum (3.36 kW)			Olemoncho (2.64 kW)			Remarks
	Qty	Unit Price	Price	Qty	Unit Price	Price	
Deep cycle solar battery (24V, 200Ah)	3	28,500	85,500	2	28,500	57,000	Same as Lot-1 price
Charge contoller with DC/DC	1	51,000	51,000	1	34,000	34,000	
Wiring and works	1	8550	8,550	1	5700	5,700	10% of battery
TOTAL			145,050			96,700	

As for reverse-flow system with battery, the above cost is the minimum requirement. Here, battery voltage is assumed to be 24 V, the same as original voltage of off-grid PV system. In the actual design, the battery voltage needs to be adjusted with the rated DC voltage of power conditioner specification, which is dependent on manufacturer's design and not clear at this moment. Series battery arrangement or DC/DC converter and charge controller modification is necessary for the actual application, and cost needs to be increased accordingly.

Prepared by JET

The initial investment cost estimation for grid-tied non-reverse flow system is shown in the table below.

Table 2.8.12 Initial Investment Cost for Grid Connection Non-Reverse-Flow System

Item Description	Iltumtum (3.36 kW)			Olemoncho (2.64 kW)			Remarks
	Qty	Unit Price	Price	Qty	Unit Price	Price	
Inverter charger (24V, 4 kW)	1	295,000	295,000	0	295,000	0	Supplier's estimation
Inverter charger (24V, 3 kW)	0	221,250	0	1	221,250	221,250	
Connection box	1	39,200	39,200	1	30,800	30,800	8% of PV panel
Deep cycle solar battery (24V, 200Ah)	3	28,500	85,500	3	28,500	85,500	Same as Lot-1 price
Rewiring	1	20985	20,985	1	20985	20,985	5% of equipment
Training	1	10,000	10,000	1	10,000	10,000	Same as Lot-1 price
Labor	1	50,000	50,000	1	50,000	50,000	Same as Lot-1 price
Transportation	1	60,000	60,000	1	60,000	60,000	Same as Lot-1 price
Administration	1	2,000	2,000	1	2,000	2,000	Same as Lot-1 price
TOTAL			562,685			480,535	

*Original charge controller in off-grid system is assumed to be used for inverter charger system after grid connection.

Prepared by JET

The training, labour, and transportation cost is assumed to be the same as that of Lot 1 contract price, since those items are considered to be almost the same considering required time for system installation.

For the operation and maintenance cost, the replacement cost of equipment (PCs with/without battery, or inverter charger) is considered. The life of PCs, battery, and inverter charger is assumed to be 10 years, 5 years, and 7 years respectively. The cost for administration, labour, and transportation is considered with application of 5.2% of equipment cost, which is the same as the percentage in Lot 1 procurement.

The equipment system cost is annualized to apply to the cash flow in financial evaluation. The annual cost is summarized in the table below.

Table 2.8.13 Operation and Maintenance Cost

Item Description	Life	Unit	Price KSh.	
			Iltumtum	Olemoncho
Price and Life of PCS	10	years	392,500	305,000
Price and Life of battery	5	years	145,050	96,700
Price and Life of inverter charger	7	years	295,000	221,250
Administration, labor, and transportation percentage		5.2%		
Annualized cost for reverse flow without battery system		KSh./year	41,291	32,086
Annualized cost for reverse flow withbattery system		KSh./year	71,810	52,432
Annualized cost for non-reverse flow system		KSh./year	61,434	37,446

Prepared by JET

(10) Result of Financial Analysis

According to the above base, cost, and benefit, financial evaluation was conducted. Followings are common conditions of financial analysis:

Discount rate	10%
Project year	20 Years
Tax	0% (Exempted)

The discount rate is from the rate of Kenya Treasury Bonds with 20 years maturity (Issue no. FXD1/2011/20). The revenue is calculated with the tariff rate multiplied by the energy consumption from PV generated energy. In case of reverse-flow system without battery, power cut hour at 2.1 hours/day is assumed, which is counted as a loss of benefit. In case of reverse-flow system with battery, power outage is not considered. The example of cash flow for the case of reverse-flow without battery in Iltumtum is shown in the table below.

Table 2.8.14 Example of Cash Flow of Grid Connection Reverse-Flow (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**

Prepared by JET

Since the net present value becomes negative, FIRR cannot be calculated in the above table.

The cash flows for other cases, reverse-flow with battery and non-reverse-flow system in Iltumtum and all cases in Olemoncho are included in Attachment-18.

The summary of financial analysis result is shown in the table below.

Table 2.8.15 Summary of Financial Evaluation Result of Grid Connection

Item Description	Unit	Iltumtum			Olemoncho		
		Reverse flow, no battery (RNB)	Riverse flow, with battery (RWB)	Non reverse flow (NRF)	Reverse flow, no battery (RNB)	Riverse flow, with battery (RWB)	Non reverse flow (NRF)
Tariff rate (Net metering)	KSh./kWh	18.5					
Average Energy supplied from PV	kWh/year	2,551	2,799	2,799	1,975	2,167	2,167
Average Power Cut Hours	hrs/day	2.13					
Average Benefit from PV system	KSh./year	55,512	60,918	51,783	43,616	47,864	40,089
Investment Cost	KSh.	848,685	993,735	562,685	712,065	751,765	480,535
Annual O&M Cost	KSh./year	41,291	71,810	61,434	32,086	52,432	37,446
Net Present Value (cost, DR10%)	KSh.	1,123,065	1,514,750	1,034,557	920,498	1,129,803	755,646
Net Present Value (benefit, DR10%)	KSh.	488,402	535,970	437,831	383,745	421,119	339,201
Net Present Value (B/C)	-	0.43	0.35	0.42	0.42	0.37	0.45
Net Present Value (B/C) with -10% equipment cost	-	0.47	0.37	0.45	0.45	0.39	0.46

Prepared by JET

In all cases, net present value B/C is lower than 1.0. Although there are financial benefit for users, it requires financial input for the initial cost.

As for the selection of optimum system, in case of Iltumtum, B/C of reverse-flow with no battery (RNB) is slightly higher than Non-reverse flow system (NRF) with inverter charger. In case of Olemoncho, the result is opposite. Both differences are small and the B/C of RNB and NRF is nearly the same in two case studies. Meanwhile, B/C of reverse-flow with battery (RWB) is apparently lower than RNB and NRF. Which has more financial advantage, RNB or NRF? The answer depends on assumption of equipment cost and status of user demand. Since initial cost for RNB is higher than NRF, same initial cost reduction percentage puts larger impact on RNB. If equipment cost becomes lower or user saves their internal consumption and reverse-flow energy become larger, RNB will be more advantageous than NRF.

(11) Conclusion

The grid connection with reverse-flow will benefit users at the range of 10,000 to 20,000 KSh./year, when net metering is applicable in case of Iltumtum. The benefit by cost (B/C) of net present value (NPV) of all cases of (i) –a) reverse-flow with battery, (ii)-b) reverse-flow without batter, and (ii) non-reverse flow (with inverter charger) was studied. In the case studies, B/C's were less than 1.0. Thus, governmental or donor support is necessary to cover the initial cost for equipment.

As the result of financial analysis, when B/C is considered, the financial efficiency of reverse-system with no battery and no-reverse-flow system is almost the same. The advantage of reverse-flow system depends on user's demand and amount of possible reverse-flow and possible equipment cost reduction. Meanwhile, reverse-flow with battery system has low financial efficiency. If battery is installed, the benefit cannot cover the annual cost especially for batteries. Benefit of power supply during power cut is not worthwhile to cover battery initial and replacement cost.

Meanwhile, grid connection of reverse-flow would contribute to mitigate voltage drops in long distribution lines in rural areas in Kenya. Reverse-flow without batteries is likely to be the optimum system, however, it needs case study to select optimum system for actual site before implementation.

Although formulation of regulation for net-metering is stipulated in Energy Policy, there are many hurdles that Kenya Power implements grid connection of small off-grid PV systems at the level of 1-10 kW. The systems are dispersed in local areas and provision of continuous and proper maintenance support is challenging both physically and financially. Regulatory framework establishment for small scale grid connection in rural areas is necessary.

It is certain that energy from PV system after grid connection provides benefit to users. However, it is thought that the equipment cost for grid connection is still quite high in remote areas. Above result is a case study to install equipment for grid-connection one by one. Since there is no large market in Kenya for small scale grid-connection at the level of 3-10 kW, at present there is no scale merit and the cost becomes higher than that of other countries. The initial cost will be reduced if bulk procurement can be conducted and large number of system installed in one lot.

2.9 Preparation of the Pilot Projects for Business/Industrial Facilities

The pilot projects to establish the rural electrification model for business/industrial facilities using renewable energy (MHP, Biogas/Biomass and Wind) were planned in the original scope of works. However, cancellation of the pilot projects for business/industrial facilities was mutually agreed among JICA, REA and MoE&P in November 2012 due to the reasons described below, and the contract between JICA and JET was amended in March 2013.

The cancellation was because difficulty was found to engage with UNIDO in establishment of a practical business pilot model within the limited implementation period of the project. In addition, JICA has conducted a survey to review the existing UNIDO energy Kiosks. On the basis of the evaluation of the findings and discussions between JICA and REA, project component for output 3 was decided to concentrate on building the capacity of REA.

Although the implementation of the pilot projects for business facilities using renewable energy were cancelled, plans were prepared in each component. This chapter describes the activities for the preparation of the pilot projects for business/industrial facilities conducted in the first year (2012).

2.9.1 Preparation of the Pilot Project by Micro Hydro Power

(1) Potential Area of Hydropower Development

The potential areas of hydropower development in Kenya are limited to the surrounding areas of Mt. Kenya region and Western Kenya region in view of rainfall distribution and low flow runoff. Therefore, appropriate site for the pilot project by MHP was studied within these areas.

(2) Site Investigation

Site investigation to identify the pilot project site was conducted by JET as summarized in table below.

Table 2.9.1 Records of Site Investigation for Pilot Project by MHP

Date	Region	No.	Existing/On-going Project	Planning Project	Remarks
18 May 2012	Mt. Kenya	1	Kibai		UNIDO Energy Kiosk
29 May 2012	Mr. Kenya	2	Kathamba		Practical Action
		3	Thima		Practical Action
31 May 2012	Western Kenya	4	Kibolgong		KIRDI/GPower Report
		5		Asurur	KIRDI/GPower Report
		6		Zaaba	KIRDI/GPower Report
12 Jun. 2012	Western Kenya	7		Machagawa	GPower
		8	Inajogo		Community
		9	Thiba		GPower
		10	Muketua		GPower
		11	Kianguwe-I		GPower
		12		Kianguwe-II	GPower
19 Jun. 2012	Mt. Kenya	13	Tuungu Kabili		Practical Action
21 to 23 Jun. 2012	Western Kenya			Asurur	
18 to 20 Jul. 2012	Western Kenya			Asurur	

Prepared by JET

Based on the above site investigation, it was concluded that:

1) Mt. Kenya Region

Development of small/micro hydropower is active, in cooperation with NGO's and by private communities as well. The current situation is that two power lines co-exist in many places, with lines by community and KPLC. New developments are being geared towards grid connection rather than off-grid systems.

2) Western Kenya Region

In comparison with the Mt. Kenya region, small/micro hydropower development in the Western Kenya region is lagging behind due to reasons including accessibility to the area and community characteristics.

Accordingly, the Western Kenya region was found to be preferable for the pilot project. The purpose of the pilot project was also taken in to consideration, especially in terms of establishing and disseminating the rural electrification model.

(3) Selection of the Pilot Project Site

The pilot project site was selected taking the following issues into consideration:

- The area surrounding the site should not exists electrification plans by REA or KPLC at least in the near future,
- The scale of the project should be within range of 10 to 20 kW as suitable applications for business/industrial activities,
- The stage of the project should not be in progress of any construction works to avoid any confusion, and
- The reliable stakeholders group should exist for sustainable O&M of the project.

As a result, "Asurur MHP project" was selected as the pilot project by MHP as summarized in the table below. The pilot project was cancelled as mentioned before; however, Asurur MHP was adopted for the simple pre-feasibility study from the second year (2013).

Table 2.9.2 Summary of the Selected Pilot Project of MHP

Item	Description
Name	Asurur MHP Project
Contents	The project shall construct MHP facilities with installed capacity of 10 to 20 kW and demonstrate sustainable energy model with small business activities in off-grid areas.
Location	Kibwareng and Kapkolei, Nandi South District, in Nandi County. The project site is located about 1.5 hours away from Kisumu town by road and around 3.6 km away from the existing power grid. There is a waterfall with a minimum head of 15 m.
Stakeholder	Asurur Multi-purpose Water Project (Self-help group in Nandi South District registered on 20 June 2012)
Power Demand	The four kinds of power demand, i.e., refrigerator (for milk, fruits, vegetable, etc.), water pumping, posho mill, and charging business, are conceivable.

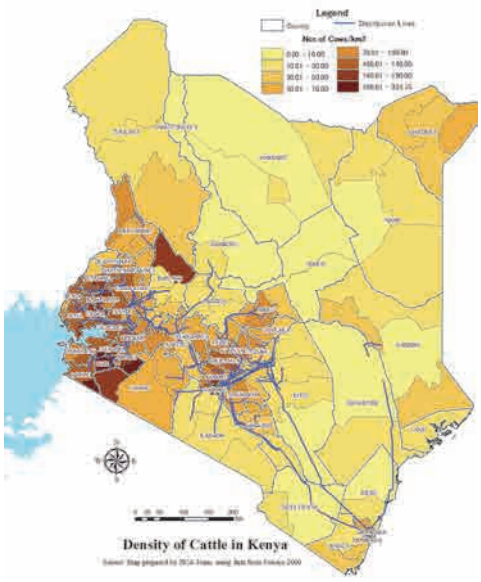
Prepared by JET

2.9.2 Preparation of the Pilot Project by Biogas

(1) Potential Area of Biogas Development

The available potential sources of feedstock for the biogas system were assessed in the main agricultural sectors: dairy, horticulture, pig and chicken farming. The dairy sector (milk production) was selected for the reasons that (i) cow dung from dairy cows is the best feedstock for biogas, (ii) the dairy industry can be the target of electricity service of off-grid areas, and (iii) the dairy sector has shown a strong interest in biogas generation systems for rural development.

A preliminary assessment of areas with dairy industry potential was conducted based on available information, including GIS data, district wise density of cattle, and alignment of the electricity distribution line. The results of the preliminary assessment are mapped out in the figure in the right.



Prepared by JET

Figure 2.9.1 Cattle Density (Number of Cows per km^2)

(2) Site Investigation

Site surveys were conducted in June and July 2012 in dairy production areas such as Narok, Bomet and Sotik. Consultation meetings were held with local dairy farmers association and district officials of Kenya Dairy Board. Further industry assessment was conducted in Bomet, and Siongiroi milk cooling facility was investigated as the target. Off-grid villages within Siongiroi milk cooling facility's catchment area were identified and surveyed. Three villages were identified as the candidate, Kapchumbe, Chemamit, and Chesoen villages.

(3) Selection of the Pilot Project Site

The general criteria applied in the selection of the biogas generation candidate sites were as follows:

1) Availability of feedstock (cow dung)
2) Considerable distance from the existing grid, without a possibility of grid connection in the near future
3) Commercial activity of the community (Existence of electricity demand for productive end use)
4) Reasonable assurance of security of staff and project
5) Proximity to Nairobi: for ease of monitoring and evaluation as a functional model
6) Solidarity and initiative of the community including leadership and governance structures in the target village

Chemamit village was selected based on the following reasons:

1) The village is located at the center of the three candidate villages, all of which have good potential for such a project. The possibility of future replication of the model is high,
2) The village has implemented projects through community initiative, with completed projects such as the construction of two community schools and an ongoing water distribution project,
3) The community management body/structure, though informal is already mature, and
4) The community willingness to participate in and contribute to the project is high.

Table 2.9.3 Comparison of Candidate Villages

Item	Description of Chemamit
District	Transmara
Population	13,070
Household	2,369
Area	38.7 km^2
Proximity to Grid	>6 km
Road condition	Seasonally accessible, 5 km from an all-year accessible road
Public facility	3 primary schools, 2 secondary schools, and 1 dispensary
Ownership of cows	>10 cows/HH

Prepared by JET

The main project concept was the introduction of commercial value for currently wasted evening milk in off-grid areas, by establishing a cooling facility specifically for milk chilling overnight.

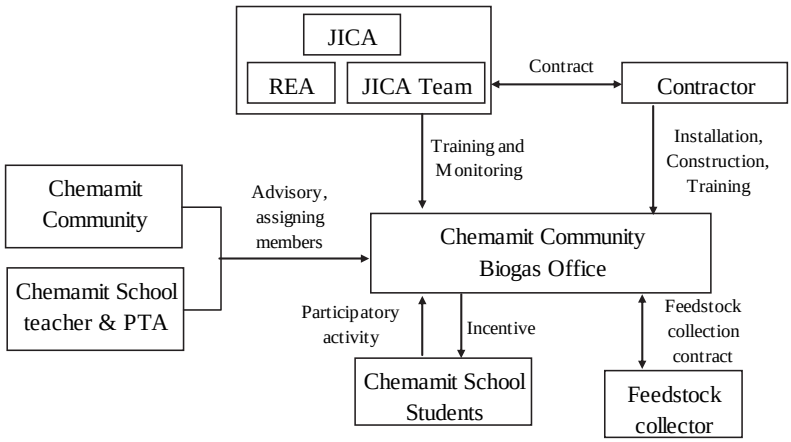
This value addition was assumed to be the source of income for the project operation and maintenance. The plan was developed in October 2012. The main system components were:

- Equipment: Engine, Generator, Refrigerator, Posho Mill, Deep Cycle Battery, Inverter, Mobile Charger, LED Lamp, Distribution Board, Sensors, Safety Devices, and Meters.
- Biogas unit: Biogas Digester, Biogas Holder, Biogas Filtering Unit, and Gas Meters
- Civil Work: Power House, Feedstock Reception, Water Tank, Cow Shed, and Water Supply Pipe

The main system specifications were tentatively considered as:

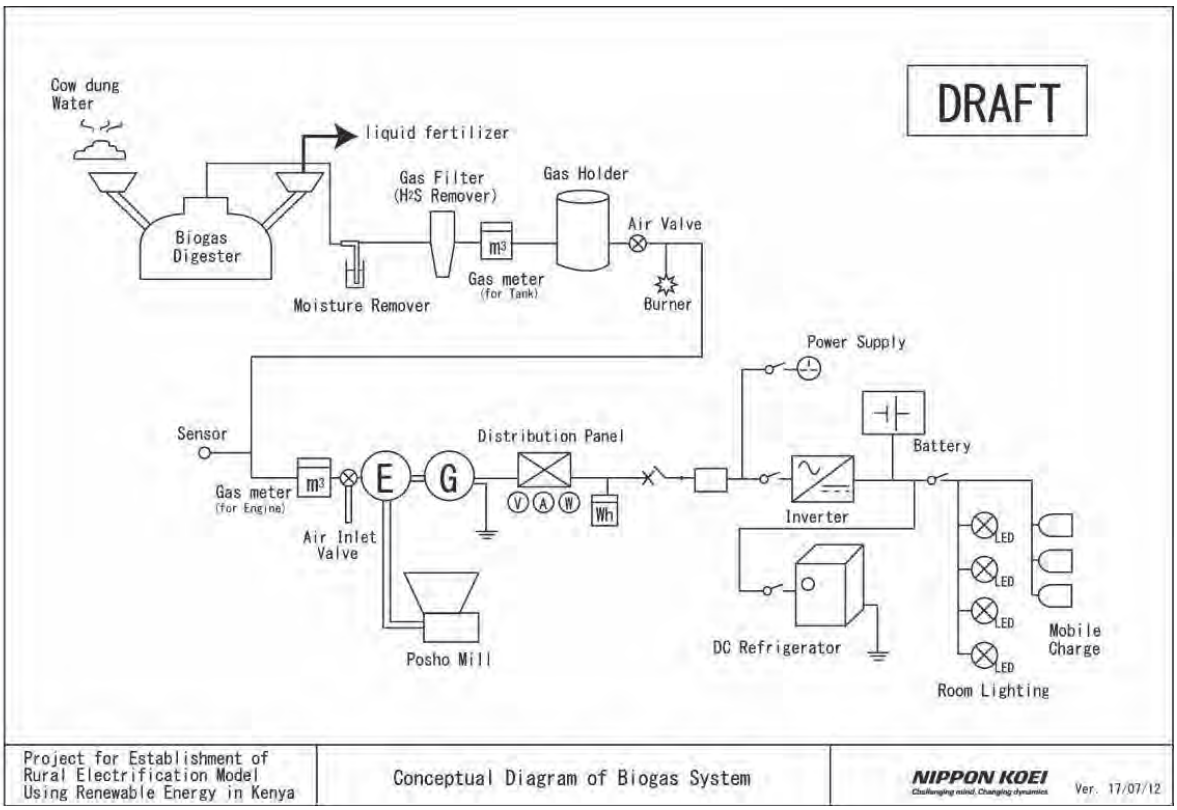
- Size of digester: 50 m^3 (associated with 20 m^3 gas bag)
- Generation capacity: 13 kW (actual output: 6.2 kW)
- Assumed demand: 16 kWh/day

The preliminary project design concept and the proposed implementation structure are shown in the figures below.



Prepared by JET

Figure 2.9.2 Implementation Structure of Biogas Project



Prepared by JET

Figure 2.9.3 Conceptual Diagram of Biogas System

Table 2.9.4 Daily Income and Expenditure Factor (for Feedstock 500kg/day)

Income Factor

Description	Amount	Unit
Milk purchase	15	Ksh/L
Milk sales	25	Ksh/L
Overhead	10	Ksh/L
Amount of milk	300	L
Income of milk cooling	3000	Ksh/day
Rate of mobile charge	15	Ksh/time
Income of mobile charge	450	Ksh/day
Income of posho mill	60	Ksh/day
Total Income	3510	Ksh/day

Annual Income	1,053,000	Ksh
Annual Expense	912,812	Ksh
Annual O&M cost	110,000	Ksh
Annual Saving	30,188	Ksh

Expendidure Factor

Description	Amount	Unit
Feedstock Collection Cost		
Required cow dung	33.07	kg/m3
Cow dung production rate	22.95	kg/cow/d
Nos of existing cow in school	4.00	
Required cow dung collection	421	kg/day
cost per dung weight	2	ksh/kg
Student incentive rate	1	Ksh/kg
Min Collection cost	421	Ksh
Max Collection cost	843	Ksh/d
Milk Transportation Cost		
Transp. capacity of donkey	80	kg/donkey
Nos of required donkey	4	Donkey
Milk transp. cost to Chebunyo*	300	Ksh/trip
Total transp. cost to Chebunyo	1200	Ksh/trip
Unit cost to Transp. Chebunyo	4.0	Ksh/L
Other operation cost	1,000	Ksh/day
Total operation cost	3,043	

*Donkey is assumed to be donated by comminity
Chebunyo is the nearest milk selling station.

Prepared by JET

After the project cancelation, Chemmamit village was included in the grid expansion plan and connected to the grid in 2014. Thus, above plan is not required any more, however, the same concept can be applied in other dairy industry off-grid areas in Kenya.

2.9.3 Preparation of the Pilot Project by Wind Power

(1) Selection Criteria

A general set of criteria was applied in the primary screening process to identify and select candidate sites for the pilot business/industrial facility. These considerations included:

- Abundant renewable energy potential on site
- Distance from the existing grid line is long (over 15 km) and no immediate plan for grid connection
- Potential for business / industrial activities
- Locate in personnel security area for Japanese expert

The candidate site for the pilot project was then selected in accordance with the following procedures:

Selection of Candidate Area

- Selection of potential area
- Personnel security area
- Electrification ratio in candidate area
- Conduct site survey
- Collect basic information
- Demand of business / industrial activity
- Based on the above information select target community

(2) Electrification Ratio

The community selected for pilot project implementation must be located in a non-electrified area. Therefore considering the objective of dissemination of the model which will be established in this project, the area with a lower electrification ratio was selected as a priority area. In accordance with Kenya/County Fact Sheet 2009, the electrification ratio of Narok was found to be lower than that in Laikipia (Dol Dol).

Narok County	5.9 (%)
Laikipia (Dol Dol) County	17.7 (%)

(3) Site Visits

On the basis of the results of the wind potential study, South Narok was selected as the candidate District. A list of candidate sites with rural industrial activities in the wind potential area was provided by the Kenya Industrial Estates Narok Branch. Based on this list and additional basic information obtained from the communities in the area, sites surveys were conducted in Naikarra, Leshuta, Olderkesi, Ololaimutia and Megwara. Among these 5 communities, the following three communities were shortlisted and studied as candidate sites for the pilot project: Naikarra, Leshuta and Ololaimutia.

The following table shows general information on population and business / industry activities in the three candidate sites. The suitability of Naikarra and Ololaimutia is good and almost the same. However, settlement and construction of buildings is prohibited within 10 km of the National Reserve, and Ololaimutia is located within this prohibited area. Leshuta was found to be too small in terms of available business and industrial activities and further survey was not conducted. Naikarra was therefore selected as the candidate site for the pilot project.

Table 2.9.5 Candidate Sites

Community Name	Population*	No. of HHs*	No. of Shops	No. of Posho mills
Naikarra	6,364	1,299	24	6
Leshuta	3,547	739	10	1
Ololaimutia	6,000	n/a	25	5

Source: National Census 2009

Basic Information
Pilot Project Site: Naikarra, Narok South District
Population: 6,364 (Male: 3,046, Female: 3,318)
Area (km^2): 280.km^2
Population Density: 23 (people/km^2)

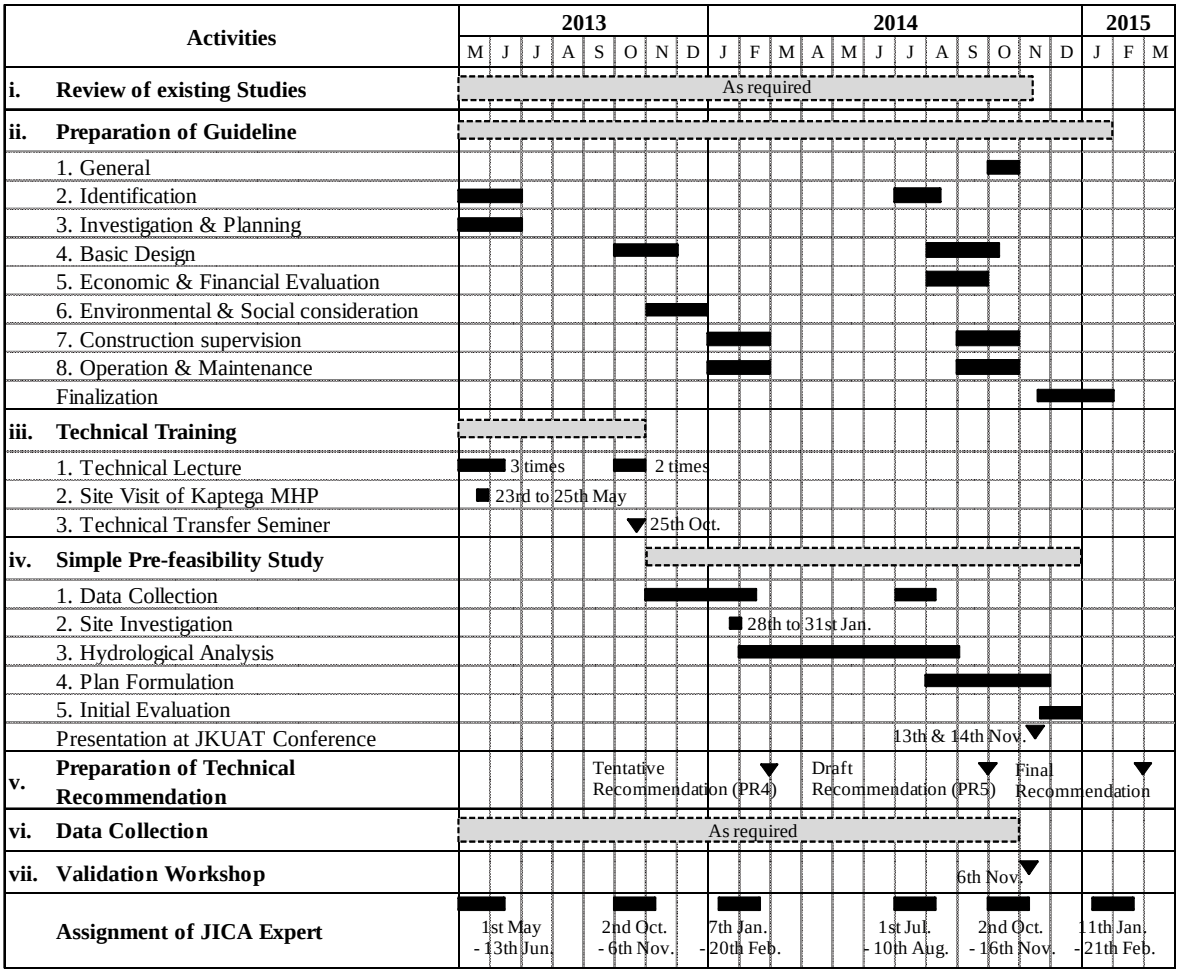
2.10 Technical Cooperation for Micro Hydro Power Technology

Technical cooperation for renewable energy (micro hydro, biomass and wind power) became one of the tasks of the Project instead of pilot projects for business/industrial facilities after the amendment of the original contract on March 2013 between JICA and JET.

Furthermore, the activities in PDM were modified through mid-term evaluations in October 2013 to be the following seven (7) tasks as Activities for Output 3 in PDM Version 3.1:

(1) Conduct inventory and review of existing studies on MHP,
(2) Prepare guidelines for rural electrification using MHP,
(3) Conduct technical training for REA/MoE&P staff on MHP,
(4) Carry out simple pre-feasibility study focusing on technical examination for MHP,
(5) Prepare technical recommendation for rural electrification using MHP,
(6) Collect necessary data and equipment for the above, and
(7) Hold workshops for stakeholders to validate guidelines on MHP.

This chapter describes activities carried out from May 2013 till February 2015 of the above tasks. Overall progresses of the technical cooperation for MHP technology are summarized in the figure below:



Prepared by JET

Figure 2.10.1 Overall Progress of Technical Cooperation for MHP Technology

REA nominated the following three (3) personnel by October 2013 as counterpart personnel for MHP technology. WG of MHP was formulated and composed of the following:

Ms. Judith Kimeu:	Assistant Engineer of Renewable Energy Department
Mr. Semekiah Ongong'a	Assistant Engineer of Renewable Energy Department
Mr. Anthony Wanjara	Technician of Renewable Energy Department
Mr. Yoshiaki Samejima	JICA expert for Micro Hydropower Generation

Ms. Judith and Mr. Semekiah were nominated as counterpart personnel before May 2013, and Mr. Anthony was nominated in October 2013, respectively.

2.10.1 Review of Existing Studies

(1) Collection and Compilation of Information Related to MHP

In order to generally access the hydropower potential in Kenya, related information was collected and compiled. Key information related to MHP is listed in the table below:

Table 2.10.1 List of Related Information to MHP

No.	Title	Date of Issue	Prepared by
1	Rural Electrification Master Plan	Aug. 2009	REA, Decon, REAC
2	Feasibility Survey on Potential of Mini and Micro-hydro Electricity Generation and Distribution	2009	GTZ, KIRDI
3	List of Small Hydroelectric Power Resources Assessment Preliminary Report	Not clear	(from REA/Mr. Murithi)
4	Mapping of Mini Hydro-electricity Generation Potential in Western Kenya Region	Aug. 2008	GPower
5	Kibolgong Community Micro-hydro Project Site Visit Report	Oct. 2011	Greening the Tea Industry in East Africa Project
6	Information of Kibolgong Falls (extract from some report?)	Not Clear	(from Mr. Alexander)
7	Developing Small Hydropower Infrastructure in Kenya (Presentation material at conference)	Apr. 2006	(from REA/Mr. Murithi)
8	History of Small Hydropower in Kenya	Jun. 2011	Practical action
9	Micro Hydropower Development in Kenya (including Appendix-A Project list)	Mar. 2011	Practical action
10	Maps related to Micro Hydro	Not Clear	(from practical action)
11	Technical and Economic Study for Development of Small Scale Grid Connected Renewable Energy in Kenya	Mar. 2012	ECA
12	Project Study on Utilization and Dissemination of Renewable Energy in Off-grid Area in Africa (Japanese Report)	Oct. 2008	JICA (Proact)
13	Preparatory Survey for Renewable Energy Promotion Program in Africa – Public Facility Electrification –	Nov. 2009	JICA (NK, Proact)
14	Preparatory Survey for Renewable Energy Promotion Program in Africa – Business Promotion and Financial Mechanism –	Nov. 2009	JICA (NK)
15	Preparatory Survey on Renewable Energy Promotion Program in Africa (2)	Jun. 2010	JICA (NK)
16	Detailed Feasibility Study on Fourteen Small Hydropower Sites in Kenya; Final Report, Greater Oroba Site	Sep. 2011	MoEn (Que Energy)

Prepared by JET

(2) Meetings with Related Organizations

JET had meetings with organizations concerned with MHP. The discussions have been summarized as follows:

1) Practical Action

They are active in small/micro hydropower development especially in the Mt. Kenya region. JET expects to utilize their experiences as a valuable reference, especially in O&M, including some business/industrial activities.

2) GPower

They are also active in small/micro hydropower development in Kenya. JET observed that their intention in the near future is connection with the national grid rather than off-grid system installations.

3) Kenya Tea Development Authority (KTDA)

KTDA has a subsidiary company dedicated to mini/small hydropower development, for electricity supply to their tea processing factories.

iv) Kenya Industrial Research and Development Institute (KIRDI)

In accordance with NGO's, KIRDI has carried out potential study for small/micro hydropower development. In addition, they intend to develop small scale hydro turbines and generators in Kenya.

(3) Current Status of the existing Pico and Micro Hydropower Stations

The current status of the existing pico and micro hydropower stations in Kenya as of 2012 is summarized in the table below.

These MHP projects require O&M of the facilities to be undertaken by the community due to the scale of the projects. Ensuring technical and financial sustainability is a challenge that projects are unable to address, with very few exceptions.

Table 2.10.2 Status of the Existing Pico and Micro Hydropower Stations in Kenya

No.	Name /Capacity	Status	Remarks
1	Kibai / 2 kW	Not in operation	- Energy Kiosk by UNIDO. - Hybrid power generation (solar & hydro). - There are no solar panels in the system and the MHP component is not in operation. - Demand facilities such as battery charging and barber shops are not in operation. - The problems are technical issues such as insufficient spare parts and financial issues such as collection of service fees. ➢ Estimation of appropriate demand and strengthening of the O&M system is required.
2	Kathamba / 1.1 kW	Not in operation	- Implemented by NGO (Practical action). - The power is distributed to households. - Not in operation due to theft of distribution lines. ➢ Strengthening of the O&M system is required.
3	Thima / 2.2 kW	In operation	- Implemented by NGO (Practical action). - The power is distributed to households. - There are some ongoing activities as the community aims to expand the project. ➢ It is a successful project requiring technical and financial assistance for expansion.
4	Thiba / 50 kW	In operation	- Implemented by NGO (GPower). - The power grid has been extended and is within reach of the project. - The project is considering selling power to the grid. ➢ The project is not considered to be in the category of rural electrification.
5	Tunngu Kabili / 14 kW	Not in operation	- Implemented by NGO (Practical action). - The project aims to provide power for business facilities and water supply. - The power grid has been extended and is within reach of the project. - Demand facilities such as battery charging and barber shops are therefore not in operation. - The community requests power distribution to households. ➢ The power plant can be operated. Estimation of appropriate demand and technical/financial assistance for power distribution to households is required.

Prepared by JET

(4) Studies during the Project Period

Studies related with small scale hydropower development are briefly explained below.

1) Detailed Feasibility Study on Fourteen (14) Small Hydropower Sites

MoE&P conducted the above study for fourteen (14) small hydropower schemes by fiscal year 2012/2013 as the second phase of small hydropower development. Twelve (12) small hydropower schemes were studied as the first phase. The small hydropower means the scale between 1 to 10 MW.

The study aimed at enhancing provision of electricity that targets among others, poverty reduction in the country side; creation of wealth and job opportunities especially in the rural

areas. The study identified the potential site of small hydropower to meet partial or full load demands of local industries and to supply the bulk to the national grid.

2) Feasibility Study on Rural Electrification Project for Communities by Micro Hydropower (August 2013 – February 2014)

Kenya and Japan concluded an agreement of "JCM, Joint Crediting Mechanism" in June 2013. "JCM" is a brand new carbon reduction scheme proposed by Japanese Government. Japan will provide low carbon technologies together with financial schemes to reduce greenhouse gas in Kenya.

The study aims to establish a business model for community development by productive use of electricity. The electricity is planned to be developed by ultra-low-head micro hydro power system named "STREAM" developed by Sea bell International. The ultra-low-head means less than 5 m.

The next step of the study is planned to execute a technical pilot project with implementing STREAM by 2016, then to develop a business for community development with Kenyan public and private sectors by 2018.

3) Upgrade the Atlas for MHP Potential

MoE&P is conducting an upgrade of the Atlas for MHP potential, which will be finalized in March 2015.

2.10.2 Technical Transfer

(1) Technical Lecture

Technical transfers to REA counterpart personnel were conducted by lecture style three times as listed below. The major reason why the technical transfer had been conducted only five (5) times is that the counterpart personnel have other tasks outside of the Project, and they do not have enough time to meet with the JICA expert.

Table 2.10.3 Meeting and Lecture of MHP Technical Transfer

Date	Item	Description
01 May – 13 June 2013		**Technical Transfer regarding Identification and Planning**
06 May 2013	Kick-off Meeting	JET requested REA to work with JET at least twice a week. REA appointed two personnel for MHP technical transfer.
07 May 2013	MHP Meeting	Planning for the activities, and decided that the technical transfer will not focus on some individual MHP schemes but general technical matters in each stage of MHP project.
16 May 2013	MHP Lecture-1	Lecture for required information for MHP planning and development scale of MHP.
22 May 2013	MHP Lecture-2	Lecture for measurement of head and discharge by simple tools.
07 Jun. 2013	MHP Lecture-3	Lecture for hydrological analysis focusing into preparation of available data, estimation of reliable discharge, and estimation of flood discharge.
11 Jun. 2013	MHP Meeting	Planning for next schedule of the activities, and advice on the next step for study on Kaptega MHP.
02 October – 06 November 2013		**Technical Transfer regarding Basic Design**
04 Oct. 2013	MHP Meeting	Planning for the activities in this period.
11 Oct. 2013	MHP Lecture-4	Lecture for estimation of power output and generation energy, basic layout and basic design of civil structures.
18 Oct. 2013	MHP Lecture-5	Lecture for basic design of turbine and generator.
01 Nov. 2013	MHP Meeting	Planning for the schedule of simple pre-feasibility study. Asurur MHP scheme was adopted. Data collection was instructed.

Prepared by JET

The technical transfer by lecture style was conducted from May 2013 till October 2013. After that, WG concentrated to conducting the simple pre-feasibility study which became one of the large tasks strongly requested by REA through discussion of revision of PDM in October 2013.

The lecture materials were utilized for the preparation of the guideline, and compiled in the guideline.

(2) Site Visit to Proposed Kaptega MHP

Local Government of Trans-Nzoia County requested REA to visit the proposed Kaptega MHP site and to assist the formulation of the proposed MHP project. The proposed Kaptega MHP is situated on a tributary of Suam River at eastern side of Mt. Elgon and located beside the international boundary with Uganda.

WG of MHP visited Trans-Nzoia County in May 2013 as summarized in the table below.

Table 2.10.4 Site Visit to Proposed Kaptega MHP

Date	Description
23 May 2013	✓ Move to Trans-Nzoia County (Nairobi to Eldoret)
24 May 2013	✓ Visit the Kitale City Hall for courtesy call to the local governor and brief explanation of the proposed project. ✓ Visit the Anderson Farm. The proposed project is located in a private farm named Anderson Farm, and discussed with land owner. ✓ Visit the proposed intake site and head pond site.
25 May 2013	✓ Move to Nairobi (Kitale to Nairobi)

Prepared by JET

There is a study report on the electrification plan for Kaptega but the report is not yet obtained. The JICA expert advised the counterpart personnel to conduct the following studies:

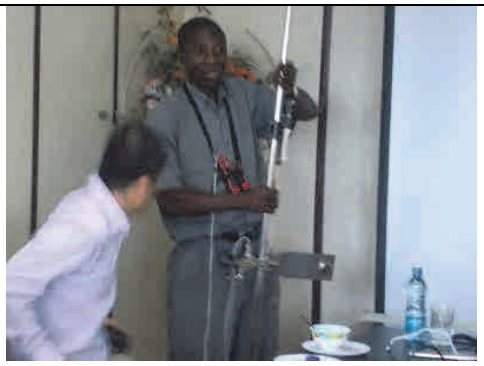
- To obtain the study report,
- To obtain the topographic map with scale of 1: 50,000 including the catchment area of the proposed site to measure the catchment area,
- To confirm available gauging station surrounding the proposed site, and obtained rainfall and discharge data, if any, for hydrological analysis,
- To confirm the reserved area surrounding the proposed site, and
- To confirm grid extension plan surrounding the proposed site.

(3) Technical Transfer Seminar

The technical transfer seminar of MHP technology was conducted together with that of Biogas technology on 25 October 2013 in REA headquarters. The seminar was arranged as an opportunity for counterparts to present what they had learned from the Project. The presentation in the seminar was, therefore, mainly executed by the counterparts of MHP.

The materials of technical seminar for MHP are attached as Attachment K-3, and the major contents were summarized below:

Table 2.10.5 Summary of the Technical Transfer Seminar of MHP

Item	Presentation-1	Presentation-2
Presenter	Mr. Semekiah Ongong'a	Ms. Judith Kimeu
Title	Planning of Micro Hydro Power Generation	Design of Civil Structures
Major Topics	✓ Necessity of off-grid mini hydro, ✓ Identification of the project, and ✓ Investigation and planning.	✓ Design of head works, ✓ Design of power canal, ✓ Design of head tank, and ✓ Design of penstock.
Photo	 Explanation of Current Meter	 Presentation Scene

Prepared by JET

The presentations by the counterparts were not limited by the lectured points but also included their own knowledge regarding each presentation topics. It was also a good opportunity for JICA expert to confirm their understandings.

(4) Technical Presentations

The counterpart personnel of MHP made presentations of his own activities with the assistance of JICA expert in the following opportunities. These opportunities also contribute their understanding of transferred technologies.

Validation Workshop: Brief explanation of the guideline
(Refer to Chapter 2.10.4)
JKUAT Conference: Explanation of the simple pre-feasibility study on Asurur MHP
(Refer to Chapter 2.14.3)
International Workshop: Brief explanation of MHP in Kenya and the guideline
(Refer to Chapter 2.15)

2.10.3 Simple Pre-feasibility Study

During the review of PDM in October 2013, CEO of REA strongly requested inclusion of activities which REA personnel will be able to formulate planning by themselves.

JET and REA agreed to carry out simple pre-feasibility study for some specific scheme of MHP within the available time and budget, and it was added as one of the activities specified in PDM. WG adopted Asurur MHP scheme in Nandi County as the target of simple pre-feasibility study, which was originally selected for the pilot project of for business/industrial facilities.

Because of the limitation of time and budget, the simple pre-feasibility study is not a full scale of pre-feasibility study commonly executed, and it is limited only to power demand forecast, hydrological analysis to determine design discharges, plan formulation through alternative comparison, and initial evaluation of the scheme.

The report on the simple pre-feasibility study on Asurur MHP is attached in Attachment K-2. Major activities for the simple pre-feasibility study are briefly explained hereinafter.

It is noted that even if the activities of the simple pre-feasibility study had been limited, WG confirmed available data and its quality in Kenya through the study. It assisted to prepare the guideline. The guideline has been compiled in light of lessons learnt from the study.

(1) Data Collection

WG collected the following major data for the Study:

Table 2.10.6 List of Collected Major Data for the Simple Pre-feasibility Study

Collected Data	Purpose
Daily Discharge Data from WRMA (purchased) - 1HA01/ Great Oroba: 1932 – 1999 (68 years) - 1HA02/ Little Oroba : 1931 – 2008 (78 years)	To evaluate flow duration at Asurur MHP site.
Monthly Rainfall Data from KMD (purchased) - 8934157/ Kabujoi Forest Station: 1993 – 2012 (20 years) - 8935033/ Savani Estate: 1993 – 2012 (20 years) - 8935161/ Kibweri Tea Estate: 1993 – 2012 (20 years)	To evaluate flow duration at Asurur MHP site.
Final Report of NWMP 2030 from WRMA (Download) - Volume – IV Sector Report B: Meteorology and Hydrology - Data Book Part A: Meteorological and Hydrological Data	To evaluate flow duration at Asurur MHP site.
Topographic Map of the Broad Area with scale of 1: 50,000 from Land Survey Department, Ministry of Land, Housing and Urban Development (purchased) - 4 sheets: 102-4, 103-3, 116-2 & 117-1)	To confirm catchment area of Asurur MHP scheme.
Topographic Map surrounding Asurur MHP site with scale of 1: 500 from JET (which was prepared for the pilot project in the first year, 2013)	To calculate water levels and layout study of Asurur MHP scheme.
Grid Extension Plan in Nandi County from REA	To confirm electrification status surrounding Asurur MHP scheme.
Current Construction Costs handbook 2012/13 from Quantities & Contracts Department, Ministry of Public Works (purchased)	To confirm unit prices for cost estimation.
Detailed Feasibility Study on Fourteen Small Hydropower (Greater Oroba Site) from REA	For reference while Greater Oroba site is located downstream of Asurur MHP site.

Prepared by JET

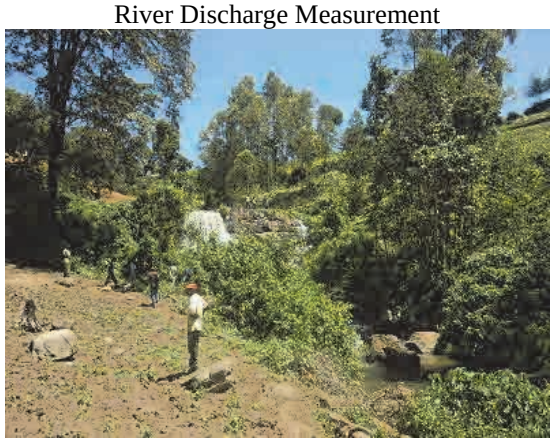
(2) Site Investigation

WG conducted site investigation from 28 to 31 of January 2014. Asurur MHP was proposed by the registered local community group named “Asurur Multipurpose Water Project Group (the Group)”. WG visited the Group and had an interview to the members regarding present situation of the community and future planning of electricity use, and carried out the measurement of coordinates, elevation, and river discharge.

Interview to the Group Members

River Discharge Measurement

Asurur Waterfall



Proposed Powerhouse Site

Taken by JET on January 2014

Figure 2.10.2 Site Investigation on Proposed Asurur MHP Site in Nandi County

(3) Power Demand Forecast

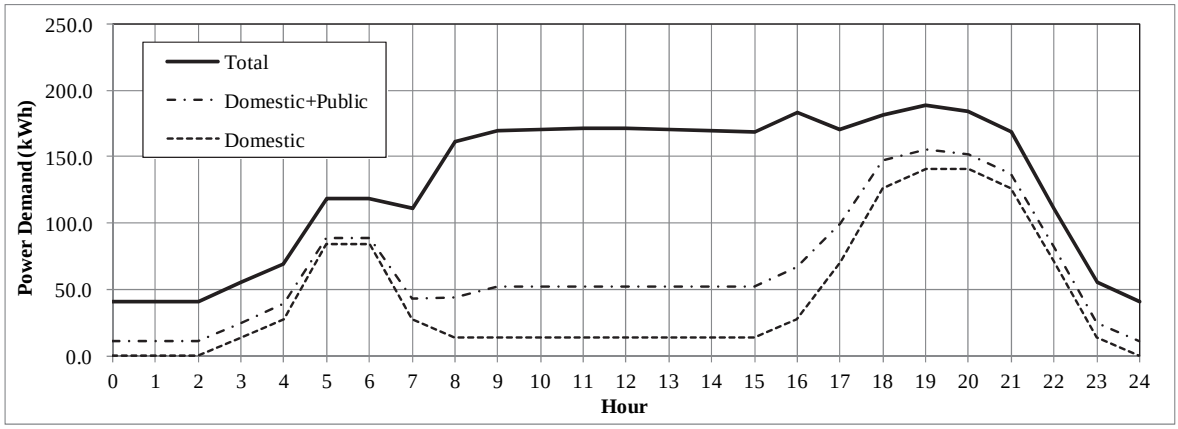
Power demand in the communities is unknown before electrification. Therefore, power demand was forecasted based on the interview result to the Group and the assumptions by WG.

WG assumed users in the project area in three (3) categories, i.e.,

1) Domestic user (household),
2) Public user (schools, dispensaries, trading centers and streetlights), and
3) Business user (Posho mills, dairy husbandry and restaurants).

WG assumed unit power demand of each user, and number of each user based on the interview result to the Group and own assumption. Total power demand was estimated to be 310 kW by multiplying the unit power demand and number of each user.

Power demand varies hourly, daily and seasonally depending on each user. WG assumed ratios of the power demand of each user in each hour, and created a daily power demand curve by multiplying these ratios and estimated power demand as shown below:



Prepared by WG of MHP

Figure 2.10.3 Assumed Daily Load Curve for Asurur MHP System

The required generator output of Asurur MHP station was estimated as follows:

Total power demand: 310 kW → Required Generation Output: 400 kW
Peak power demand: 190 kWh → Required Generation Output: 250 kW

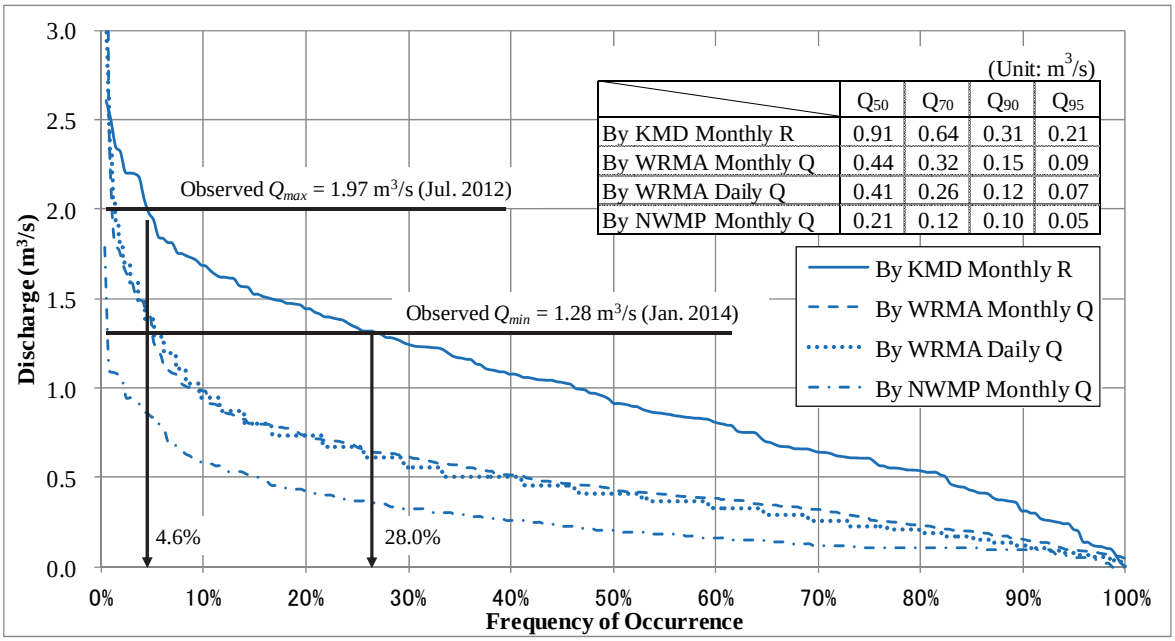
(4) Evaluation of Hydrology

WG evaluated reliable discharge and probable flood discharge at Asurur MHP site using the following four (4) sets of data:

- Collected daily discharge data from WRMA,
- Collected monthly rainfall data from KMD,
- Observed discharge data measured by WG, and
- Simulated discharge data and regional area flood curve by NWMP 2030.

A gauging station 1HA01 of WRMA is located downstream of the planned Asurur MHP site. Initially, WG considered determining reliable discharge based on the WRMA discharge data, and WG conducted hydrological analysis of the discharge data from WRMA. However, the flow duration shows relatively low discharges against range of the observed discharges.

Then, WG collected different data, i.e., KDM rainfall data and simulated basin discharge data in NWMP 2030. Three (3) kinds of flow duration curves at Asurur MHP site were prepared based on those three (3) data, and compared with the observed discharge data as shown below.



Prepared by WG of MHP

Figure 2.10.4 Comparison between Observed Discharge and Flow Duration Curves

Probable flood discharge was estimated by rational formula and regional area flood curve by NWMP 2030. WRMA discharge data was not applied because annual maximum discharges in the discharge data at 1HA01showed relatively small values compared with the observed discharge. The adequacy of estimated flood discharges is checked by the Creager envelope curve.

As a result, the design discharges of Asurur MHP were defined as follows:

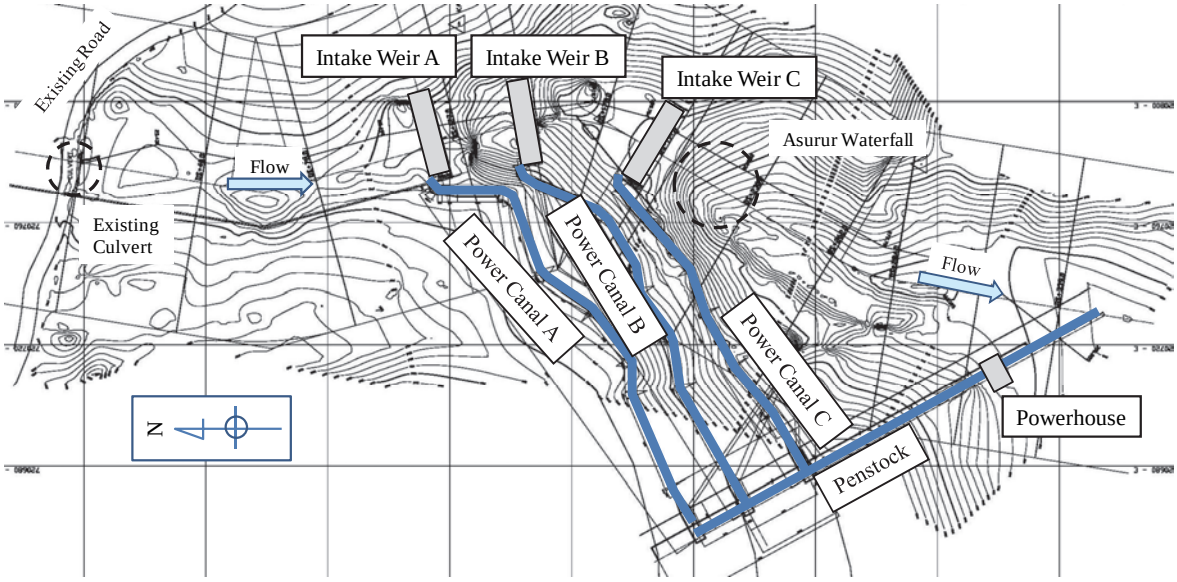
Minimum Design Plant Discharge:	0.1 m^3/s (Q_{90}% - Q_{95}%)
Maximum Design Plant Discharge:	0.7 m^3/s (Q_{50}% - Q_{95}%)
Design Flood Discharge:	42.0 m^3/s (50-year probable discharge)

(5) Plan Formulation and Initial Evaluation

WG identified three (3) alternative sites of intake weir and one (1) site of powerhouse from the topographic map with scale of 1: 500 surrounding Asurur MHP site, and three (3) alternative layouts, Layout A, Layout B and Layout C, were prepared as shown in the figure below.

WG estimated the development cost (C) and benefit (B) for each alternative layout. The development cost (C) was estimated using empirical equations and the benefit (B) was estimated based on the different available heads and same design discharge. Then, alternative layouts were compared in terms of ratio of cost and benefit as well as generation power against the estimated power demand as summarized in the table below.

As a result, Layout A was selected as an optimum layout.



Prepared by WG of MHP

Figure 2.10.5 Alternative Layouts of Asurur MHP for Comparison

Table 2.10.7 Summary of Comparison among Three (3) Alternative Layouts

Item	Unit	Layout A	Layout B	Layout C
Maximum Plant Discharge	m^3/s	0.7	0.7	0.7
Effective Head	m	31.2	25.1	16.3
Maximum Output	kW	154.1	124.0	80.5
Project Cost	KSh.	140,511,000	134,607,000	125,105,000
Annualized Project Cost (C)	KSh./year	15,456,210	14,806,770	13,761,550
Annualized Project Benefit (B)	KSh./year	28,970,442	23,311,698	15,133,850
B / C	-	1.87	1.57	1.10
B – C	-	13,514,232	8,504,928	1,372,300
Generation Cost	KSh./kWh	15.79	18.80	26.92

Prepared by WG of MHP

(6) Recommendation to the Next Stage

The Study result shows that the estimated power generation is smaller than the forecasted power demand. WG recommended the following issues will be considered for the next stage:

1) To monitor the water level at the site continuously in order to upgrade accuracy of hydrological analysis by accumulation of discharge data,
2) To compare optimum height of the intake weir in order to increase minimum power generation to meet power demand,
3) To obtain quotations of electrical equipment from manufacturers in order to increase accuracy of estimation of the project development cost, and
4) To study other power source such as hybrid with diesel generator, grid connection in order to provide electricity to meet with forecasted power demand.

2.10.4 Technical Guideline

WG of MHP prepared the technical guideline during the project period. The guideline describes how to implement MHP projects from identification stage to O&M stage based on the existing guidelines and manuals on small scale hydropower development for rural electrification.

The guideline for MHP development is attached in Attachment K-1. Summary of the guideline is briefly explained below.

(1) Objectives of the Guideline

Definitions of micro/mini/small hydro in the guideline are set as follows:

- Micro hydro: Less than 100 kW
- Mini hydro: 100 kW to 1,000 kW (1.0 MW)
- Small hydro: 1,000 kW to 10,000 kW (1.0 MW to 10.0 MW)

The guideline was prepared for MHP projects whose capacity ranges between 10 to 1,000 kW (Micro hydro and Mini hydro).

The guideline is to be provided to the personnel in Renewable Energy Department of REA, as well as persons who support implementation of REA projects including engineers in power utilities, universities and local consultants, with basic information and knowledge about hydropower technology, in order to utilise it for rural electrification.

(2) Structure of the Guideline

In parallel with the making of the guideline, WG executed a simple pre-feasibility study on Asurur MHP in Nandi County. During the study, the contents of the existing guidelines and manuals were reviewed, modified and reflected on the guideline to incorporate actual conditions in Kenya, especially the planning section.

This guideline consists of the following eight (8) chapters. The general description of each chapter is summarized in the table below.

Table 2.10.8 General Description of the Guideline

Chapter	General Description
1. General	This chapter briefly explains advantage and disadvantage of MHP and basics of hydropower generation.
2. Identification of the Project	This chapter describes how to identify the potential MHP site and how to evaluate its hydropower potential and power demand by existing data before site investigation.
3. Investigation and Planning	This chapter describes key points for survey including consultation with the local community, power demand forecasting, technical investigations, and procedure of plan formulation.
4. Basic Design	This chapter describes the basic functions and hydraulic design methods of civil structures (structural design methods are not included), the standard types and estimation methods of basic technical features of electrical equipment and distribution facilities.
5. Economic and Financial Evaluation	This chapter explains key indicators for evaluation and difference between economic evaluation and financial evaluation with examples. Estimation of project cost is also explained in detail since it is important for the evaluation.
6. Environmental and Social Consideration	This chapter explains standard procedures for obtaining the environmental licence, solid waste management issues including E-waste, and other management issues for MHP.
7. Construction Supervision	This chapter explains procurement procedures of public works in Kenya and points of construction supervision works by the Client.
8. Operation and Maintenance	This chapter describes the importance of assistance to management board organized by the local community and key points of operation and maintenance works for MHP station and off-grid distribution system.

Prepared by JET

(3) Features of the Guideline

There are many guidelines and manuals on MHP development in the world. The features of this particular guideline may be the following two points:

1) Adopting the Results of NWMP 2030

Lack of hydrological data is one of the key challenges for development of MHP. WG also faced difficulty in evaluation of flow duration and definition of reliable discharge in the simple pre-feasibility study on Asurur MHP scheme due to shortage of hydrological data. The same problem might occur for the entire MHP planning process.

To mitigate this problem, WG included the simulated discharge data in "National Water Master Plan 2030 (NWMP 2030)" which was formulated by Ministry of Water & Irrigation (present Ministry of Environment, Water and Natural Resources) with technical cooperation by JICA. In NWMP 2030, rainfall-runoff analysis was conducted in nation-wise, and monthly average naturalized discharges were provided for 204 sub-basins for 20 years period.

By utilizing this data, a reliable discharge at the concerned MHP site is easily estimated without detailed hydrological analysis as preliminary evaluation. Therefore, it may contribute to preliminary identification & planning of MHP scheme.

However, measurement of discharge at the candidate site is essential for detailed planning.

2) Adopting the Empirical Equations of Japan

In general, location of intake weir, route of power canal and penstock, location of powerhouse and tailrace, etc. can vary depending on the potential site. In the planning process, the optimum locations of those major structures will be determined by comparing generating energy and construction cost. A comparative study shall be carried out to identify the optimum development plan.

Empirical equations to estimate work quantities were presented in the guideline for comparative evaluation. The empirical equations were developed based on the rich experience and actual records of MHP projects accumulated in Japan. Using these equations, a comparative study can be easily carried out by temporarily setting some major dimensions.

However, these empirical equations are applicable for comparative study only. A further detailed estimation is required in basic design and/or procurement stages.

(4) Validation Workshop for the Guideline

The validation workshop for review of the technical guideline was conducted as follows:

Date and time:	6 November 2014 (Thu.) 11:00 – 12:30
Venue:	Kivi Milimani Hotel, Nairobi
Presenter:	Mr. Semekiah Ongong'a (Renewable Energy Department of REA)

The presentation material in the validation workshop is attached in Attachment K-1.

Comments from the participants and response from the WG are summarized in the table below. The guideline was finalized with reflection of some of these comments.

Table 2.10.9 Comments in the Validation Workshop and Response from the WG

Comments from the Participants	Response from the WG
1. Application of Local-made Equipment Participant from JICA introduced JKUAT activity of manufacturing local turbine, and suggested application of local-made equipment in cost estimation.	WG stated if local-made equipment is procured parts by parts, coordination works will be difficult, as well as investment will be high due to repeated modification works if local work is poor. WG also stated about the existence of packaging concept of "water-to-wire".
2. Importance of Design against Water Hammer Participant from renewable energy engineering contractor pointed out that water hummer and cavitations are main issues for locally made penstock and turbine respectively. Therefore, if penstock is damaged by water hummer, it will collapse overall system.	WG stated that water hammer phenomenon is explained in the guideline. However, the guideline dose not describes structural and mechanical analysis against water hummer because of the objectives of the guideline.
3. Including of ULH-MHP Participants from JICA inquired if the Guideline could include ULH-MHP utilizing small head.	WG agreed to introduce ULH-MHP in the guideline.
4. Atlas for MHP Potential by MoE&P Participant from MoE&P informed that MoE&P is currently preparing Atlas for MHP potential and it will be finalized in early 2015.	WG confirmed with MoE&P in January 2015 that the Atlas for MHP will be finalized in March 2015, and it is difficult to share the Atlas before finalization
5. Economic and Financial Evaluation Participant from UK Aid suggested including executive summary of the guideline with graphics for policy makers and planners not only making it as technical booklet.	WG agreed to include executive summary.

Prepared by JET

2.10.5 Technical Recommendation for Rural Electrification

Some problems to be settled for promoting rural electrification by MHP which were discovered through the Project activities are summarized below.

(1) Integrated Master Plan and Specification Standard

The following ongoing activities by MoE&P are very important to accelerate rural electrification by MHP. It is recommended to involve these activities as one of the stakeholders:

- To formulate the integrated master plan, which will be combined with the existing master plans of REA, KPLC and KETRACO, with GIS, to update periodically, and to share with related agencies, and
- To prepare the "Guideline Specification Standard for Development of Micro/ Small Hydropower in Kenya (KS1859)" with KBS by 2015.

(2) Selection of the Target Area for MHP Planning

The potential areas of MHP are limited in the area around Mt. Kenya and the Western Kenya region. It is recommended to clarify non-electrified areas within the potential area of MHP based on the integrated master plan which is currently formulating by MoE&P. Thereafter, specify the several target areas to be electrified by MHP in order to concentrate MHP planning.

(3) Execution of Pilot Project by Direct Management Works

For implementation of rural electrification by MHP, REA personnel should to be familiar with planning, design, construction and O&M of MHP facilities. It is recommended to implement the planning, design and construction of several MHP projects in the direct management, while the direct management works is the best way to understand deeply and quickly.

For the implementation, the system to receive the technical assistant from engineers of KenGen and/or international consultant firms shall be arranged.

(4) Role-sharing Arrangement in Operation and Maintenance of MHP

Role-sharing in O&M stage of MHP is not clarified at this moment. It is recommended to start coordination with relevant agencies to discuss and arrange the role-sharing in O&M stage of MHP.

It is conceivable that scale of MHP station in a rural area is less than 1,000 households and some enterprises. It is too small to be managed by Government and/or parastatals. As a result, O&M of a MHP station has to be executed by new management body to be established and operated by local residents.

Assistance for new management body is required from the planning stage. Therefore, role-sharing of assistance in terms of establishment of management body, training programs before and after commencement of power generation shall be clarified and prepared preliminarily.

2.11 Technical Cooperation for Biogas Technology

2.11.1 Review of Existing Studies

(1) Review of Existing Material

Data and documents for the reference of technical cooperation of biogas system were collected from relevant organization. General documents required for rural electrification planning, such as “Rural Electrification Master Plan” (2009, REA), “Population and Housing Census” (2009, KNBS) and “Economic Survey” (2012, KNBS) were collected and reviewed. In addition, specific documents and reports related to biogas were collected from a number of relevant organizations and reviewed. The main materials used for technical assistance are as shown in the table below.

Table 2.11.1 Existing Studies Reviewed for Biogas

Title	Issued by	Utilization in Technical Assistance
Biogas Construction Manual	GIZ	Manual for biogas construction in PSDA program, which was referred in the Guideline.
Status Report, the dawn of an Era in Flower and Power Production	MoE&P	Report for current operation status of flower waste biogas generation system in Thika and Isinya
Biogas as an alternative to fuel wood for a household in Uleppi sub-county in Uganda	Univ. of Uganda	Reference value for gas production rate, biogas stove efficiency, retention time, etc., were obtained.
Ensuring Appropriateness of Biogas Sanitation Systems for Prisons – Analysis from Rwanda, Nepal and the Philippines	International Committee of the Red Cross	Example of toilet biogas experience in prison in three countries. The experience data is utilized in Guideline.
Kenya National Domestic Biogas Programme (KENDBIP)	MoE&P Hivos SNV	Experience of household-base biogas programme in Kenya
Promoting Biogas Systems in Kenya A Feasibility Study (Oct 2007)	ETC[*1] Group	Study for Floating Dome, Fixed Dome, and Plastic Tubular Digester and sample cost estimation and financial analysis
Agro-industrial biogas in Kenya	DBFZ[*2] and GIZ	Study for business application of biogas generation system, methane production, installed capacity, tariff and grid
Technical Guidelines for Construction of Domestic Fixed Dome Biogas Plants	RURA	Biogas digester construction manual by Rwanda Utilities Regulatory Agency

Title	Issued by	Utilization in Technical Assistance
UN Initiative on Sustainable Energy For All, Stock-taking and Gap Analysis Report on Sustainable Energy for All, (May 2013)	MoE&P, UNDP	Summarizes biogas programme in Kenya
Draft National energy and Petroleum Policy (June, 2014)	MoE&P	Policies and strategies of biogas are summarized.
Quality Standards, Biogas Appliances (2001/02)	Biogas Support Programme, Nepal	Example of specifications of biogas appliances
Biogas Plant Construction Manual	Egyptian Environmental Affairs Agency, UNDP	Small scale (gas production: 2-6 m^3) biogas fixed dorm type construction manual in Egypt

*1: ETC: a non-profit Organization (http://www.etc-international.org/) *2: DBFZ: Deutsches Biomasse Forschungs Zentrum.

Prepared by JET.

(2) Review of Existing Projects

In December 2008, Africa Biogas Partnership Programme (ABPP) was started by the initiative of Netherlands, which aims to install 10,000 household biogas systems in Kenya by the year 2015. Currently, there are reportedly more than 6,000 biogas systems in Kenya, through the Programme of SNV and MoE&P and private installation. In addition, MoE&P implements 14 biogas installation projects utilizing night soil of prison such as Embu prison.

The Association of Biogas Contractors of Kenya (ABC-K) has been formed with about 30 biogas construction companies. It can be said that household-base biogas system with 6-12 m^3 digester has become the market-based technology in Kenya. However, problems are found such as leakage of digester due to poor concrete and piping work and formation of scum which prevents biogas outflow. Design and skill of contractor still have the spaces to be improved.

Meanwhile, scale of public facility and private industry, with digester size more than 50 m^3 and with generation system, have not yet been introduced widely. Power generation system using biogas is still at the testing and demonstration stage in Kenya.

There were about ten biogas generation projects implemented with the support of various agencies. As the public-private partnership (PPP) project, MoE&P implements flower farm biogas generation projects in Thika and Isinya. Kilifi Sisal Plantation biogas is operated by sisal plantation utilizing cow dung and sisal waste.

Biogas projects in Homabay, Bungoma, Wema, and Kamahura conducted by UNIDO had challenges such as absence of operator, inadequate feedstock selection, and luck of funding.

The list of biogas of eight generation projects is shown in the table in the next page. REA installed two biogas generation systems in public schools, which is described in Chapter 2.11.2.

From the issues and challenges in sustainable operation of the past biogas projects, the following key lessons were observed.

- In addition to the overall manager, at least two technicians should be adequately trained during the construction and installation phase. This training is provided by the contractor and should be monitored as well.
- Appropriate feed stock should be selected for biogas production through anaerobic digestion.
- The biogas generation system should be as simple as possible for easy O&M.
- Supporting functions by organizations or experienced private companies are necessary in O&M for trouble shooting and sustainable operation. Budgetary allocations to contract such service providers should be planned for and included in the operation accounting system.

- In addition to the technical aspects, capacity building in project management including data recording and accounting is important, and should be addressed enough in the training.

Table 2.11.2 Biogas Generation Projects in Kenya

No.	Biogas generation Project	Equipment and Capacity	Year	Feedstock	Current Condition	Ownership	Assumed Demand	O&M Status
1	Kilifi Sisal Plantation	Digester 750 m^3, 150 kW modified diesel engine (75 kW x 2 units)	2007	4 t/day (cow dung by 250 cows: 40%, sisal waste: 60%)	In operation. Generator is operated 36 hours continuously every time to exhaust all available gas.	Kilifi Sisal Plantations Ltd.	Internal demand for sisal processing and milk cooling	Plant is operated by Biogas Power Holdings EA. Grid connected but PPA is not conclued. Annual generation is 200,000 kWh/year.
2	Nyongara Dagoretti	Modified 9 kW generator, Stove	Mar 2010	Meat waste	In operation, 2-6 am. Maintenance is well conducted by staffs of the owner and KIRDI.	Nyongara slaughter house operates, KIRDI manages.	Lighting, crane, air compressor	Manual were provided but no drawing. No inventory of spare parts. Monthly reports recorded. Manual feeding to hydrolysis tank is a heavy task. Digester temperature needs monitoring.
3	Homabay Municipal	Biogas/diesel 9 kW (40 m^3/day)	Nov 2008	Meat waste	Facility building is not completed. Operation is not started yet.	Homabay Municipal Counsil	Internal power, fish processors	Two operators are ready for operation. Supported by KIRDI.
4	Bungoma Municipal	Biogas/diesel generator 9 kW (40 m^3/day) Battery	Apr 2008	Meat waste	After 3years operation, not being operated now. Operated until early 2012.	Bumgona Municipal Cousil	Internal power, street light, water pumping, mobile/LED charge	Manual were provided. The operator trained during construction had left, and the system was stopped. Operation requires 6 times/day feeding and 3times/ day stirring.
5	Wema, Bamburi, Mombasa	Modified 9 kW generator, (20m^3/day) Stove	Sep 2007	Market fruits and vegetable	Not operated. System was dismantled. 2-week after stating, digester wall was collapsed and repaired. Poor operation was conducted for a year and gas was used only for cooking.	Wema Center NGO	Internal use, mobile charge	Two operators were trained but they were lack of technical knowledge. No records. Charging station was never used.
6	Kamahuha, Muranga	10 kW (china), 25 m^3/day Battery Stove	Mar 2008	Banana stem	Not operated. Poor operation was conducted in 6 months. Total gas was 387m3.	Kamahuha bababas CBO	Mobile/LED/ Car battery charge, ICT,	No technical operator. Technical problem is not solved.
7	Eureka Holdings Ltd.	200 m^3 digester 55 kW CHP	Apr 2013	Flower waste	In operation	PPP	Pumping and watering	Good, but gas production amount was observed to be smaller than as it was planned.
8	Isinya Roses and PJ Dave Flora	400 m^3 digester 100 kW CHP	Apr 2013	Flower waste	In operation	PPP	Pumping and watering	Good.

ICT: Information and Communication Technology, CBO: Community Based Organization, KIRDI: Kenya Industrial Research and Development Institute. CHP: Combined Heat and Power.
No.1 is PPP with GIZ. Data is obtained in site survey. No.2 to 7 is summarized from "Survey to establish the status of UNIDO Energy Kiosk/community Power Centers, Sep 2012". The detail of the investment cost is unknown.

Prepared by JET

2.11.2 Technical Transfer

(1) Objectives

Technical cooperation for biogas technology focused on knowledge transfer to counterpart personnel through preparation of Pre-F/S, preparation of guideline, conducting seminars, and monitoring of REA's and other existing biogas projects.

The main objectives of the technical cooperation are as follows:

- To assist REA in developing a sustainable approach for the implementation of biogas generation projects.
- To develop technical guidelines for biogas generation system to be applied for future REA's projects.
- To develop technical capacity of REA personnel for planning and implementation of biogas generation projects

For the successful implementation of biogas projects, technical considerations have to be adequately provided. This includes components such as project planning, design, construction supervision, testing and operation and maintenance. Accordingly, comprehensive technology transfer was required to build the capacity of REA to plan for and implement biogas power generation projects.

(2) Methodology

In order to achieve the above objectives, a number of activities were carried out collaboratively by the JICA Expert and REA's counterpart personnel.

The main methods for conducting technical cooperation for biogas generation are as follows:

- Conducting joint site visits and surveys of existing and planned REA sites
- Provision of advice and review for planning, cost estimation, and design in Pre-F/S
- Support for documentation of and presentation for technical seminar
- Preparation of guidelines/manuals based on the needs of REA's counterpart personnel.
- Provision of technical advice for implementation of other REA's biogas projects.
- Provision of monitoring equipment and training for biogas monitoring and evaluation

The JICA expert will provide technical support for the above activities. Results/outcomes and issues were shared and discussed with the key staff and the technical manager. The technical manager was called upon to participate in activities of greater importance or complexity including discussing the content for the guidelines/manuals and review of drafts for feedback.

(3) Target

Technical cooperation for biogas generation will focus on knowledge transfer to the counterpart personnel listed below:

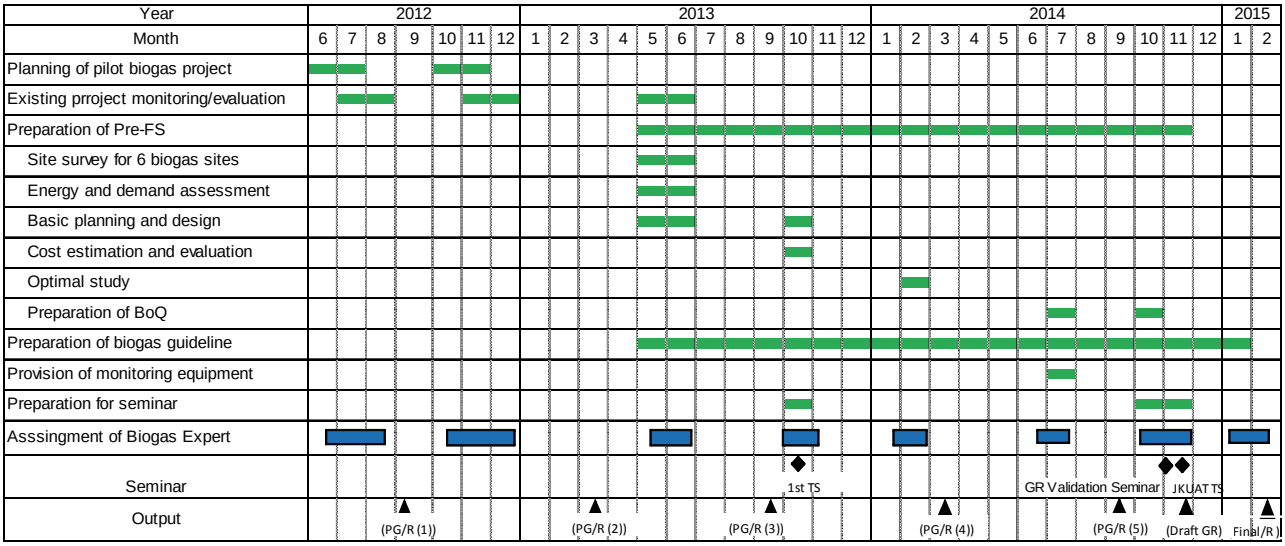
- Mr. James Muriithi- Technical manager for biogas
- Ms. Caroline Kelly- REA's key counterpart staff for biogas
- Mr. Gilbert Gichunge - REA's counterpart staff for biogas

Activities for Pre-F/S, seminar, and preparation of guideline were carried out collaboratively by the JICA Expert and counterpart personnel.

(4) Schedule

The schedule for implementation of the above items and activities is shown in the table below.

Table 2.11.3 Schedule of Technical Transfer (Biogas)



Prepared by JET

The communication for technical transfer was conducted by e-mail when the JICA expert was not in Kenya throughout above period.

In addition, site visits were conducted together with the counterpart and technical transfer for survey and planning were conducted. Site memos are attached as Attachment L-5.

(5) Technical Transfer Seminar

The technical transfer seminar of biogas was conducted on 25 October 2013 in REA. The objective of the seminar was to review the understanding of the counterpart at the middle stage of the technical transfer, and apply the findings s to the latter half of the technical transfer. Biogas working group (WG), consists of REA counterpart staff and JICA expert, prepared the presentation materials. The biogas technical seminar included following contents.

(i) Basics and Characteristics of Biogas,
(ii) REA Biogas System Model,
(iii) Lessons learnt from Past Biogas Projects,
(iv) Site Survey, and
(v) Basic Plan and Pre-F/S: Energy Production and Demand Assessment, Benefit Assessment, Basic Design, Cost Estimation, and Economic/Financial Evaluation.

The counterpart presented about the above. All of the attendants were REA counterparts. They exchanged knowledge that they had learned beyond expertise.

The biogas counterpart showed enough understandings for basics and characteristics of biogas, system model, lessons learnt from past projects, and site survey. Meanwhile, there was space to enhance understandings for design and economic/financial evaluation. The technical assistance of the latter half of the project made importance on such items.

Photos taken by JET

Photo 2.11.1 Seminar for Biogas, Presentation by Counterparts

The seminar material is attached in Attachment L-3. The technical seminar was followed by two other seminars, (i) the Guideline Validation Workshop (See chapter 2.11.4) and (ii) JKUAT Technical Conference. (See Chapter 2.14.3).

(6) Monitoring of REA's Biogas Generation Projects

In 2011, REA installed its first biogas generation projects in two schools located about 50 km from Nairobi (Mangu High School and Moi Girls' High School). Site visits were conducted by WG for the monitoring of operation and management status and data collection for the evaluation. Technical transfer for monitoring and evaluation method was conducted at/after the site visits. The site visits also highlighted lessons learnt in planning, design, and management for the future biogas generation projects.

Salient features of the two projects implemented by REA are summarized in the table below.

Table 2.11.4 Salient Features of REA's Biogas Generation Projects

Description	Mangu High School	Moi Girls' School
Location	Mangu Thika	Isinya
Installation Cost	KSh. 5,446,432	KSh. 5,338,320
Feedstock	1,000 students and 40 cows	700 students (670 staying in dormitories)
Date of Commissioning	February 2011	Not completed yet
Biogas Digester Capacity	Total 250 m^3 100m^3 x 2 + 50m^3 x 1	Total 200 m^3 100m^3 x 2
Biogas Bag Capacity	20 m^3 x 1	20 m^3 x 1
Generator Specification	Biogas generator, 20 kVA, 3 phase	Biogas generator, 12.5 kVA, 3 phase, 1500 rpm
Contractor	Biopower Systems Ltd.	Biopower Systems Ltd.
Assumed Load	15 hp (12 kW) water pump	5 hp (4 kW) water pump

Prepared by JET

The photos of biogas site visit are shown below.

Photos taken by JET

Figure 2.11.1 Biogas Digester and Biogas Generator in Moi High School

Based on the site surveys conducted, the current statuses of the two projects were found to be as follows:

1) Biogas Generation System in Mang'u High School

a) The system was well operated and the operator/technician had sufficient knowledge and understanding of operation and maintenance techniques. A part of energy generation data had been recorded, which was used for evaluation.
b) The quantity of gas being produced is considered to be about 1/3 of the expected quantity based on the system design, in terms of capacity and feedstock input.
c) The gas bag was found to have a leak, which needs to be sealed to ensure safety as well as effective storage and use of the biogas. The leak may also be a cause of the low gas quantities reported.

2) Biogas Generation System in Moi Girls' High School

a) The system had not been commissioned yet, as gas production has not started.
b) The toilet connected to the digester was being utilized, and sewage goes into the digester. The quantity of water used to clean the toilets is higher than the requirement for the digester (2.5 ton /day, while appropriate water amount was 0.6 ton/day for 670 students).
c) Detergents used to clean the toilets flowed into the digester, which includes disinfecting agents such as Chlorine. It is highly possible to negatively affect the bacteria present in the digester.
d) The valves at the digesters were corroded and there was a gas leakage.
e) The effluent was overflowing from the soak pit.

From above result, following recommendations were provided as the lessons learnt.

- If the digester uses cow dung only as the feedstock, the effluent from the digesters can be utilized as fertilizer. If the garden is located in an area of lower elevation than the digester, the effluent can be channeled through an open ditch by gravity.
- For toilet digester, excess delusion should be avoided. The quantity of water used to flush the toilets should be limited to be about 1L/person.
- Detergents, especially those with Chlorine should not be used for cleaning the toilets. Only biodegradable detergents should be used for cleaning purposes.
- The effluent from human waste digester is currently connected with septic tank. This is effective since BOD and organic component is much reduced in biogas digester. Effluent

may be used for fertilizer, but it may contain helminthes eggs or coliform. It can therefore be utilized as fertilizer only when appropriate and adequate care is taken. The system operator should wear protective gear such as gloves and boots. Vegetables growing in the areas where the effluent is flowing should not be eaten raw.

- Use of cow dung as feedstock in addition to human waste is recommended in order to provide favorable bacteria for biogas generation.
- One toilet which is not connected to the digesters should be assigned to students taking medication to prevent antibiotics from entering the digester.
- Management of disposal of sanitary towels is necessary to prevent such waste from entering the digester.

All the above issues and recommendations have been reported and discussed with counterpart personnel from REA. In 2014, REA prepared the rehabilitation work of Moi Girls High School.

(7) Equipment for Survey and Monitoring

There had been no monitoring tool for biogas system in REA. For monitoring, the equipment shown in the following table was procured for the use of survey and monitoring of biogas projects of REA in June 2014. The method of usage was instructed to the counterpart for monitoring and evaluation.

Table 2.11.5 Monitoring Items

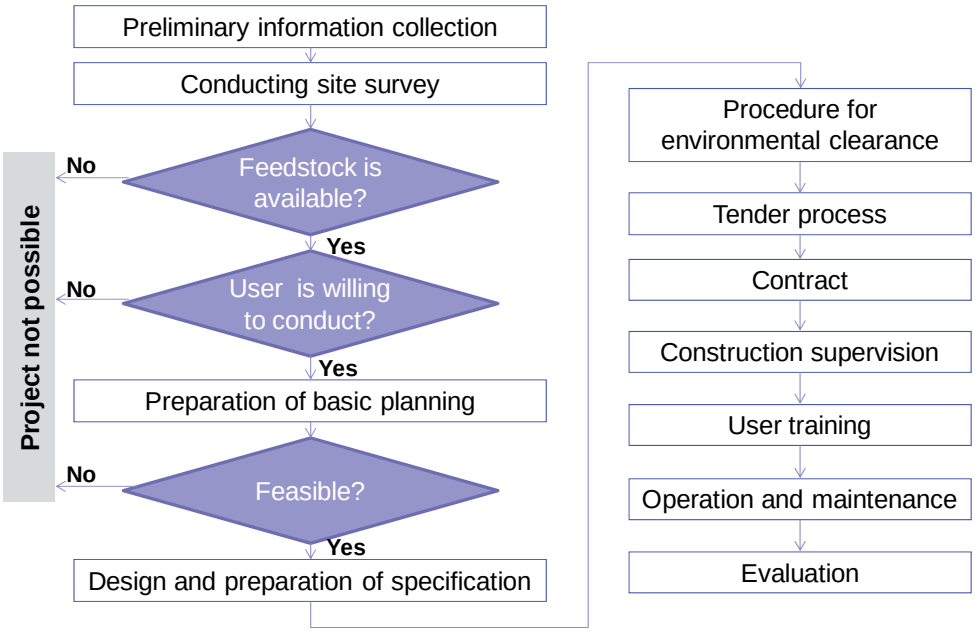
Item	Measurement	Description
pH meter	pH value	pH is the indication of acidity and alkalinity condition of slurry inside a biogas digester. Optimal pH is 7-8.5. Low pH and acid condition disturbs methane producing bacteria activity, and feedstock type or input amount needs to be reconsidered when acid condition is observed.
Methane Detector	Methane concentration, %	Percentage of Methane in biogas indicates the status of biogas production. Methane detector measures existence of methane. The concentration value is not very accurate. To measure precise methane concentration, gas chromatography analysis is necessary.
ORP Meter	Oxidation Reduction Potential (mV)	To measure oxidation and reduction potential (ORP). ORP is the indication of the extent of anaerobic condition in the biogas digester. Anaerobic digestion needs negative ORP condition. If ORP is positive, leakage may occur or feedstock is not appropriate.
Laser Distance Meter	Distance (up to 80 m)	This equipment is used in survey and design of biogas system. Distance measured between buildings and facilities is required to determine pipe digester layout and length.
GPS	Coordinate and elevation	Identification of exact location is required in planning. Elevation is used to determine facility layout.

Prepared by JET

2.11.3 Simple Pre-feasibility Study

The implementation of five biogas generation projects had once been planned by REA in FY2012-FY2013. For this, REA conducted preliminary information collection of 10 biogas sites, and information about location and possible amount of feedstock was obtained in early 2013. It was determined that six (6) sites out of these 10 candidate sites were selected to conduct surveys for the simple Pre-feasibility study (simple Pre-F/S).

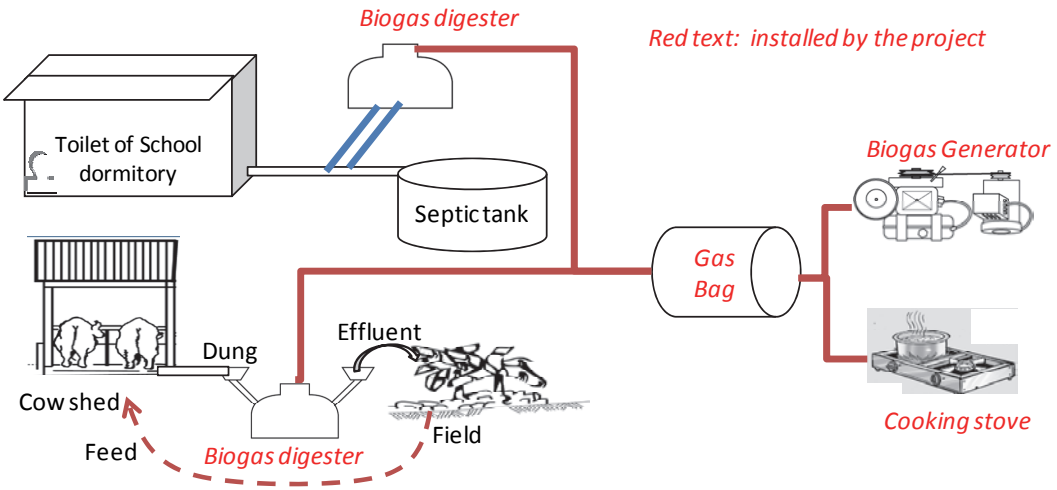
The general flow of the biogas project implementation is shown in figure below. In the flow, simple Pre-F/S included up to design and preparation of specification.



Prepared by JET

Figure 2.11.2 Flow of Biogas Project

The basic system concept applied in surveyed six (6) schools in the Pre-F/S is shown in the Figure 2.11.3.



Prepared by JET

Figure 2.11.3 Basic Concept of Biogas System

Above is the proposed implementation model for the biogas system of government projects. This has an advantage in terms of followings:

- Human waste is collective with sewer system and septic tank
- Generally schools have dormitory and own cows for milk supply. Cow dung is the best source of biogas.

Above system is selected as replicable model of biogas project implementation in schools and other public facilities such as prisons in Kenya. The feature of the above system is as follows:

- Human waste is collected in septic tank. Biogas digester is installed between toilet and septic tank. Effluent from digester will enter existing septic tank. After methane

production; solid waste, BOD, and pathogens will be reduced in the digester, and organic load to septic tank is reduced by the digester.

- Cow dung from cow shed is collected in a digester through a trench. After degradation and methane production in a digester, effluent can be used as fertilizer to increase yield of garden vegetables and feed. The feed will be supplied to cows. This enables material cycle while producing biogas energy.
- Biogas produced in digesters is collected once in gas bag, and can be used either/both for generation by biogas generator or/and cooking stove.

The items of simple pre-feasibility with the above system in six (6) schools included:

(1) Outline Feature
(2) Purpose of the Project and Justification of Selection,
(3) Particular Features of the School,
(4) Preliminary Design,
(5) Energy Production and Demand Assessment
(6) Benefit Assessment,
(7) Simple Cost Estimation, and
(8)Financial Evaluation and Economic Evaluation

Six (6) sites, out of candidate 10 sites, were jointly surveyed by WG in Nyeri, Western and Nyanza regions to collect data and information required in Pre-F/S. According to the condition and result of evaluation, the six (6) sites were ranked for the future implementation.

The photos of site visit conducted for Pre-F/S is shown in the pictures below.

Photos taken by JET

Figure 2.11.4 Candidate Location of Digester, Toilet connected to Digester, and Cow Shed

The result of cost estimation, economic and financial analysis, and ranking is shown in the table below.

Table 2.11.6 Result of Cost, Economic Analysis, and Ranking

Base condition:

Diesel Oil Price	110.00	KSh/L
Diesel efficiency	2.40	kWh/L
Emission factor of electricity	0.81805	ton-CO_2/MWh
Price of fuel wood	3,300	KSh/ton
Exchange rate	86.28	KSh/US$
Carbon credit	1,294	KSh/ton-CO_2 (15US$/ton)

Item	Unit	Nyeri High School	Rware High School	Litein High School	Kipsigis Girls High School	Mukumu Girls High School	Cardinal Otunga High School
Project Cost	KSh	3,755,264	1,453,168	6,861,967	3,658,669	4,271,187	4,703,232
Planned gas production for fuelwood saving	m^3/yr	6,248	3,285	4,466	1,533	4,822	4,411
Planned gas production for electricity saving	m^3/yr	2,321	0	4,380	5,179	2,683	4,380
Annual planned generated energy	kWh/yr	2,321		4,380	5,179	2,683	4,380
Annual planned fuelwood Saving	ton/yr	36.3	19.1	25.9	8.9	28.0	25.6
Financial benefit	**KSh/yr**	**165,466**	**62,945**	**164,856**	**130,357**	**174,026**	**171,690**
Total economic benefit	**KSh/yr**	**620,758**	**269,170**	**571,344**	**368,448**	**554,544**	**566,853**
EIRR		**15.09%**	**16.44%**	**5.85%**	**7.79%**	**11.27%**	**10.26%**
Ranking		**1**	**5**	**6**	**4**	**2**	**3**

Note: Shadow exchange rate is not considered in financial cost.

Prepared by JET

For the first ranked project, Nyeri School, detailed study was conducted to select optimal system component and to prepare BoQ and specification at Pre-F/S level.

The financial return for electricity and cooking fuel from the same amount of biogas was calculated to be 19.2 KSh/m^3 for fuel wood replacement and 19.7 KSh/m^3 for electricity supply. Those were almost the same at the present electricity tariff rate (19.7 KSh/kWh) and fuel wood price (3,300 KSh/ton), in case of Nyeri project. For generation system, engine maintenance is challenging especially in rural areas, and O&M requirement becomes a hurdle for sustainable operation for users. Considering higher installation and O&M cost necessary for the generation system, simple fuel wood replacement system is considered to be more efficient and sustainable.

As the conclusion, all the six schools visited have potential for generating biogas from the available waste. Except one school, all biogas systems are considered to be economically feasible. This biogas can be used to reduce the amount of fuel wood and electricity that the institutions are currently using. Biogas used for thermal application, i.e., cooking fuel replacement, is more economically feasible than the one used for generating electricity, considering installation and O&M cost for generation system.

The conclusion suggested that although biogas system is applicable both for fuel wood replacement and electric energy saving, simple system only for fuel wood replacement is the most sustainable especially in rural areas, where it is difficult to find and train skilled operators. Optimal system components should be selected in view of economic efficiency and feasibility in biogas projects, considering demand and possible energy supply

The works of Pre-F/S were jointly conducted with the counterpart staff, and the methodology of the Pre-F/S was transferred to the counterpart.

REA plans to conduct feasibility study (FS) based on the output result of Pre-F/S for Nyeri project in the next stage.

The document of Simple Pre-feasibility Study on School Biogas Systems in Kenya is attached in Attachment L-2.

Above result of the simple Pre-F/S was summarised in the technical paper and was presented in the poster presentation in JKUAT conference. The materials are attached in Attachment L-4.

2.11.4 Technical Guideline

This Guideline for Biogas Generation was prepared by a Working Group (WG) of JET and counterpart staffs in REA for the implementation of biogas projects in public facilities.

(1) Contents of the Guideline for Biogas Generation

The Guideline was prepared for the sustainable planning, implementation, O&M, monitoring and evaluation of biogas generation systems for public facility electrification projects by Rural Electrification Authority, Kenya (REA). The intended readers of this Guideline are government and organization staff and users who will implement biogas generation projects. This Guideline can be utilized for site survey, planning, basic design, preparation of specifications, construction supervision, O&M, recording, and evaluation of biogas generation projects.

The targeted scale of biogas systems is digester volume up to 100 m^3 and biogas generators up to 20 kVA. This is a suitable scale for secondary schools with up to 1000 boarding students. For medium to large scale projects, i.e., more than 50 kW capacity, the planning, design, and O&M will be site specific, and is beyond the scope of this Guideline. However, basic knowledge and requirements are common and can be utilized regardless of the scale of biogas projects being implemented.

The Guideline consists of the following three sections:

- Part-1 Guideline for Biogas Generation Planning
- Part-2 User Guideline for Biogas Generation Operation
- Part-3 Guideline for Monitoring and Evaluation

Part-1 is prepared for government and related organization staffs who are in charge of studying, planning, designing, evaluation, and procurement of biogas generation system. The main target of the guideline is for public institutions such as schools, which have replicability of various projects. Large private-base projects require specific planning and design, which should be formulated in respective feasibility study, and those are not the target of this Guideline.

Part-2 is prepared for the users of biogas generation system in facilities. This part includes general description about biogas system operation and maintenance. Biogas digester type and generator sets will depends on manufacturers and user manual from respective manufactures should be obtained and given to the user together with this part of the Guideline.

Part-3 is prepared for the staffs who conduct monitoring and evaluation, such as government, founder, and donor agency. This part includes items and method for monitoring and evaluation.

This Guideline for Biogas Generation is attached as Attachment L-1-1.

(2) Guideline Validation Workshop

The Guideline Validation Workshop was held on 6 November 2014. For the validation procedure, draft guideline was sent to stakeholders such as donor organizations (JICA, GIZ, and IDA), companies of biogas contractors association, Kenya Renewable Energy Association, university (JKUAT) for their review. JICA, GIZ, MoE&P, and ABC-K had attended the validation workshop and discussions were held. The key discussions were:

- The attendant mentioned that draft standard for biogas is under public review by KNBS, and after its publication, it should be incorporated into the guideline. WG replied that guideline will be updated accordingly.
- Technician of contractor should be locally available and the Guideline should be useful.
- The reason why digester size is limited to 100 m^3 was inquired and WG replied that it was determined considering replicability and typical amount of feedstock availability.

WG took note for such discussion and the contents were reflected to the final guideline.

The presentation material of the Guideline Validation Workshop is attached as Attachment L-1-2.

2.11.5 Technical Recommendation for Rural Electrification

(1) Challenges

Many challenges were identified in the field of biogas technology in Kenya during the technical assistance activities. Based on the challenges, following technical recommendations are proposed as shown in the table below.

Table 2.11.7 Challenges and Recommendation for Biogas System in Kenya

SN	Challenges	Recommendations
1	Insufficient capacity of local government at county and district (sub-county) level	Capacity enhancement programme of local government at county and district (sub-county) level is necessary in terms of data collection, planning, implementation, and construction supervision of biogas systems.
2	Lack of information linkage between local user and supplier for O&M	Information chain of user and supplier should be established at the local level with coordination of local government as necessary to enhance sustainability. Local users should be able to make contact to local authority and local suppliers in case of any trouble.
3	Insufficient knowledge and experience of private contractor for biogas system in terms of quality management	Orientation and guidance and provision of technical standard for private supplier are required for proper construction and quality assurance. Full-time construction supervision should be provided by the Engineer.
4	Necessity of construction supervision and supplier control in public projects and also lack of budget for it	Construction supervision should be provided from the government side in public projects. If necessary, consultants should be hired and the budget for it should be allocated.
5	Insufficient understanding of user about O&M, missing of succession of necessary knowledge about O&M or lack of operator due to staff change	Sufficient user training should be provided by the contractor. User participation is required from the stage of planning, construction supervision and also in the O&M training. The achievement of user training should be monitored and evaluated by agencies in public projects. The number of users who undertake training should be more than three. O&M manual should be provided both in paper and electronic file and kept in the facilities so that users can duplicate.
6	Application of complicated and costly system for biogas generation and selection of hard feedstock for users in public and donor project, which causes difficulties of O&M after the project period	Sufficient study should be conducted on the system design and economic/financial analysis, considering local condition and availability of operators, based on field survey and data collection before implementation. Optimal system should be selected according to the result of study.
7	Necessity of enhancement of data collection and monitoring record for project evaluation	For public project, monitoring system and an easy -to –handle reporting format should be provided to the users.
8	Government's vertical administrative structure and insufficient information sharing among ministries and donors, which causes duplication of roles and objectives.	Inter-Ministerial approach and donor coordination is necessary for efficient implementation of projects that require sufficient information sharing and role demarcation.

Prepared by JET

(2) Recommendation for Off-grid Biogas Application

For energy supply in off-grid areas, biogas is more feasible for cooking fuel than that of for the electricity. The reasons are:

1) Biogas requires continuous bulk feedstock input. Meanwhile, scale of feedstock production in public facilities such as schools and community is small in off-grid areas. For example, 300-400 kg/day of cow dung are required to generate 10 kWh/day electricity. It is difficult to collect feedstock quantity at such level for generation purpose.

2) Maintenance for generation such as engine oil supply, spare parts for engine, replacement of filter, and engine overhaul, is difficult in off-grid areas. Meanwhile, cooking fuel supply does not require maintenance of mechanical component and its O&M cost is small.
3) Initial cost for generation system is high and financial feasibility of generation system is low in off-grid areas.

Biogas generation project in off-grid areas should be promoted only if sufficient feedstock and skilled operator is confirmed to be available in the target area. Sufficient potential and feasibility study should be conducted to assess the sustainability for this.

(3) Recommendation for On-grid Biogas Application (Public facilities)

The objective of biogas in on-grid areas is to save electricity and to reduce usage of fuels such as fuel wood, LPG, coal, and charcoal.

Biogas project should be conducted after study of demand and energy, economic and financial analysis in feasibility study, and selecting optimized system. Biogas can be applied both (i) alternative cooking fuel and (ii) electricity supply replacing grid electricity. Generally, the amount of biogas produced from feedstock in facility does not cover all the consumption of internal energy requirement. Accordingly, the system should select most cost-effective fuel type to save energy usage.

Since generation requires engine, generator, electric boards, etc., the investment cost and O&M cost is higher than it is with cooking fuel supply only. It should conduct feasibility study including optional cases of (i) including generation and (ii) supply for alternative cooking fuel only.

(4) Other recommendations

- Feasibility study should be conducted with sufficient economic and financial analysis based on field survey and data collection and analysis about demand and feedstock production. Optimal system should be selected according to the result of feasibility study.
- In design, optimal layout should be considered. For example, pipe route should not be too long to avoid pressure loss. Layout of cow dung digester should consider vertical arrangement of digester, expansion chamber, and garden to enable automatic effluent transport by gravity.
- For biogas connected from toilet, notification for toilet users should detergent with disinfecting agent should strictly be prohibited for cleaning toilet. Biodegradable agent should be used. Amount of water flush should be maintained to optimal concentration for digester, since water in flushing toilet tends to be too much and substrate in digester is too diluted for anaerobic digestion. Such items should be included in the contract with a contractor, and check the extent of users' understanding at the commissioning test.
- Full-time engineer staff or consultant should be assigned for construction supervision during supplier's construction work, testing and commissioning, and user training, to ensure progress and quality of works. Sufficient budget and human resource should be secured for construction supervision.
- Safety should be thoroughly checked during construction. Leakage through pipelines and gas bags and safety arrangement to prevent fire should carefully be checked before backfilling.
- Monitoring forms including produced gas amount, generated energy, electricity tariff, usage of fuel food, etc., should be recorded by users and be submitted to REA for monitoring. Financial and economic evaluation of the project should be conducted accordingly, according to the guideline.
- Guideline for Biogas Generation prepared in the technical assistance should be utilized for planning, survey, energy and demand assessment, design, procurement, construction supervision, monitoring, and evaluation.

2.12 Technical Cooperation for Wind Power Technology

For wind technology, technical transfer was carried out focused on analysis of wind power. In this Project, site survey for existing two Wind-Diesel Hybrid systems were conducted together with REA C/Ps. In addition, simple-Pre-F/S for Wind Diesel Hybrid system was carried out in Baragoi. Guideline was also prepared together with C/Ps of REA. Technical recommendations for rural electrification using wind are also written in this Chapter.

2.12.1 Review of Existing Studies

Multiple sources of information on the wind resource potential in Kenya were reviewed. The data taken into consideration to determine the viability of the wind pilot project was derived from the documents and materials listed below.

Table 2.12.1 List of Collected Documents and Data

No.	Document	Organization	Format	Year
1	Wind Data (Dol_Dol 092010-082011)	MoEn	pdf	2011
2	Wind Data (Kapiti_Plain 052011-082011)	MoEn	pdf	2011
3	Wind Data (Kieni 072010-082011)	MoEn	pdf	2011
4	Wind Data (Kilimambogo 042011-082011)	MoEn	pdf	2011
5	Wind Data (Maili_Nne__Nyahururu 062011-082011)	MoEn	pdf	2011
6	Wind Data (Narok 072010-082011)	MoEn	pdf	2011
7	Wind Data (Njabini 072011-082011)	MoEn	pdf	2011
8	Wind Data (Nyambene_Hills 032011-052011)	MoEn	pdf	2011
9	Wind Data (Tharaka 032011-082011)	MoEn	pdf	2011
10	Wind Energy Resource Atlas of Kenya	MoEn	pdf	2003
11	Kenya Energy Atlas	UNDP/GVEP	pdf	2005
12	Solar and Wind Energy Resource Assessment (SWERA)	UNEP / GEF	pdf	2004
13	Hybrid Energy System for Off – Grid Rural Electrification	Department of Wind Energy Gotland University	pdf	2011
14	Assessment and Utilization of Wind Power in Kenya – A Review	University of Nairobi	pdf	2008
15	Wind Data (Habaswein 072011 – 012013)	MoEn	excel	2013
16	Wind Data (Baragoi – 092010 – 092011)	MoEn	excel	2013
17	“ Study on Small Wind Turbines for Base Transceiver Stations and Rural Electrification”	Foreign Ministry of Japan (Contract : Zephyr Corporation, Pacific Consultants Co.,Ltd.)	pdf	2014
18	FINAL PROJECT REPORT	Wind Force Management Services Pvt.Ltd.	pdf	2013

Prepared by JET

2.12.2 Technical Transfer

Overall, wind power development in Kenya is in the early stages of the dissemination. The project aims to build the capacities of REA and MoE&P and improve on the knowledge required for development and implementation of wind power projects.

(1) Objectives

- Existing information on wind power projects is collected and summarized.
- Prepare guideline for wind power development and implementation
- Enhance the capacity of REA and MoE&P to successfully develop and implement projects using wind power

(2) Methodology

The basic approach to technical cooperation and transfer was “on the job training”. In order to achieve the above objectives, a number of activities were carried out collaboratively by the JICA expert and REA’s counterpart personnel.

The main methods for conducting technical cooperation for wind power technology are as follows:

- Review of existing wind projects and development plans
- Conducting technical transfer seminars
- Preparation of guidelines/manuals on wind power technology

Technical cooperation for wind power technology was focused on knowledge transfer to the counterpart personnel listed below:

Mr. Hannington Gochi- REA

Ms. Colleta Koech - REA

(3) Results of Activities

Technical cooperation for wind power technology is comprised of the items and activities summarized below.

1) Review of existing wind power projects and development plans

- Review of existing wind power systems (micro and small class, hybrids and middle and large class) was conducted to determine the current status and technical aspects
- Review of existing wind power development plans to determine the prevailing trend of future wind development was conducted.
- Guideline on wind power technology was prepared together with C/Ps. Through the preparation works knowledge of the wind technology have transferred.

2) Conducting technical transfer seminars

- Small-scale Wind Energy System Seminar was held on 15 November 2013 at JKUAT. Presentation materials were prepared together with Japanese expert and REA counterparts. Mr. Hannington Gochi of REA explained about operational data of wind diesel hybrid system and wind potential in Habaswein. The presentation material is attached “Attachment M-3 Material of Technical Seminar for Wind”. In addition, result of the simple pre-feasibility study was presented at the JKUAT conference which was held in 13th November 2014 by Mr. Hannington of REA. The presentation material is attached in “Attachment M-4 Material of JKUAT Technical Conference for Wind”. In addition same presentation was made at International workshop which was held in 3 February 2015.

3) Preparation of guideline on wind power technology

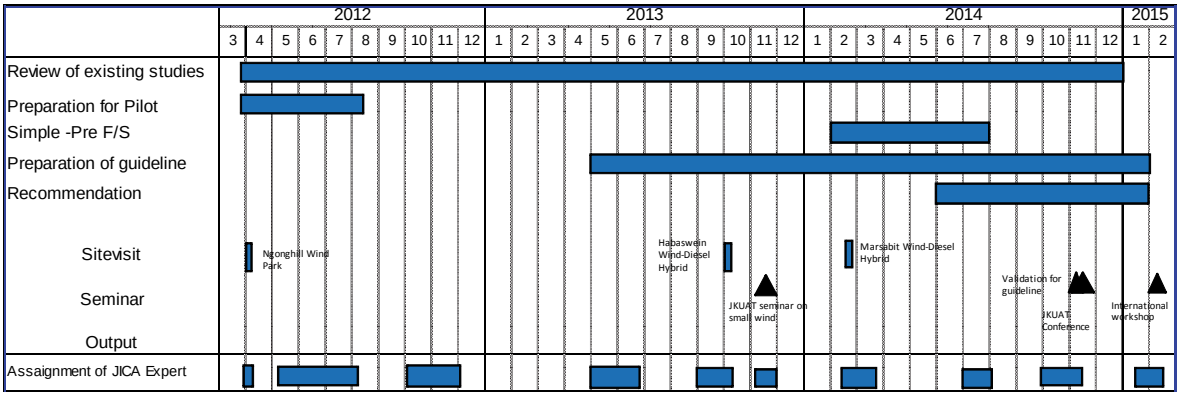
- Guideline for development and implementation of wind power projects was prepared together with counterparts of REA

- Discussion, review and transfer of knowledge on the content, technologies required for the utilization and dissemination of wind power and use of developed guideline was done in preparation process.
- A workshop to validate the guideline was carried out on 6 November 2014, at Kivi Milimani Hotel, Nairobi.

(4) Schedule

The schedule of activities on wind power is shown in the table below.

Table 2.12.2 Schedule of Technical Transfer (Wind)



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2.12.3 Simple Pre-feasibility Study

As for simple pre-feasibility study of wind technology, Diesel-Wind hybrid system was studied. In Kenya, small scale isolated wind power stations have been introduced through private sector, especially for base station of mobile phone in remote areas. In addition, public facilities such as schools and dispensaries are being electrified by solar PV. Selection criteria of simple pre-F/S are as shown below.

(1) Where diesel power station is located
(2) Where wind data is available
(3) Where Japanese expert can visit

Candidate sites for the simple pre-Feasibility Study is as shown below.

- Baragoi
- Hola
- Mfangano Island

The existing wind data of Hola was not appropriate for simple pre-F/S because umber of monitored data is too small to evaluate. No wind data of Mfangano Island was obtained. Baragoi was selected as a site for simple pre-feasibility study since necessary information, both of power station and wind data were obtained.
Result of the analysis is attached “Attachment M-2 Simple Pre-feasibility Study on Wind-Diesel Hybrid System in Baragoi”.
The result of the simple pre-feasibility study was presented at the JKUAT conference which was held in 13th November 2014. The presentation material is attached in “Attachment M-4 Material of JKUAT Technical Conference for Wind”.

2.12.4 Technical Guideline

Technical Guideline for wind power was prepared with C/P of REA. Site survey for Baragoi diesel power station and wind monitoring system was carried out with the C/P. The guideline focuses on wind data analysis, estimation of power output and design of isolated wind power generation system including diesel-wind hybrid. Calculation procedures and information on the wind power was transferred in the Project. A workshop for validation of the guideline for wind power development was made on 6 November 2014 and the C/P made presentation. The guideline was revised including results of discussions at the validation workshop.

In Chapter 1, General information of wind power development is explained. In Chapter 2, calculation procedures for analyzing wind power using spreadsheets such as EXCEL are explained. Reader can understand meaning of the calculation and analysis practically. In addition, it is useful for who has interested in the estimation of the power output from wind. Chapter 3 explains Micro and Small wind turbines which usually applied for isolated wind system with battery storage. In addition, wind solar PV hybrid system is also explained in this chapter. Chapter 4 explains Wind and Diesel hybrid system. At diesel power station, wind turbine can be intergraded to existing mini-grid if steady and strong wind is available. In Chapter 5, basics of operation and maintenance of wind turbine are written. Chapter 6 describes economical analysis on wind and diesel hybrid system. In addition isolated solar PV and small wind are compared from economical aspect. Chapter 7 explains procedures to gain environmental assessment or report. And in Chapter 8, procurement procedure is explained.

2.12.5 Technical Recommendation for Rural Electrification

(1) Wind Monitoring and Analysis

In Kenya, wind monitoring has been conducted at around 90 sites. In the wind data which was obtained for simple Pre-F/S, there are many errors in monitored data and therefore it’s difficult to use it for potential estimation. The monitoring error can be avoided by compiling and updating wind data periodically. In addition, it is proposed to check the operation of monitoring equipment regularly.

(2) Operating Record of Generation System

There are wind and diesel hybrid generation systems in Kenya. However, operational data of those systems is not collected and analysed yet. For the future installation of the wind and diesel hybrid system, operational data should be monitored and accumulated.

(3) Bidding Document for Wind - Diesel Hybrid System

Wind penetration ratio has to be calculated to indicate optimum capacity of wind and diesel generation system in the bidding documents of wind-diesel hybrid system.

(4) Preparation of Database on Wind-power Generator which is Available in Kenya

Power output from wind turbine is estimated based on the performance of turbine and wind characteristics. It is proposed to prepare specification in bid document of wind power project if a database of available wind turbine in the country is prepared.

(5) Pre-F/S for Wind Project

In implementation of project using middle or small size wind turbine, it is necessary to shorten the wind monitoring period for project design to reduce project cost. Therefore, it is recommendable for REA/MoE&P to carry out the pre-F/S at wind potential sites because they already have monitored wind data in many sites.

2.13 Environmental and Social Considerations

The following environmental and social conditions in Kenya recognized by reviewing existing relevant literatures, reports and books have been shared with REA staff as the initial step of the Technical Cooperation in the field of the environmental and social considerations.

2.13.1 Natural Environmental Features of Kenya

(1) Land Profile

The land profile of Kenya can be summarized as shown in Table 2.13.1.

Table 2.13.1 Land Profile of Kenya

Land	Overview
Topography	✓ The altitude varies from sea level to the peak of Mt. Kenya, situated north of the capital Nairobi, which is 5,199m above sea level. ✓ An inland region of semi-arid, bush-covered plains constitutes most of the country's land area. ✓ In the northwest, high-lying scrublands straddle Lake Turkana (Lake Rudolf) and the Kulal Mountains. ✓ In the southwest lie the fertile grasslands and forests of the Kenya Highlands, one of the most successful agricultural production regions in Africa. ✓ North of Nairobi, the Kenya Highlands is bisected by the Great Rift Valley, an irregular depression that cuts through western Kenya from north to south in two branches. ✓ The Rift Valley is the location of the country's highest mountains, including, in the eastern section, the snow-capped Mt. Kenya, the country's highest point and Africa's second highest. In the south, mountain plains descend westward to the shores of Lake Victoria.
Principal Rivers	✓ Kenya's principal rivers are the 710-km-long Tana, and the Athi, both flowing southeast to the Indian Ocean. ✓ Other rivers include the Ewaso Ngiro, flowing northeast to the swamps of the Lorian Plain, and the Nzoia, Yala, and Gori, which drain into Lake Victoria. ✓ The country shares a number of rivers with other countries; ・ The Umba, Mara, and Pangani basins shared with the United Republic of Tanzania ・ The Sio, Malaba, and Malakisi basins shared with Uganda ・ The Omo and Daua basins shared with Ethiopia and the Nile basin shared with nine other countries
Climate	✓ The climate is generally equatorial and influenced by the movement of the inter-tropical convergence zone (ITCZ) and the country's position on the Indian Ocean seafront. ✓ This influence is again modified by the altitudinal differences, giving rise to varied climate regimes FAO (2007) ranging from permanent snow above 4,600m on Mt. Kenya to true desert type in the Chalbi desert in the Marsabit District in the north of the country. ✓ The rainfall distribution pattern is bimodal with long rains falling from March to June and short rains from October to November for most parts of the country. ✓ The driest month is August, with 24mm average rainfall, and the wettest is April, the period of "long rains," with 266mm. ✓ The hottest month is February, with temperatures of 13°C to 28°C, and the coolest is July, with temperatures of 11°C to 23°C. The highlands feature a bracing temperate climate. ✓ Nairobi, at an elevation of 1,820 m, has a very pleasant climate throughout the year.
Soils	✓ The soil types in the country vary from place to place due to topography, the amount of rainfall and the parent material. ✓ The soils in western parts of the country are mainly acrisols, cambisols, and their mixtures, highly weathered and leached with accumulations of iron and aluminium oxides. ✓ The soils in central Kenya and the highlands are mainly the nitosols and andosols, which are young and of volcanic origin. ✓ The soils in the arid and semi-arid lands (ASAL) include the vertisols, gleysols, and phaeozems and are characterized with pockets of sodicity and salinity, low fertility, and vulnerability to erosion. Coastal soils are coarse textured and low in organic matter and the common types are the arenosols, luvisols, and acrisols. ✓ Widespread soil salinity, which has adversely influenced irrigation development, is found in isolated pockets around the Lake Baringo basin in the Rift Valley and in the Taveta division in the coastal provinces (FAO, 2007).

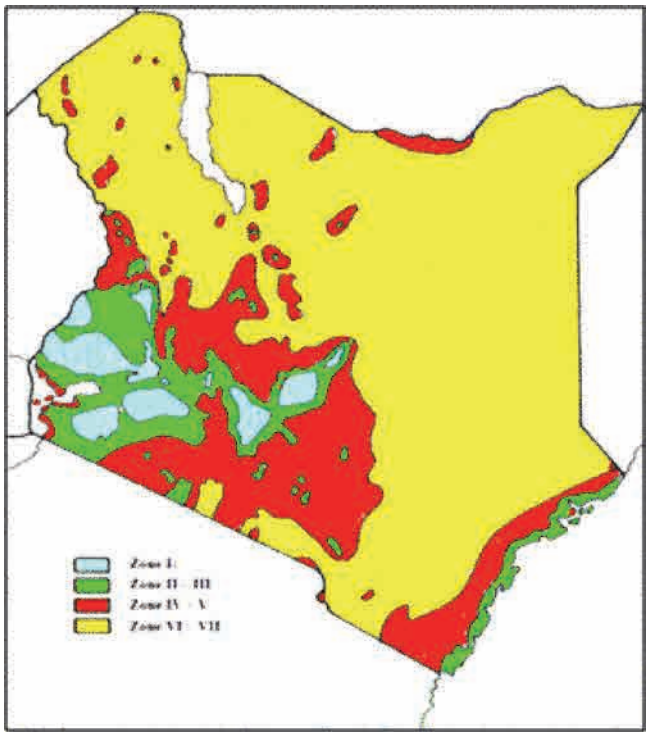
Source: KENYA NATIONAL ENVIRONMENT ACTION PLAN 2009 – 2013, 2009 NEMA

(2) Ecological Zones

National Environment Action Plan (NEAP, 2009-2013 NEMA) lists the ecological zones of Kenya as follows;

- ✓ Kenya has seven Agro-Ecological Zones that represent the major ecosystems in the country.
- ✓ The land surface area comprises 20% high to medium potential agricultural and supports 80% of the population.
- ✓ The remaining 80% of land surface area is arid and semi arid lands (ASALs) which supports only 20% of the population.
- ✓ However, it is important to note that the ASALs house 50% of the livestock and 80-90% of wildlife resources in the country (DRSRS: Department of Resource Surveys and Remote Sensing, Ministry of Environment and Mineral Resources).

Figure 2.13.1 shows the seven ecological zones.



Legend

Zone I	: Afro-alpine moorland and grassland or barren land above forest line.
Zone II	: Forests and derived grasslands and bush lands.
Zone III	: Land of high agricultural value, low forest potential.
Zone IV	: Semi-humid, annual rainfall: 700 – 850 mm.
Zone V	: Semi-arid, annual rainfall: 550 – 700 mm.
Zone VI	: Arid, annual rainfall: 300 – 500 mm.
Zone VII	: Very arid, annual rainfall: 200 – 300 mm.

(Original Source: Pratt & Gwynne, 1977; GoK, 1992)
Source: KENYA NATIONAL ENVIRONMENT ACTION PLAN (NEAP) 2009 – 2013, 2009 NEMA

Figure 2.13.1 Ecological Zones of Kenya

(3) Wild life and Protected Areas

The wildlife and protected areas of Kenya are summarized in NEAP 2009- 2013 (NEMA, 2009) as follows;

- ✓ Kenya's wildlife is one of the richest and most diversified in Africa with several of its protected areas and wetlands being internationally recognized and protected as World Heritage Sites, RAMSAR sites and Man and Biosphere Reserves.
- ✓ Kenya's wildlife resource also constitutes a unique natural heritage that is of great importance both nationally and globally.

- ✓ National parks and reserves currently occupy 8% of Kenya's land area.
- ✓ However, 80% of the wildlife is found outside the protected areas (Reference; State of the Environment Report, NEMA 2003).

In addition, "Kenya State of the Environment and Outlook 2010 (NEMA 2011)" describes the status of the protected areas;

- ✓ The area covered by protected areas grew from 12.1 % in 1990 to 12.7 % in 2007 (UNEP 2009).
- ✓ The national parks and reserves are strategically located in terrestrial and aquatic ecosystems that teem with wildlife and are globally recognized as havens for biodiversity protection.
- ✓ The biodiversity protection accorded by these national parks and reserves is complemented by private conservancies.

The protected areas in Kenya are shown in Table 2.13.2.

Table 2.13.2 Protected Areas in Kenya

Protected Areas	Covered (km^2)	Numbers
National Parks	30,348.3	24
National Reserves	16,478.4	27
Marine National Parks	70.1	4
Marine National Reserves	706.0	6
National Sanctuaries	71.3	4
Ramsar Sites	286.0	5

(Original Source; KWS 2010)

Source: Kenya State of the Environment and Outlook 2010, NEMA 2011

Among these protected areas, three have been inscribed as "Natural Heritage" sites of "World Heritage" by UNESCO, as shown in Table 2.13.3.

Table 2.13.3 UNESCO Natural Heritage Sites in Kenya

No.	Natural Heritage	Individual Site Name	Location	Year Inscribed
N1	Lake Turkana National Parks	Sibiloi National Park	Marsabit District	1997
		Central Island	Marsabit District	1997
		South Island	Marsabit District	2001
N2	Mount Kenya National Park/Natural Forest	Mount Kenya	Mount Kenya	1997
N3	Kenya Lake System in the Great Rift Valley	Lake Elementaita	Great Rift Valley	2011
		Lake Nakuru	Great Rift Valley	2011
		Lake Bogoria	Great Rift Valley	2011

Source: UNESCO World Heritage Kenya (http://whc.unesco.org/en/statesparties/ke)

Protected and conservation areas in Kenya (including "Ramsar" and "Natural Heritage" sites) are shown in the map below.

(Base Map; KWS 2010)
Note; N.P.: National Park, N.R.: National Reserve, N.F.: Natural Forest

Source: Kenya State of the Environment and Outlook 2010, 2011 NEMA (amended and modified by the JICA expert Team)

Figure 2.13.2 Protected and Conservation Areas (including Ramsar and Natural Heritage Sites)

Details for biodiversity, fauna, and flora are summarized in Attachment N-4.

2.13.2 Social Environmental Features of Kenya

(1) Minorities and Indigenous Peoples

Minority Rights Group International (MRGI) has categorized minorities and indigenous peoples in Kenya in it publication of "Kenya: Minority, Indigenous Peoples and Ethnic Diversity (MRGI 2005)" as tabulated in Table 2.13.4.

Table 2.13.4 Minorities and Indigenous Peoples in Kenya

Category	Description
Religious minorities	✓ Having been colonized by a Christian nation, most Kenyans today profess to be Christians, although there is no state religion. ✓ This has made followers of non-Christian religions religious minorities. ✓ Thus, Muslims are a religious minority in Kenya, along with Buddhists, Hindus, and those Kenyans who practice traditional African religions.
Ethnic minorities	✓ An ethnic group is a tribalistic grouping. ✓ It has a sense of common historic origins and frequently develops a sense of common destiny. ✓ Sharing a number of cultural traits and institutions, such as dress, food, language, and family patterns, nationalities generally precede the much later establishment of nation states, tracing their origins back to times before historical records were kept. ✓ Kenya's population is a composite of ethnic communities. ✓ According to the population census, Kenya has three big homogenous communities – the Kamba, Kikuyu and Luo. ✓ Ethnic minorities here are distinguished
Linguistic minorities	✓ Because ethnic groups invariably speak their own language, most ethnic minorities are similarly linguistic minorities. ✓ The Kenyan Constitution recognizes only two languages: English and Kiswahili. Kiswahili is the national language and English is the official language. ✓ Other languages are not officially recognized as national or official, save as 'mother tongues' (or 'first languages'). ✓ This makes all the African languages spoken in Kenya, apart from Kiswahili, carry the minority status. ✓ These minority languages are increasingly becoming endangered and yet more have become extinct, including the Malakote and Terik.
Indigenous peoples	✓ Post-colonial Constitutions, based on the Westminster model, have failed to recognize indigenous peoples as entities with their own cultures. ✓ Such Constitutions see land and resource ownership as individual or corporate, rather than collective. ✓ Governments are often reluctant to recognize indigenous peoples because of the implications in terms of land and resources. ✓ In Kenya, traditional indigenous activities such as pastoralism and honey gathering are not recognized as economic activities. ✓ Further, indigenous peoples are not benefiting from tourism on their lands. ✓ They are too poor to access health care and are blocked from their traditional lands, which provided traditional cures. ✓ For example, the Ogiek have been excluded from the forests, which have been declared government property, yet these had been their homes and source of livelihood. ✓ Some of the Ogiek's traditional forests include Tinet Forest in Nakuru District, Narok Forest and Mt Elgon Forest within Narok and Mt Elgon Districts respectively. ✓ The focus on the cash economy has prevented recognition of their cultural and spiritual identity. ✓ The Endorois and the Turkana are among Kenya's other indigenous communities.

Source: Kenya: Minority, Indigenous Peoples and Ethnic Diversity, by Maurice Odhiambo Makoloo with a preface by Yash Ghal, Minority Rights Group International (2005), Tabulated by the JICA Expert Team

In addition, "East Africa Living Encyclopedia, the African Studies Center at the University of Pennsylvania" describes ethnic groups and indigenous groups in Kenya on the web site (http://www.africa.upenn.edu/NEH/kethnic.htm) as follows;

- ✓ Over 70 distinct ethnic groups are in Kenya, ranging in size from about seven million Kikuyu to about 500 El Molo who live on the shore of Lake Turkana.

- ✓ Kenya's ethnic groups can be divided into three broad linguistic groups Bantu, Nilotic and Cushite.
- ✓ While no ethnic group constitutes a majority of Kenya's citizens, the largest ethnic group, the Kikuyu, makes up only 20% of the nation's total population.
- ✓ The five largest - Kikuyu (disproportionately represented in public life, government, business and the professions), Luo (mainly traders and artisans), Luhya, Kamba (represented in defense and law enforcement) and Kalenjin (mainly farmers) - account for 70%.
- ✓ 97.58% of Kenya's citizens are affiliated with its 32 major indigenous groups.
- ✓ The principal non-indigenous ethnic minorities are the Arabs and Asians.
- ✓ Almost all the Kenyan Arabs live in Coast Province, more than half of them in Mombasa.
- ✓ Over 99% of the Arab residents have Kenyan citizenship, speak Swahili rather than Arabic, and generally see themselves as Africans.
- ✓ Non-Kenyan Arabs, mainly petty traders from Yemen, are called Shihiri.

Table 2.13.5 lists the Ethnic groups in Kenya.

Table 2.13.5 Ethnic Groups in Kenya

Group	%	Language	Area	Group	%	Language	Area
Kikuyu	20.12	*Bantu*	Central	Samburu	0.50	*Paranilotic*	Rift Valley
Luo	13.91	*Nilotic*	Nyanza	Tharaka	0.45	*Bantu*	Eastern
Luhya	13.28	*Bantu*	Western	Mbere	0.45	*Bantu*	Eastern
Kamba	10.95	*Bantu*	Eastern	Pokomo	0.32	*Bantu*	Coast
Kalenjin	10.88	*Paranilotic*	Rift Valley	Boran	0.31	*Cushitic*	Eastern
Kisii	6.41	*Bantu*	Nyanza	Bajun	0.22	*Bantu*	Coast
Meru	5.07	*Bantu*	Eastern	Nderobo	0.19	*Paranilotic*	Rift Valley
Mijikenda	4.76	*Bantu*	Coast	Rendille	0.17	*Ushitic*	Eastern
Somali	2.29	*Cushitic*	Northeastern	Orma	0.15	*Cushitic*	Coast
Turkana	1.86	*Paranilotic*	Rift Valley	Gabbra	0.15	*Cushitic*	Eastern
Masai	1.42	*Paranilotic*	Rift Valley	Swahili	0.09	*Bantu*	Coast
Embu	1.08	*Bantu*	Eastern	Njemps	0.06	*Paranilotic*	Rift Valley
Taita	1.00	*Bantu*	Coast	Taveta	0.06	*Bantu*	Coast
Iteso	0.78	*Paranilotic*	Western	Sakuya	0.04	*Cushitic*	Eastern
Kuria	0.54	*Bantu*	Nyanza	Bani & Sanye	0.07	*Cushitic*	Coast

(Original Source: Kurian, George Thomas 1992. *Encyclopedia of the Third World, fourth edition*, volume III, Facts on File: New York, N.Y., p. 970.)

Source: East Africa Living Encyclopedia, the African Studies Center at the University of Pennsylvania (http://www.africa.upenn.edu/NEH/kethnic.htm)

As noted above, Kenya is composed of major three linguistic groups of Bantu, Nilotic and Cushitic speaking peoples.

These are summarized in Table 2.13.6.

Table 2.13.6 Three Major Linguistic Ethnic Groups in Kenya

Linguistics	Ethnic Groups	Descriptions
1. Bantu	Kikuyu, Meru, Gusii, Embu, Akamba, Luyha (or Luyia), Swahili and Mijikenka constitute the majority of the Bantu speaking peoples of Kenya	✓ **Kikuyu** (or Gikuyu) homeland is around Mt. Kenya and it is believed they migrated into the area from East and North East Africa around the 16th century. ✓ **Meru** are actually eight different groups of people who migrated to the North East side of Mount Kenya around the 14th century from the coast ✓ **Embu** are well known for their honey and also for dancing on stilts which is performed by men wearing long black coats and white masks. ✓ **Akamba** (or Ukambani) migrated into their present homeland, which is east of Nairobi towards Tsavo national park, about 200 years ago. ✓ **Luyha's** traditional homeland is around Kakamega in western Kenya. They are Kenya's third largest ethnic group after the Kikuyu and the Luo. ✓ **Swahili** are not really one ethnic group. The term Swahili refers to different peoples who share a common link, the Swahili language, although it is spoken with different variations and dialects up and down the coast. Sub-groups of the Swahili include Bajun, Siyu, Vumba, Pate, Mvita, Shela, Fundi, Ozi, and Amu who live in Lamu. ✓ **Mijikenka** in fact is a group of different ethnic groups
2. Nilotic	Luo, Masai, Turkana, Samburu, and the Kalenjin	✓ **Luo** are the second largest ethnic group in Kenya and they live for the most part on the shores of Lake Victoria. ✓ **Maasai** migrated to Kenya from what is today the Sudan about 1,000 years ago and constitute about 2% of the total population. ✓ **Turkana** are closely related to the Maasai and the Samburu and they live in Northern Kenya, near Lake Turkana on arid land. ✓ **Samburu** are closely related to the Maasai and their traditional homeland is around Maralal in Northern Central Kenya. ✓ **Kalenjin** are actually the name the British gave to several different ethnic groups that speak the same language but different dialects. Some of the ethnic groups that comprise the Kalenjin are the Kipsigis, Nandi, Tugen, and Elyogo**.** They mostly live in the Rift Valley and probably migrated from the Sudan about 2,000 years ago.
3. Cushitic	Somali, El Molo, Boran, Burji Dassenich, Gabbra, Orma, Sakuye, Boni, Wata, Yaaka, Daholo, Rendille, and Galla.	✓ **Cushitic speaking people** comprise a small minority of Kenya's population. ✓ **Somali** tend large herds of cattle, goats, sheep, and camels in the dry, arid lands of Northern Kenya.

Source: East Africa Living Encyclopedia, the African Studies Center at the University of Pennsylvania, (http://www.africa.upenn.edu/NEH/kethnic.htm), Modified and Tabulated by the JICA Expert Team

In addition, the main ethno-linguistic minorities in Kenya are shown in Attachment N-4.

Archeological and Cultural Sites in Kenya are summarized in Attachment N-4.

2.13.3 Statute Framework on Environment

(1) Relevant Policies, Strategies and Action Plans

Table 2.13.7 summarizes the relevant statute including Policy, Action Plan and Vision on environment and social aspects in Kenya

Table 2.13.7 Policy, Action Plan and Vision

Title	Year	Outline
National Policy on Environment and Development (NPED)	1999	NPED was drawn up in 1999 based on the premise that environmental protection/degradation is closely linked to poverty levels. The objectives of the NPED include; · To conserve and manage natural environment including air, land, flora and fauna · Promote environmental conservation with regard to soil fertility, soil conservation, biodiversity and to foster a forestation activities · Protect water catchment areas · To enhance public awareness on and appreciation of the of the essential linkages between development and environment · To initiate and encourage well-coordinated programmes on environmental education and training at all levels · Involve NGO' s, private sector, and local communities in the management of natural resources and their living environment · To support a coordinated approach to policy formulation on environment · To ensure development policies, programmes and projects take environmental consideration into account · To develop and enforce environmental standards · To provide economic and financial incentives for sustainable utilization, conservation and management of natural resources · To apply market forces, taxation and other economic instruments including incentives and sanctions to protect the environment and influence attitudes and behavior towards the environment · To ensure adherence to the polluter pays principle · To develop adequate national laws regarding liability and compensation for the victims of pollution and other environmental damage · The policy culminated into the enactment of the Environment Management and Coordination Act of 1999, which is the main piece of legislation governing environmental issues
National Policy on Culture and Heritage	2009	· The Policy states that the Government shall take all necessary steps to ensure the protection and promotion of culture and of cultural diversity among Kenyans. · The Government shall take all necessary steps to ensure the protection and promotion of the Country's national heritage · The Policy is aimed at mainstreaming culture and heritage and infusing them in public policy as integral parts of public policy and development
National Land Policy	2009	· Prior to the passage of the policy that there has not been a single and clearly defined National Land Policy since independence in 1963 · Numerous and incompatible land laws necessitated the formulation of the policy · The vision of the policy is to guide the country towards efficient, sustainable and equitable use of land for prosperity and posterity
Energy Policy	2004	The energy policy was to lay the framework upon which cost effective, affordable, and adequate quality energy service will be made available to the domestic economy on a sustainable basis for a period of 2004-2023. The objectives of the energy policy are: · To provide sustainable quality energy services for development · To utilize energy as a tool to accelerate economic empowerment for urban and rural development · To improve access to affordable energy services · To provide enabling environment for provision of energy services · To enhance security of supply · To promote development of indigenous energy resources · To promote energy efficiency and conservation as well as prudent environmental health and safety practices *Note: A new energy policy is being developed to set out national policies and strategies for the energy sector aligned to the new constitution and are in tandem with the Vision 2030*
Forest Policy	2005	· This policy was formulated to address the challenge of dwindling forest cover which currently stands at less than 10%

Title	Year	Outline
		· The policy alludes to the importance of forests as sources of energy (wood fuel), raw materials for paper and wood based industries, conservation of biodiversity, regulation of water supply, acting as carbon sinks are especially. · The goal of this policy is to enhance the contribution of the forest sector in the provision of economic, social and environmental goods and services.
Kenya Fisheries Policy (Draft)	2005	The Policy has been necessitated by among others, to promote responsible and sustainable utilization of fishery resources taking into account environmental concerns
Wetlands Policy (Draft)	2008	Formulation process has taken over 10 years (1997-2008) The development of this Policy is in cognizance of the importance of wetlands nationally and Kenya's obligation under the Ramsar Convention
Wildlife Policy (Daft)	2011	Aims to ensure sustainable management of wildlife resources
National Environment Action Plan (NEAP)	1994	· NEAP was drawn based the principles of UNCED (1992). The Objectives of NEAP include: To facilitate optimal use of national land based and water based resources in improving the quality of the human environment To promote sustainable use of natural resources To treat environmental conservation and economic development as integral aspects of sustainable development To generate income and meet national goals and international obligations by conserving biodiversity, reversing desertification, mitigating effects of disasters and maintaining ecological balance of the earth
National Environment Action Plan (NEAP) 2009-2013	2009	Second after the first NEAP after the first one in 1994 Formulation was participatory encompassing the public, private and civil society. The NEAP highlights priority themes for achieving sustainable development, the Millennium Development Goals (MDG's), Vision 2030 and medium term Plan 2008-2012 The NEAP addresses environmental issues from various sectors in an integrated manner and their significance in development planning.
Kenya Vision 2030	2007	· This is Kenya's development blueprint covering 2008-2030. It aims to transform Kenya into a newly industrializing economy, middle income economy providing high quality life to the citizens by the year 2030. The following are some of the aims of the vision in terms of energy To generate more energy at a lower cost and increase efficiency in consumption To commit to institutional reforms in the energy sector including a strong regulatory framework encouraging more private generators of power and separating generation from transmission To find new sources of energy through exploitation of geothermal power, coal, renewable energy sources and connecting Kenya to energy surplus countries in the region

Note: NEAP, *National Environment Management Plan,* ***NPED****, National Policy on Environment and Development,* ***Vision 2030*** *is Kenya's new development blue print that seeks to move Kenya into a newly industrializing, middle income country providing a high quality of life to all citizens by the year 2030. It covers a period of 2008-2030*

Source: Ministry of Environment and Mineral Resources, ECOLEX (http://www.ecolex.org), Ministry of Energy, Ministry of Lands, NEMA(www.nema.go.ke), National Environment Action Plan 2009 - 2013 (http://www.ecolex.org/server2.php/libcat/docs/LI/MON-083009.pdf), Ministry of Forestry and Wildlife, Kenya Forest Services, Ministry of Planning

(2) Relevant Acts and Regulations

Table 2.13.8 summarizes the Constitution, relevant Acts of Parliament and Regulations on environment and social aspects in Kenya.

Table 2.13.8 Constitution, Relevant Acts of Parliament and Regulations

Title	Year	Outline
The Constitution of Kenya	2010	This is the supreme law of Kenya promulgated in August 2010 and therefore any other law inconsistent with it is null and void. The constitution in part 2 of chapter 5 on Land and environment advocates for, · Sustainable exploitation, utilization, management and conservation of the environment · Achievement and maintenance of a tree cover of at least 10% of the land area of Kenya · Protection and enhancement of intellectual property in, and indigenous knowledge of, biodiversity and genetic resources of the communities. · Encouraging public participation in management, protection and conservation of the environment · Protection of genetic resources and biological diversity · Establish system of EIA, EA and monitoring of the environment · Eliminate processes and activities that are likely to endanger the environment
Antiquities and Monuments (Repealed) Act	1983	· An Act of Parliament to provide for the preservation of antiquities and monuments · The application of this Act shall extend to monuments and antiquities on the sea-bed within the territorial waters of Kenya. · It spells out how monuments are to be declared and maintained · Also spells how acquisition (compulsory) and compensation for land that has been declared as a monument can be done
Environment and Land Court Act No. 19	2011	· An Act to establish a superior court to hear and determine disputes relating to the environment and the use and occupation of, and title to, land, and to make provision for its jurisdiction functions and powers, and for connected purposes · The court is superior to a high court and it shall have original and appellate jurisdiction to hear and determine all disputes relating to environmental planning and protection, climate issues, land use planning, title, tenure, boundaries, rates, rents, valuations, mining, minerals and other natural resources, · Deals with land administration and management, and any other issue relating to environment and land
Environmental Management and Coordination Act	1999	· Came into force in 2000 · The Act provides for the creation of NEMA as the principal instrument of government in the implementation of all policies relating to the environment · The Act also stipulates how EIA is done, projects which require EIA and registration of EIA experts
Environmental Management And Co-ordination (Water Quality) Regulations, 2006, legal notice No. 120	2006	· These regulations, among other functions are meant to prevent pollution of water bodies (Lakes, Rivers, Streams, springs, wells and any other water sources · Also check on water usage to maintain acceptable water quantity and quality · Helps in maintaining the sanctity of 6-30m buffer as riparian reserve on either side of a stream or a river.
Environmental Management And Co-ordination (Waste management) Regulations 2006, legal notice No. 69	2006	· The regulations deal with all categories of wastes. · They also spell out how collection, segregation, transportation, disposal, re-use and recycling of wastes is to be done · Requirement of environmental auditing for waste disposal sites.
The Environmental Management and Co-ordination (Wetlands, River banks, Lake shores and Sea shore Management) Regulations, 2009, legal notice No. 19	2009	· The regulations apply to all wetlands in Kenya whether occurring in private or public land · Provide for the conservation and sustainable use of wetlands and their resources in Kenya · One of the objectives is to promote the integration of sustainable use of wetland resources into the local and national management of natural resources for socio-economic development · Stipulates for mandatory EIA & EA for all activities likely to have adverse impacts on wetlands
The Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009, legal	2009	· The regulations are concerned with control of noise pollution · Sets out permissible noise levels · Control the establishment of quarries and use of explosives and machinery within 2km of human settlements · Requirement for all projects which are likely to lead to generation of noise to conduct EIA.

Title	Year	Outline
notice No. 61		
Environmental (Impact Assessment and Audit) Regulations	2003	· The regulations came into force in 2003 and were amended in 2009 by a legal notice No. 30. · The amendment revised the EIA licence fee from 0.1% of the project cost to 0.05% of the project cost with minimum being Kenya 10,000 and max 1,000,000 (Kenya Shillings) · The current regulations can therefore be referred to as The Environmental (Impact Assessment and Audit) (Amendment) Regulations, 2009
Electric Power Act	1997	· A Parliament act that amended and consolidated the laws relating to the generation, transmission, transformation, distribution, supply and use of electrical energy for lighting and other purposes
Energy Act	2006	· Enacted to amend and consolidate the laws relating to energy · It also provided for the establishment, powers and functions of ERC and REA. Among other functions, REA is to promote use of renewable energy sources including small hydro, wind, solar, biomass, geothermal, hybrid systems as well as updating and managing of rural electrification master plans
Films and Stage plays Act	1963	· An Act of Parliament to provide for controlling the making and exhibition of cinematograph films, for the licensing of stage plays, theatres and cinemas, and for purposes incidental thereto and connected therewith
Forest Act No. 7 of 2005 (enacted year)	2007	· An Act of Parliament to provide for the establishment, development and sustainable management, including conservation and rational utilization of forest resources for the socio-economic development of the country · The Act recognizes that forests provide the main locus of Kenya's biological diversity and a major habitat for wildlife, · The act also provides for the establishment of Kenya Forest Service which among other functions is to formulate , policies and guidelines regarding the management, conservation and utilization of all types of forest areas in the country
Lakes and Rivers (repealed by Merchant Shipping Act, No 4 of 2009)	2009	· An Act of Parliament to regulate dredging and the use of steam vessels on certain lakes and rivers
National Museums and Heritage Act, 2006	2006	· An Act of Parliament to consolidate the law relating to national museums and heritage, · To provide for the establishment, control, management and development of national museums and the identification, protection, conservation and transmission of cultural and natural heritage · To repeal the Antiquities and Monuments Act and the National Museums Act, and for connected purposes
Kenya Cultural Centre Act, Cap 218	1951	· An Act of Parliament to incorporate the Kenya Cultural Centre and to confirm and extend its powers · The Act provides for the performance of music, drama and dancing, for the exhibition of works of art and craft and for the holding of meetings for discussion of matters of literary, historical, scientific or educational interest or importance, and such other purposes generally as may be approved by the Council, not being incompatible with the objects hereinbefore expressed.
Physical Planning Act of 1996 (enacted year)	1998	· The Act envisages existence of special planning regions with unique development potential or problems for purposes of preparation of physical development plans · The Act empowers local authorities to reserve and maintain land planned for open spaces, parks, urban forests and greenbelts · In section 36, It also anticipates development proposals that may be injurious to the environment and such requires Environmental Impact Assessment
Water Act 2002 (enacted year)	2003	· The Act repealed the Water Act (Cap. 372) and certain provision of Local Government Act · Provides for the regulation, management, conservation, use and control of water resources and for the acquisition and regulation of rights to use water, to provide for the regulation and management of water supply and sewerage services · The Act provides for the establishment of Water Resource Management Authority to be among other functions, responsible for protection and management of water catchment areas

Title	Year	Outline
Wildlife (Conservation and Management) Act	1976	· An Act of Parliament to consolidate and amend the law relating to the protection, conservation and management of wildlife in Kenya, and for purposes connected there with and incidental thereto · Provides for how an area may be declared a National Parks, Game Reserves or Local Sanctuary and such areas may cease to be · The Act also provides for the establishment of Kenya Wildlife Service which is a uniformed and disciplined service responsible for management of wildlife · Provides for the declaration of national parks

Note: *ERC, Energy Regulatory Commission, REA, Rural Electrification Authority, EIA, Environmental Impact Assessment, NEMA, National Environment Management Authority, Cap: Chapter*

Source: National Council for Law Reporting (www.kenyalaw.org), NEMA homepage (www.nema.go.ke)

(3) Relevant Acts by Sector

Table 2.13.9 shows relevant Acts on Environment and Social by sector.

Table 2.13.9 Relevant Acts of Parliament by Sector

Sector	Acts
Air	· Environmental Management and Coordination Act, 1999 · Environment Management and Coordination (Fossil Fuel Emission Control) Regulations, 2006 · Occupational Safety and Health Act, 2007 · Penal Code (Cap, 63) · Public Health Act (Cap 242)
Culture and Heritage	· Antiquities and Monuments (Repealed Act) 1983 · National Museums and Heritage Act, 2006 · Kenya Cultural Center Act (Cap 218) 1951 · Films and Stage Plays Act 1963 · Forest Act, 2005
Conservation of Natural Resources	· Environment and Land Court Act No. 19, 2011 · Environmental Management and Coordination Act, 1999 · Forest Act, 2005 · Lakes and Rivers Act (repealed), 2009 · Physical Planning Act, 1996 · Water Act, 2003 · Wild Life (Conservation and Management) Act, 1976
Energy	· Energy Act, 2006 · Electric Power Act, 1997 · Electric Supply Lines Act · *Ewaso Ng'iro* South River Basin Development Authority (Cap 447)
E-waste	· Guidelines for E-waste Management, 2010 · Environmental Management and Coordination (waste management) Regulations
Fisheries	· Fisheries Act (Cap 378)
Forests	· Forest Act, 2005 · Wildlife (Conservation and Management) Act (Cap 376) · Protected Area Act (Cap 204) · Plant Protection Act (Cap 324) · Timber Act (Cap 386) · Trespass Act (Cap 294)
Land	· Agriculture Act (Cap 318) · Trust Land Act (Cap 288) · Registered Land Act, 2012 · Land Act, 2012 · Land Acquisition Act (Cap 295) · Land Adjudication Act (Cap 284) · Land Consolidation Act (Cap 283) · Land Titles Act (Cap 242) · Physical Planning Act, 1996
Noise & Vibration	· Environmental Management and Coordination Act, 1999 · Environmental Management and Coordination (Noise and Excessive Vibration Pollution) (Control) Regulations, 2009 · Penal Code (Cap 63) · Occupational Safety and Health Act, 2007,

Sector	Acts
Solid waste	· Environmental Management and Coordination Act, 1999 · Environmental Management and Coordination (waste management) Regulations, 2006 · Local Government Act (Cap 265), 1963 · Physical Planning Act, 1996 · Public Health Act (Cap 242) · Penal Code (Cap 63),
Water	· Water Act, 2002 · Environmental Management and Coordination (water quality) Regulations, 2006 · Environmental Management and Coordination Act, 1999 · Environmental Management and Co-ordination (wetlands, river banks, lake shores and sea shore management) Regulations, 2009 · *Ewaso Ng'iro* South River Basin Development Authority (Cap 447)

Source: National Council for Law Reporting (www.kenyalaw.org), NEMA homepage (www.nema.go.ke)

(4) International Conventions, Protocols and Treaties on Environment

Relevant international treaties, conventions and so on to which Kenya is a party are summarized in Table 2.13.10.

Table 2.13.10 International Conventions, Protocols and Treaties on Environment

Title	Year (Ratification/ Entry into Force)
African Convention on the Conservation of Nature and Natural Resources, 1968	1969
Agenda 21(Rio declaration on Environment and Development)	1992
Agreement on the Conservation of African Eurasian Migratory Water Birds	1999
Bamako Convention on the ban of the import into Africa and the Control of Trans-boundary Movement and Management of Hazardous Wastes Within Africa, 1991	2005
Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal, 1989	2000
Cartagena Protocol on Bio-safety to the Convention on Biological Diversity, 2000	2002
Convention of the African Energy Commission	2006
Convention on the Conservation of Migratory species of Wild Animals, 1979	1999
Convention on Biological Diversity	1994
Convention on the Continental Shelf	*
Convention on Fishing and Conservation of the Living Resources of the High Seas. Geneva, 29 April 1958	*
Convention on International Trade in Endangered Species of Wild Fauna and Flora	1978
Convention for the Protection, Management and Development of the Marine and Coastal Environment of the East African Region, 1985.	*
International Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972	*
International Convention for the Prevention of Pollution of the Sea by Oil, 1954.	*
International Convention on Oil pollution Preparedness, Response and Co-operation, 1990.	*
International plant protection convention	2005
Kyoto protocol to the United Nations framework Convention on Climate change	2005
Langkawi Declaration on the Environment	1989
Phyto-sanitary Convention for Africa	*
1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter of 29 December 1972	*
Ramsar convention on wetlands	1990
Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	2005
Stockholm Convention on Persistent Organic Pollutants (Stockholm, 22 May 2001)	2001
United Nations Convention to Combat Desertification	1964
UNESCO Convention Concerning Protection of the World Cultural Natural Heritage	1964
United Nations Framework Convention on Climate Change, 1992	1994
United Nations Convention on Environment and Development (UNCED)	1992
United Nations Convention to Combat Desertification	1964
United Nations Framework Convention on Climate Change, 1992	1994
Vienna Convention For the Protection of Ozone Layer	1988

*Note: * the year is unknown*

Source: www.kenyalaw.org, www.ramsar.org

2.13.4 Environmental Management System in Kenya

(1) Statutory Bodies on Environmental Management

The Environmental Management and Coordination Act (EMCA) has created several statutory bodies of a council, committees and others on environmental management whose functions complement each other as summarized in Table 2.13.11.

Table 2.13.11 Statutory Bodies on Environmental Management in Kenya

Institution	Overview
National Environment Council (NEC)	・ The Chairman of NEC is the Minister responsible for Environment and is responsible for, ・ Policy formulation and directions for purpose of the Act ・ Setting national goals and objectives and determining policies and priorities for the protection of the environment ・ Promoting co-operation among public departments, local authorities, private sector, non-governmental organizations and such other organizations engaged in environmental protection programmes, and ・ Performs such other functions as are assigned under the Act
National Environment Action Plan Committee (NEAPC)	・ The Chairman of NEAPC is the Permanent Secretary in the Ministry of Planning and National Development ・ The membership of the committee is listed in the First and Third Schedules of EMCA. Its function is to prepare a National Environment Action Plan every five years for consideration and adoption by the National Assembly
Standards and Enforcement Review Committee (SERC)	・ SERC advises the Authority on how to establish criteria, procedures and standards for water quality, conditions for discharge of effluents into the environment, guidelines or regulations for the preservation of fishing areas, aquatic areas, water sources, and reservoirs and other areas where water may need special protection, and collect, maintain and interpret data from industries and local authorities on the pre-treatment, nature and levels of effluents. It is chaired by the Permanent Secretary, Ministry of Environment and Mineral Resources (MEMR), while membership is drawn from lead agencies, representatives of the private sector, research institutions, universities, and civil society organizations
Environmental Impact Assessment Technical Advisory Committee (EIA-TAC)	・ EIA-TAC is responsible for the review of EIA related reports received by National Environment Management Authority (NEMA). The Director General appoints members and prescribes the terms of reference and rules of procedure
Public Complaints Committee (PCC)	・ PCC consists of a Chairman and six members. It's Chairman and members hold office for a period of three years and are eligible for re-appointment so long as no member holds office for more than two terms. The function is to investigate any allegations against any person or against the Authority in relation to the condition of the environment. PCC can on its own volition investigate any case of environmental degradation and make a report of its findings together with its recommendations to the National Environment Council
National Environmental Tribunal (NET)	・ NET consists of a Chairman and four members. Members of the Tribunal hold office for a term of 3 years and are appointed by the Minister of Environment. The NET reviews administrative decisions made by NEMA relating to issues of revocation or denial of licenses and conditions of licenses. It also provides legal opinion to NEMA on any complex matter where NEMA seeks such advice. The Tribunal has a number of powers including the power to change or give an order, give direction and to carry out investigations where necessary
National Environment Trust Fund (NETF)	・ NETF is administered by a Board of five Trustees, including its Chairman. The object of the Trust Fund is to facilitate research intended to further the requirements of environmental management, capacity building, environmental awards, environmental publications, scholarships and grants. Additionally, the Board of Trustees may, on the recommendation of the National Environment Council, determine that certain donations to the Trust Fund shall be applied specifically and reserved only for prizes and awards for exemplary services to the environment

Source: National Environment Management Authority Strategic Plan 2008-2012, June 2009, NEMA

(2) Ministry of Environment and Mineral Resources (MEMR)

The Ministry of Environment and Mineral Resources (MEMR) is the nodal Ministry of Kenyan Government handling environment and natural resources of which overview is shown in Table 2.13.12.

(MERM was renamed to Ministry of Environment, Water and Natural Recourses in 2013; See Section 2.13.6)

Table 2.13.12 Ministry of Environment and Mineral Resources (MEMR)

MEMR	Overview
Mandate	· To monitor, protect, conserve and manage the environment and natural resources through sustainable exploitation for socio-economic development aimed at eradication of poverty, improving living standards and ensuring that a clean environment is sustained now and in the future
Compositions	· National Environment Management Authority (NEMA) · Kenya Meteorological Department · Mines and Geology Department · Department of Resource Surveys and Remote Sensing (DRSRS)
Core Functions	· Environment and Natural Resources Policy formulation, analysis and review · Sustainable management of Mineral resources and conservation of environment · Continuous development of geo-database for integrated natural resources and environmental management systems · Conduct applied research and dissemination of research findings in land resources and geology · Carry out geological surveys, mineral exploration and regulation of mining and use of commercial explosives. · Promote, monitor and coordinate environmental activities and enforce compliance of environmental regulations and guidelines · Meteorological services

Source: Ministry of Environment and Mineral Resources (www.environment.go.ke)

(3) National Environment Management Authority (NEMA)

The National Environment Management Authority (NEMA), one of the compositions of the Ministry of Environment and Mineral Resources (MEMR), has been established under the Environmental Management and Coordination Act (EMCA) No. 8 of 1999, and became operational on 1 July 2002, as the principal instrument of government in the implementation of all policies relating to the environment. (Source, NEMA)

NEMA is the practical official body responsible for managing environment, reviewing "EIA Project Reports" and "EIA Study Reports" and issuing Environment Licenses for development projects in Kenya. Table 2.13.13 provides an overview of the functions of NEMA

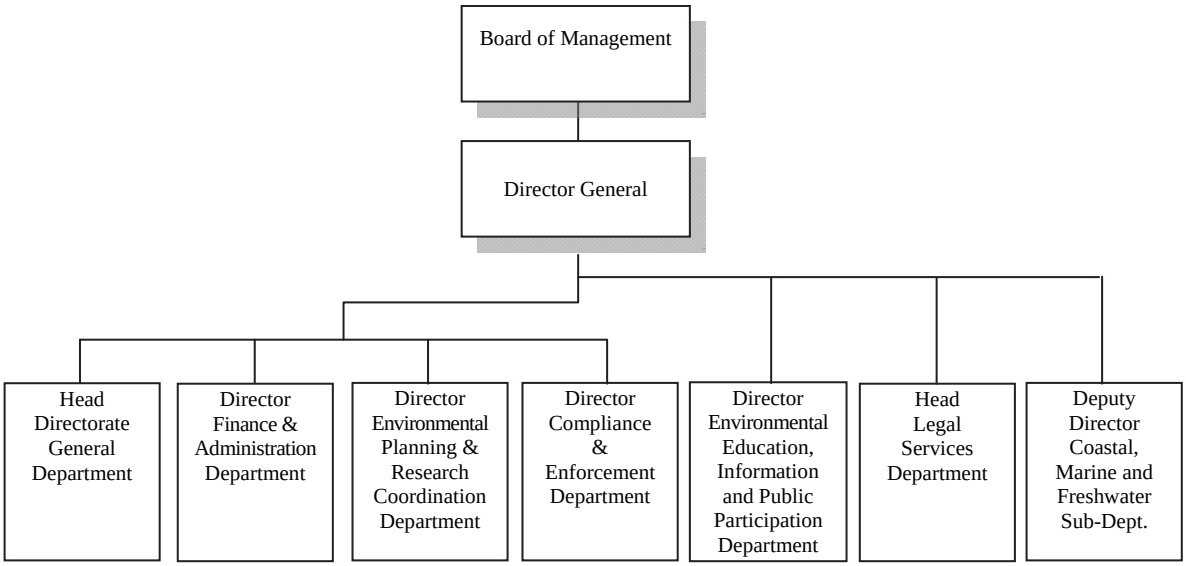
Table 2.13.13 National Environment Management Authority (NEMA)

NEMA	Overview
Core Functions	· Coordinating the various environmental management activities being undertaken by the lead agencies · Promote the integration of environmental considerations into development policies, plans, programmes and projects, with a view to ensuring the proper management and rational utilization of environmental resources, on sustainable yield basis, for the improvement of the quality of human life in Kenya · To take stock of the natural resources in Kenya and their utilization and conservation. · To establish and review land use guidelines · Examine land use patterns to determine their impact on the quality and quantity of natural resources. · Carry out surveys, which will assist in the proper management and conservation of the environment. · Advise the Government on legislative and other measures for the management of the environment or the implementation of relevant international conventions, treaties and agreements. · Advise the Government on regional and international conventions, treaties and agreements to which Kenya should be a party and follow up the implementation of such agreements. · Undertake and coordinate research, investigation and surveys, collect, collate and disseminate information on the findings of such research, investigations or surveys. · Mobilize and monitor the use of financial and human resources for environmental management. · Identify projects and programmes for which environmental audit or environmental monitoring must be conducted under this Act. · Initiate and evolve procedures and safeguards for the prevention of accidents, which may cause environmental degradation and evolve remedial measures where accidents occur e.g. floods,

NEMA	Overview
	landslides and oil spills. · Monitor and assess activities, including activities being carried out by relevant lead agencies, in order to ensure that the environment is not degraded by such activities. Management objectives must be adhered to and adequate early warning on impending environmental emergencies is given.
Creating Awareness	· Undertake, in cooperation with relevant lead agencies, programmes intended to enhance environmental education and public awareness, about the need for sound environmental management, as well as for enlisting public support and encouraging the effort made by other entities in that regard. · Publish and disseminate manual codes or guidelines relating to environmental management and prevention or abatement of environmental degradation. · Render advice and technical support, where possible, to entities engaged in natural resources management and environmental protection, so as to enable them to carry out their responsibilities satisfactorily. · Prepare and issue an annual report on the State of Environment in Kenya and in this regard, may direct any lead agency to prepare and submit to it a report on the state of the sector of the environment under the administration of that lead agency.

Source, NEMA HP & Ministry of Environment HP

NEMA consists of the Board and the Director General at the top of the Authority, under which six departments and one sub-department have been organized as shown in Figure 2.13.3.



Source: National Environment Management Authority Strategic Plan 2008-2012, June 2009, NEMA (Modified by the

Figure 2.13.3 NEMA Organizational Structure

Among those departments, the following ones have functions on EIA related activities,

- The Director General appoints members of Environmental Impact Assessment Technical Advisory Committee (EIA-TAC) and prescribes the terms of reference and rules of procedure of the review of EIA related reports received by NEMA. (See Attachment N-4 Section N-4.3)
- The Compliance and Enforcement Department, identifies projects and programmes or types of projects and programmes, plans and policies for which environmental audit (EA) or environmental monitoring must be conducted under the Act and ensure EIAs and EAs are conducted. (Source, National Environment Management Authority Strategic Plan 2008-2012, June 2009, NEMA)

(4) Environmental Management System at County Level

1) Decentralization and Administrative Structure Reform (Transitional Period)

Since the New Kenyan Constitution came into force in 2010, decentralization, administrative structure reforms and regulatory revisions for "Country System" in place of former "Province and District System" have started. As far as reforms of environmental management and EIA review procedure are concerned, the reform processes are in the transitional period at present as shown below (Source: Outcomes from discussions with NEMA HQ and a County office).

- ✓ As a matter of fact, NEMA issued a public notice with regard to the decentralization of its county functions on EIA as of 1 of July 2012 (See Attachment N-4 Section N-4.3).
- ✓ On the other hand, EMCA 1999 and EIA/EA Regulation (Amendment) 2009 have not been revised yet, both of which are under review process for revisions, namely, EMCA 1999 and EIA/EA 2003 keeping "Provincial Environmental Committee" as well as "District Environmental Committee" functions are adaptive for the EIA procedure at the moment.
- ✓ Review of EIA reports takes place at either national or county level, namely certain projects can be reviewed and decisions given at the county level while there are specific projects that must only be reviewed at the NEMA headquarters.
- ✓ In addition, although the review of EIA reports have been devolved to the counties, the "District Environment Committees" are still in existence until the creation of "County Environment Committees" probably through an amendment of EMCA 1999 and EIA/EA Regulations (Amendment) 2009.
- ✓ The "District Environment Committees" are still in place since their existence is by EMCA 1999 and therefore cannot be replaced by a mere administrative directive without the necessary amendments.
- ✓ However lead agencies remain un-changed and are selected at the discretion of NEMA officials depending on the project for which an EIA has been done.
- ✓ That is to say, due to the fact that the environmental management and EIA procedural reforms have not adequately come into effect in order to conform to the new constitutional dispensation especially on administrative units, the provisions of the current EMCA 1999 and EIA/EA Regulations (Amendment) 2009 are still in force until such a time that they will be reviewed. However the NEMA through an administrative procedure has done away with District and Provincial offices and effectively replaced them with County offices.
- ✓ The transition period therefore means that the former systems (especially where the relevant laws are concerned) are still in operation alongside the current administrative re-alignment. Therefore, the former local systems of "Provincial Environmental Committee" as well as "District Environmental Committee" are envisaged to be reviewed.

2) Provincial and District Environmental Committees

According to the current EMCA 1999 and EIA/EA Regulations (Amendment) 2009, NEMA operates at provincial and district levels. Namely the Provincial Environment Committees (PECs) and District Environment Committees (DECs) are a primary mechanism for NEMA to undertake its functions, which will be reviewed to County Environment Committee in order to conform to the new administrative structure of County system.

Table 2.13.14 summarizes PEC and DEC functions, structures and others in EMCA 1999 and EIA/EA Regulations (Amendment) 2009.

Table 2.13.14 Functions of Provincial and District Environmental Committees

Category	Provincial Environmental Committee (PEC)	District Environmental Committee (DEC)
Chairperson and Secretary	· Every Province has constituted a PEC as stated under EMCA. PEC is chaired by the Provincial Commissioner. The Secretary is the Provincial Director of Environment.	· Every District has a DEC as stated under EMCA · DEC is chaired by the District Commissioner · The Secretary is the District Environment Officer.
Primary Responsibility	· PECs are responsible for the proper management of the environment within the Province in which they have been appointed providing an effective decision-making mechanism at the grassroots level.	· DECs are responsible for the proper management of the environment within the District in which they have been appointed providing an effective decision-making mechanism at the grassroots level.
Committee Members	· One representative of each of the Ministries responsible for the matters specified in the First Schedule at the provincial level, · A representative of every local authority whose area of jurisdiction falls wholly or partly within the province, · Two representatives of farmers or pastoralists within the Province, · Two representatives of the business community operating within the Province, · Two representatives of NGOs engaged in environmental management programmes within the Province, · A representative of every regional development authority whose area of jurisdiction falls wholly or partially within the Province.	· One representative of each of the Ministries responsible for the matters specified in the First Schedule at the District level, · A representative of every local authority whose area of jurisdiction falls wholly or partly within the District, · Four representatives of farmers, women, youth and pastoralists within the District, · Two representatives of the business community operating within the District, · Two representatives of NGOs engaged in environmental management programmes operating within the District, · Two representatives of CBOs engaged in environmental programmes operating in the District.
Term	· PEC members are nominated and gazetted and their term is three (3) years. · They met at least four (4) times per year.	· DEC members are nominated and gazetted and their term is three (3) years. · They met at least four (4) times per year.

Source: NEMA (modified and tabulated by the JICA Expert Team based on a Discussion with NEMA)

2.13.5 EIA procedures and Licensing System of Kenya

(1) Projects Sectors Subject to EIA

Project Sectors subject to EIA procedures in Kenya are specified in the Environmental Management and Coordination Act of 1999 (EMCA) as “Second Schedule” (Table 2.13.15).

Table 2.13.15 "Second Schedule" Specified in EMCA (Project Sectors Subject to EIA)

Sector	Items Included	
General	· An activity out of character with its surrounding any structure of a scale not in keeping with its surroundings	· Major changes in land use
Urban developments	· Designation of new townships · Establishment of industrial estates · Establishment or expansion of recreational areas	· Establishment or expansion of recreational townships in mountain areas, national parks and game reserves · Shopping centers and complexes
Transportation	· All major roads · All roads in scenic, wooded or mountainous areas and wetlands, Railway lines	· Airports and airfields · Oil and gas pipelines · Water transport
Dams, rivers and water resources	· Storage dams, barrages and piers · River diversions and water transfer between catchments	· Flood control schemes · Drilling for the purpose of utilizing ground water resources including geothermal energy
Aerial spraying.	· -	· -
Mining	· Quarrying and open cast extraction of · Precious metal, Gemstones, Metal liferous ores, Coal, Phosphates, Limestone and dolomite	· Stone and slate · Aggregates, sand and gravel, Clay, Exploration for the production of petroleum in any form, Extracting alluvial gold with use of mercury
Forestry related activities	· Timber harvesting · Clearance of forest areas	· Reforestation and afforestation
Agriculture	· Large scale agriculture · Use of pesticide · Introduction of new crops and animals	· Use of fertilizers · Irrigation
Processing and manufacturing industries	· Mineral processing, reduction of ores and minerals · Smelting and refining of ores and minerals · Foundries · Brick and earth wear manufacture · Cement works and lime processing · Glass works · Fertilizer manufacture or processing · Explosive plants · Oil refineries and petrochemical works · Tanning and dressing of hides and skins · Abattoirs and meat processing plants · Chemical works and processing plants · Brewing and malting · Bulk grain processing plants	· Fish processing plants · Pulp and paper mills · Food processing plants · Plants for manufacture or assembly of motor vehicles · Plant for the construction or repair of aircraft or railway equipment · plants for the manufacture or assembly of motor vehicles · plants for the manufacture of tanks, reservoirs and sheet metal containers · plants for manufacture of coal briquettes · plants for manufacturing batteries
Electrical infrastructure	· Electrical generation stations · Electrical transmission lines	· Electrical sub-stations · Pumped storage schemes
Management of hydrocarbons	· Storage of natural gas and combustible or explosive fuels	
Waste disposal	· Sites for solid waste disposal · Sites for hazardous waste disposal · Sewage disposal works	· Works involving major atmospheric emissions · Works emitting offensive odors
Natural conservation areas	· Creation of national parks, game reserves and buffer zones · Establishment of wilderness areas · Formulation or modification of forest management policies · Formulation of modification of water catchment management policies	· Policies for the management of ecosystems especially by use of fire · Commercial exploitation of natural fauna and flora · Introduction of alien species of fauna and flora · Introduction of alien species of fauna and flora into ecosystems
Nuclear Reactors	-	-
Major developments in biotechnology	· Introduction and testing of genetically modified organisms	

Source: Environmental Management and Coordination Act of 1999 (EMCA) (tabulated by the JICA Expert Team)

However, "Second Schedule" does not specify the scale and size of each project. Namely without reference to scale or size of a project fall under the Second Schedule, such a project shall go through the EIA procedures.

1) JICA Pilot Project and necessity of EIA

The JICA Pilot Projects are in the field of renewable energy (PV, Mini hydro, Bio-gas and Wind power systems) which falls under "No. 10 Electrical Infrastructure" in the "Second Schedule" of EMCA. Therefore, all JICA Pilot Projects are naturally subject to the EIA procedures.

2) Draft NEMA EIA Guidelines and Administration Procedures

In addition, NEMA developed a Draft EIA Guidelines and Administration Procedures in November 2002 in response to the National Policy on Environment and EMCA 1999. The NEMA Draft EIA Guidelines provides procedural guidelines for,

- Implementation of EIA
- Monitoring and Environmental Audit (EA)
- Strategic Environmental Assessment (SEA)
- Issues of Trans-boundary, Regional and International Conventions, Treaties and Agreements
- Steps in EIA studies and Environmental Audits
- The contents and format of the study reports to be submitted to NEMA
- The EIA study review process and decision-making, and
- Others.

CHAPTER 7 of the NEMA Draft EIA Guidelines mentions that Lead agencies are mandated by section 58 of the EMCA 1999, in consultation with the Authority to develop EIA Guidelines to ensure that environmental concerns are integrated in sector development policies, plans, projects or programmes. The sector guidelines shall focus on specific mandates in line with the statutory relationships with the administration of the EIA process.

However, such sector guidelines have not been developed by relevant lead agencies excluding the sector of petroleum (Source, A meeting with NEMA HQ). In addition, the Draft Guidelines is rendered a rather conceptual guidance. Practically, processes of EIA and the licensing shall refer to EIA/EA Regulations (Amendment) 2009.

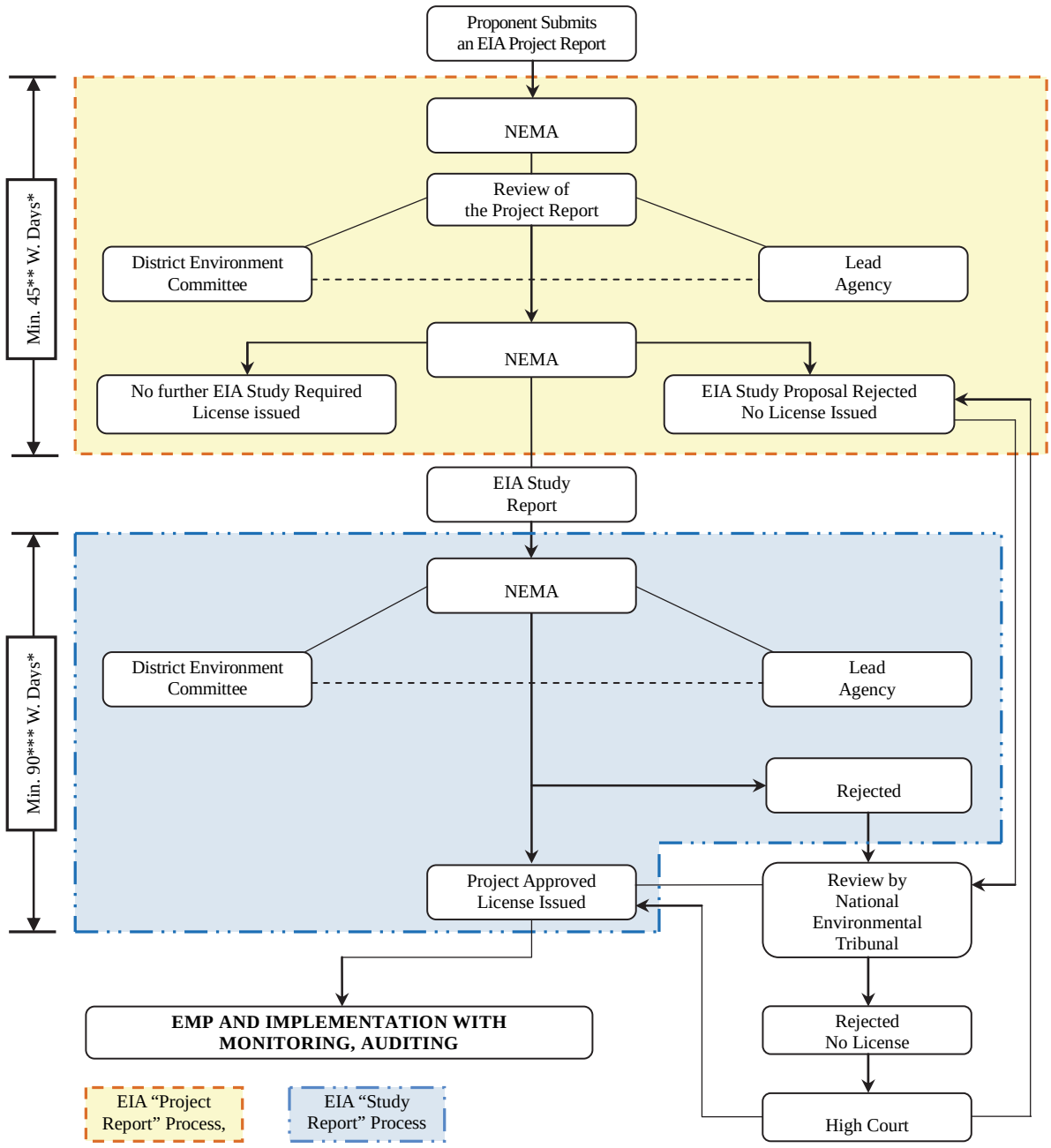
(2) EIA Review Process and Licensing

The Environmental Management and Coordination Act of 1999 (EMCA) and EIA/EA Regulations (Amendment) 2009 specify the EIA Review process which consists of the following two steps:

- ✓ EIA "Project Report" Process
- ✓ EIA "Study Report" Process

1) Overview of the EIA Process

Based on EMCA 1999, EIA/EA Regulations (Amendment) 2009 and discussions with NEMA officials as well as considering the decentralization of NEMA's functions at the County level, Kenyan EIA entire procedures can be depicted as shown in Table 2.13.3. In addition, detailed flow Charts of "EIA Project Report" and "EIA Study Report will appear afterward (See Figure 2.13.4 and Figure 2.13.5)



*Note, *According to NEMA, "days" in the procedures stands for "Working days"*

*** According to NEMA, not "within forty-five days" but "Minimum forty-five days" for the EIA Project Report Review and Licensing period*
**** According to NEMA, not "within 90 days" but "Minimum 90 Working days" for the EIA Project Report Review and Licensing period*

Source: NEMA, (modified by JICA Expert Team based on discussions with NEMA HQ officials)

Figure 2.13.4 Overview of the EIA Process

2) EIA "Project Report"

According to EMCA 1999, EIA/EA Regulation (Amendment) 2009 and discussions with NEMA officials as well as considering the decentralization of NEMA's functions at the County level, the EIA "Project Report" Process can be summarized as follows and depicted in Figure 2.13.4.

- ✓ The process starts by a project proponent, selecting a consultant which must be licensed and registered with NEMA as a Lead Expert on EIA/EA
- ✓ An EIA "Project Report" shall be prepared by the consultant (Registered Lead Expert on EIA/EA).
- ✓ The following shows contents to be stated in the "Project Report".

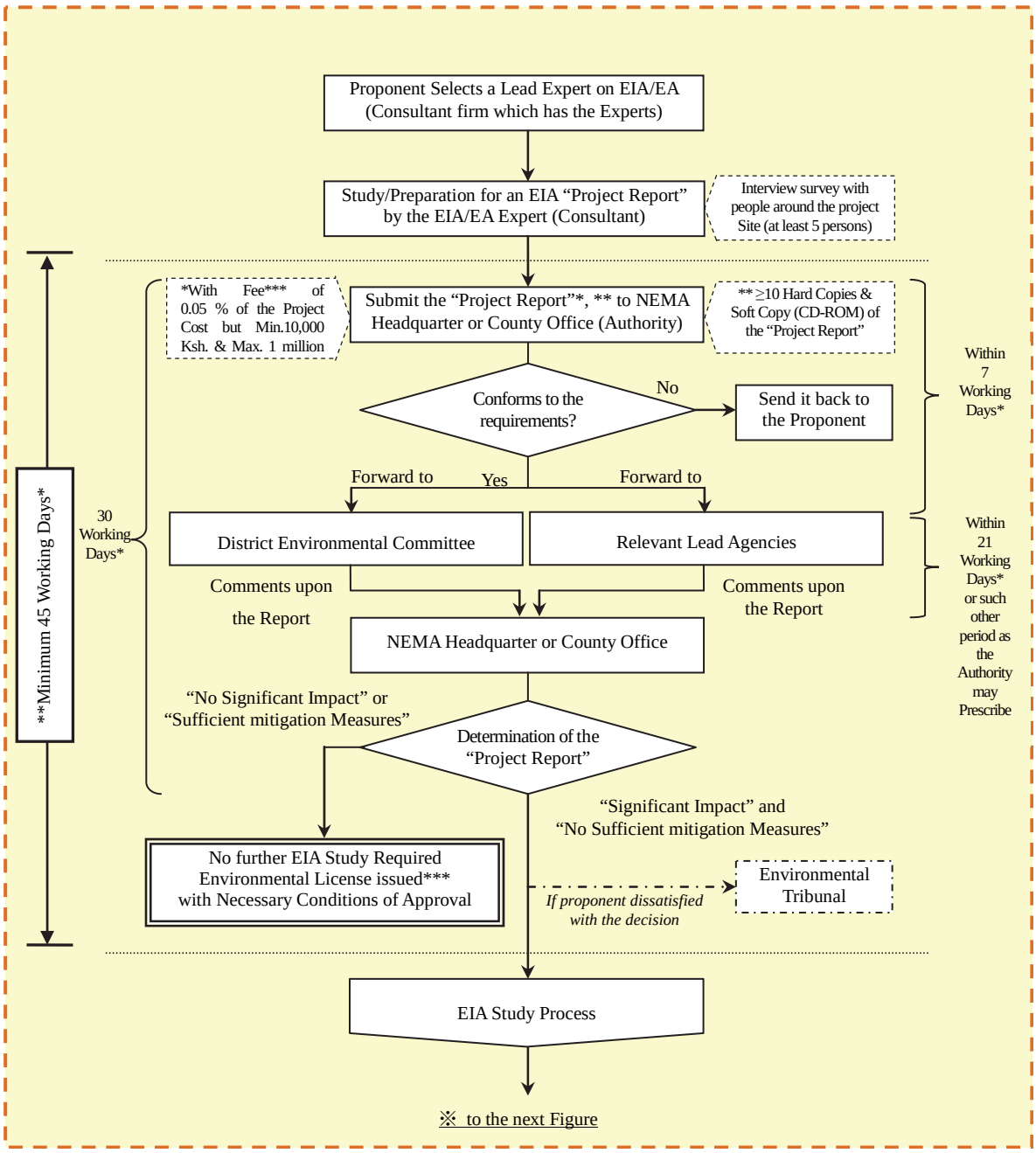
Table 2.13.16 Contents of the Project Report

Nature of the project Location of the project including the physical area that may be affected by the project's activities Activities that shall be undertaken during the project construction, operation and decommissioning phases Design of the project Materials to be used, products and by-products, including waste to be generated by the project and the methods of their disposal	Potential environmental impacts of the project and the mitigation measures to be taken during and after implementation of the project Action plan for the prevention and management of possible accidents during the project cycle Plan to ensure the health and safety of the workers and neighbouring communities Economic and socio-cultural impacts to the local community and the nation in general Project budget Any other information the Authority may require

Prepared by JET

- ✓ The proponent shall submit at least ten copies and one soft copy (CD-ROM) of the EIA "Project Report" to the Authority (NEMA HQ or its County Office(s)) accompanied by the prescribed fees of 0.05% of the project cost. (50% of the 0.05 of the project cost paid at the time of submission of the EIA "Project Report" and the remainder of 50% paid at the time of collection of license)
- ✓ The Authority shall **within seven (7) days** upon receipt of the project report, where the "Project Report" conforms to the requirements of regulation, distribute a copy of the "Project Report" to Relevant Lead Agencies and Relevant District Environment Committee(s) (DEC(s)) for their review and written comments.
- ✓ Those comments of Lead Agencies and DECs shall be submitted to the Authority **within twenty one (21) days** from the date of receipt of the "Project Report" from the Authority, or such other period as the Authority may prescribe.
- ✓ On receipt of the comments or where no comments have been received **by the end of the period of thirty (30) days** from the date of receipt of the "Project Report", the Authority shall proceed to determine the project report.
- ✓ On determination of the "Project Report", the decision of the Authority, together with the reasons thereof, shall be communicated to the proponent **within forty-five (45) days**[26] of the submission of the "Project Report".
- ✓ Where the Authority is satisfied that the project will have no significant impact on the environment, or that the project report discloses sufficient mitigation measures, the Authority may issue a license
- ✓ If the Authority finds that the project will have a significant impact on the environment, and the project report discloses no sufficient mitigation measures, the Authority shall require that the proponent undertake an EIA study.

[26] According to NEMA, not "within forty-five days" but "Minimum forty-five days" for the EIA Project Report Review and Licensing period



*Note: *According to NEMA, "days" in the procedures stands for "Working days"*
*** According to NEMA, not "within forty-five days" but "Minimum forty-five days" for the EIA Project Report Review and Licensing period*
*** 50% of the 0.05 of the project cost paid at the time of submission of the EIA Project Report and the remainder of 50% paid at the time of collection of license

Prepared by JET referring to the EIA/EA Regulations (Amendment) 2009 and based on discussions with NEMA HQ

Figure 2.13.5 EIA Project Report Review Process and Duration

A proponent, who is dissatisfied with the Authority's decision that an environmental impact assessment study is required, may **within fourteen (14) days** of the Authority's decision appeal against the decision to the Tribunal.

3) EIA "Study Report"

According to EMCA 1999, EIA/EA Regulation (Amendment) 2009 and discussions with NEMA officials as well as considering the decentralization of NEMA's functions at the County level, the EIA "Study Report" Process can be summarized as follows and depicted in Figure 2.13.5.

- ✓ An EIA study shall be conducted in accordance with a TOR to be developed during the "Scoping" exercise, Then the TOR shall be submitted to be approved **within seven (7) days** by the Authority, Every EIA study shall be carried out by an EIA/EA Lead Expert
- ✓ During the process of conducting an EIA study, the proponent shall in consultation with the Authority, seek the views of persons who may be affected by the project.
- ✓ Namely, holding at least three public meetings with the affected parties and communities to explain the project and its effects, and to receive their oral or written comment
- ✓ A proponent shall submit to the Authority, an environmental contents of EIA "Study Report" incorporating but not limited to the following information:

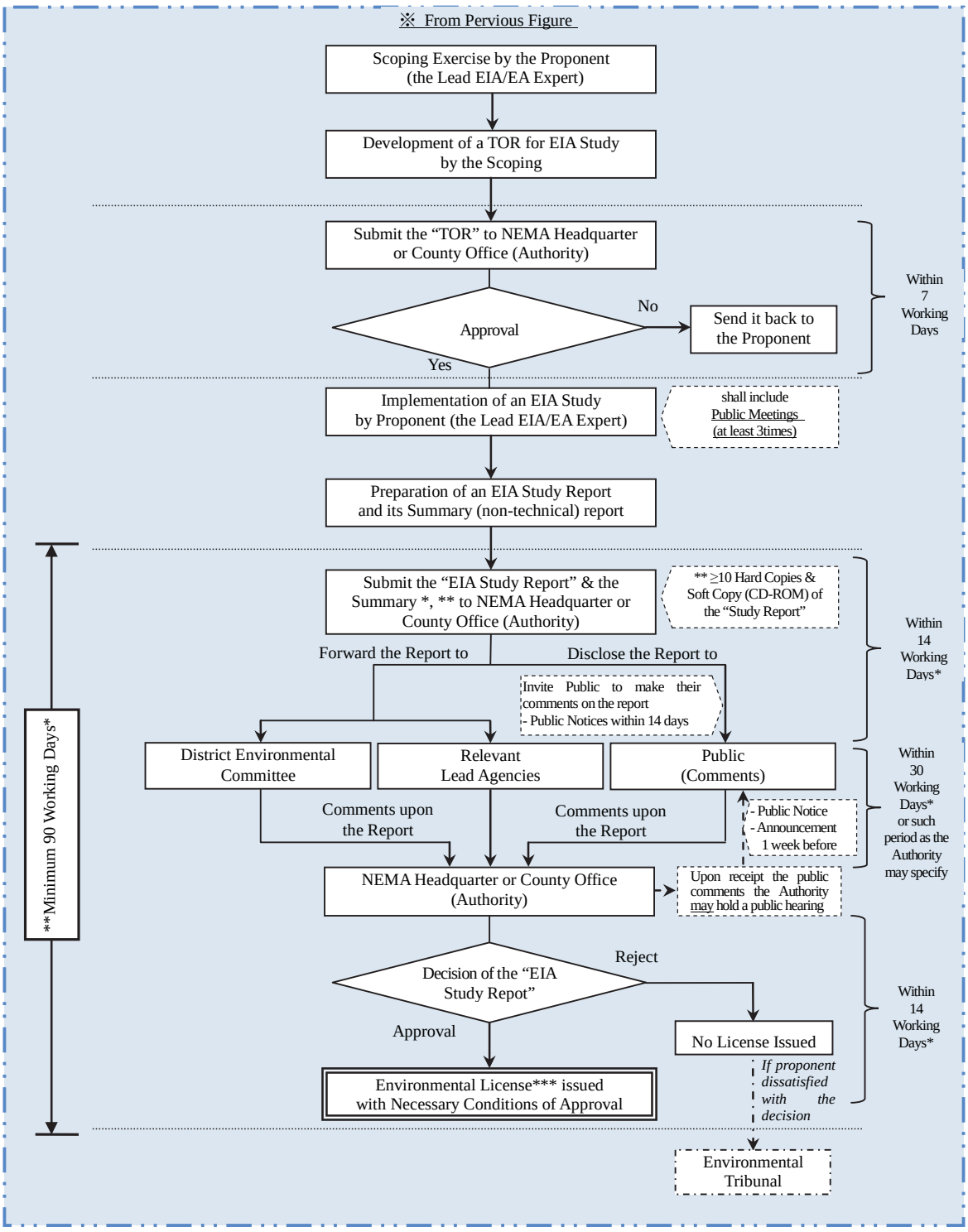
Table 2.13.17 Contents of the Study Report

Proposed location of the project Concise description of the national environmental legislative and regulatory framework, baseline information, Any other relevant information related to the project, the objectives of the project Technology, procedures and processes to be used, in the implementation of the project Materials to be used in the construction and implementation of the project Products, by-products and waste generated project Description of the potentially affected environment Environmental effects of the project including the social and cultural effects and the direct, indirect, cumulative, irreversible, short term and long-term effects anticipated Alternative technologies and processes available and reasons for preferring the chosen technology and processes Analysis of alternatives including project site, design and technologies and reasons for preferring the proposed site, design and technologies	Environmental management plan proposing the measures for eliminating, minimizing or mitigating adverse impacts on the environment, including the cost, time frame and responsibility to implement the measures, Provision of an action plan for the prevention and management of foreseeable accidents and hazardous activities in the cause of carrying out activities or major industrial and other development projects, Measures to prevent health hazards and to ensure security in the working environment for the employees and for the management of emergencies Identification of gaps in knowledge and uncertainties which were encountered in compiling the information Economic and social analysis of the project Indication of whether the environment of any other state is likely to be affected and the available alternatives and mitigating measures Such other matters as the Authority may require

Prepared by JET

- ✓ EIA "Study Report" shall be accompanied by a non-technical summary outlining the key findings, conclusions and recommendations of the study, Proponent shall submit ten copies and a soft copy (CD-ROM) of an EIA "Study Report" to the Authority
- ✓ The Authority shall **within fourteen (14) days** of the receipt of the EIA "Study Report" submit a copy of the report to any Relevant Lead agencies as well as District Environmental Committee(s) (DEC(s)) for their comments.

- ✓ Upon receiving the EIA "Study Report", the lead agencies and DEC(s) shall review the report and shall thereafter send their comments on the "Study Report" to the Authority **within thirty (30) days** or such extended period as the Authority may specify.
- ✓ The Authority shall **within fourteen (14) days** of receiving the EIA "Study Report", invite the public to make oral or written comments on the report, at the expense of the proponent.
- ✓ Upon receipt of these comments, the Authority may hold a public hearing
- ✓ The Authority shall give its decision on EIA "Study Report" **within three (3) months** of receiving an EIA "Study Report"
- ✓ Where the Authority approves an EIA "Study Report" , it shall issue an EIA license on terms and conditions as it may deem necessary
- ✓ A person who is aggrieved by the decision may appeal to the Tribunal against the decision.



*Note: *According to NEMA, "days" in the procedures stands for "Working days"*

*** According to NEMA, not "within 90 days" but "Minimum 90 Working days" for the EIA Project Report Review and Licensing period*

*** 50% of the 0.05 of the project cost paid at the time of submission of the EIA Project Report and the remainder of 50% paid at the time of collection of license

Prepared by JET referring to the EIA/EA Regulations (Amendment) 2009 and based on discussions with NEMA

Figure 2.13.6 EIA Study Report Review Process and Duration

4) Public Comments and Public Hearing in the EIA Study Report Process

Table 2.13.18 shows differences between “Public Comments” and “Public Hearing” in the course of the EIA Study Report Process. Both public comments and public hearing are means of public consultation.

Table 2.13.18 Public Comments and Public Hearing in EIA Study Report Process

Public Comments	Public Hearing
· Invitation is done both at the time of conducting EIA and after submission of Study report	· Conducted only after submission of the EIA study report at NEMA offices
· Invitation of public comments must be done as follows · At least three public meetings for comments must be done by the EIA consultant in the course of the study · One public comments window after submission of EIA study report at NEMA office	· Public hearing done only once after submission of EIA study report
· Comments are received both by EIA consultant and NEMA	· Sessions for public hearing only organized by NEMA and the report of the public hearing only prepared by the presiding NEMA official
· Invitation for public comments is mandatory as per the regulations	· Conducting public hearing sessions is at the discretion of NEMA based on the nature of the proposed study and adequacy of the study report

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5) Kenyan EIA Procedures & JICA Environmental and Social Considerations Guidelines

JICA has issued the "JICA guidelines for environmental and social considerations" to encourage project proponents etc. to have appropriate consideration for environmental and social impacts, as well as to ensure that JICA’s support for, and examination of environmental and social considerations are conducted accordingly.

The pilot projects to be proposed and their EIA “Project Reports” and “Study Reports” shall meet the JICA Guidelines.

Therefore, REA, the proponent for the Kenyan EIA procedure, shall prepare all EIA documents required for the pilot projects referring to the JICA Guidelines. In cases where the JICA Environmental and Social Consideration Guidelines is applied for the Kenyan EIA procedures, these two processes of EIA “Project Report” and EIA “Study Report” are considered as shown in Table 2.13.19. It can be therefore evaluated that the Kenyan EIA procedures have structurally an affinity to the JICA Environmental and Social Consideration Guidelines.

Table 2.13.19 Sequences of EIA Procedure and JICA Guidelines

Kenyan EIA Procedures EMCA 1999 and EIA/EA Regulations 2009	JICA Environmental and Social Consideration Guidelines
EIA “Project Report” Process	Screening, Initial Environmental Examination (IEE)
EIA “Study Report” Process	Scoping, EIA Study

Prepared by JET

(3) Possible Schedule of EIA Review Process and Licensing for REA Projects

In accordance with EIA processes noted above, a possible schedule of EIA reviews and licensing for REA Projects can be depicted as a bar-chart shown in Figure 2.13.7.

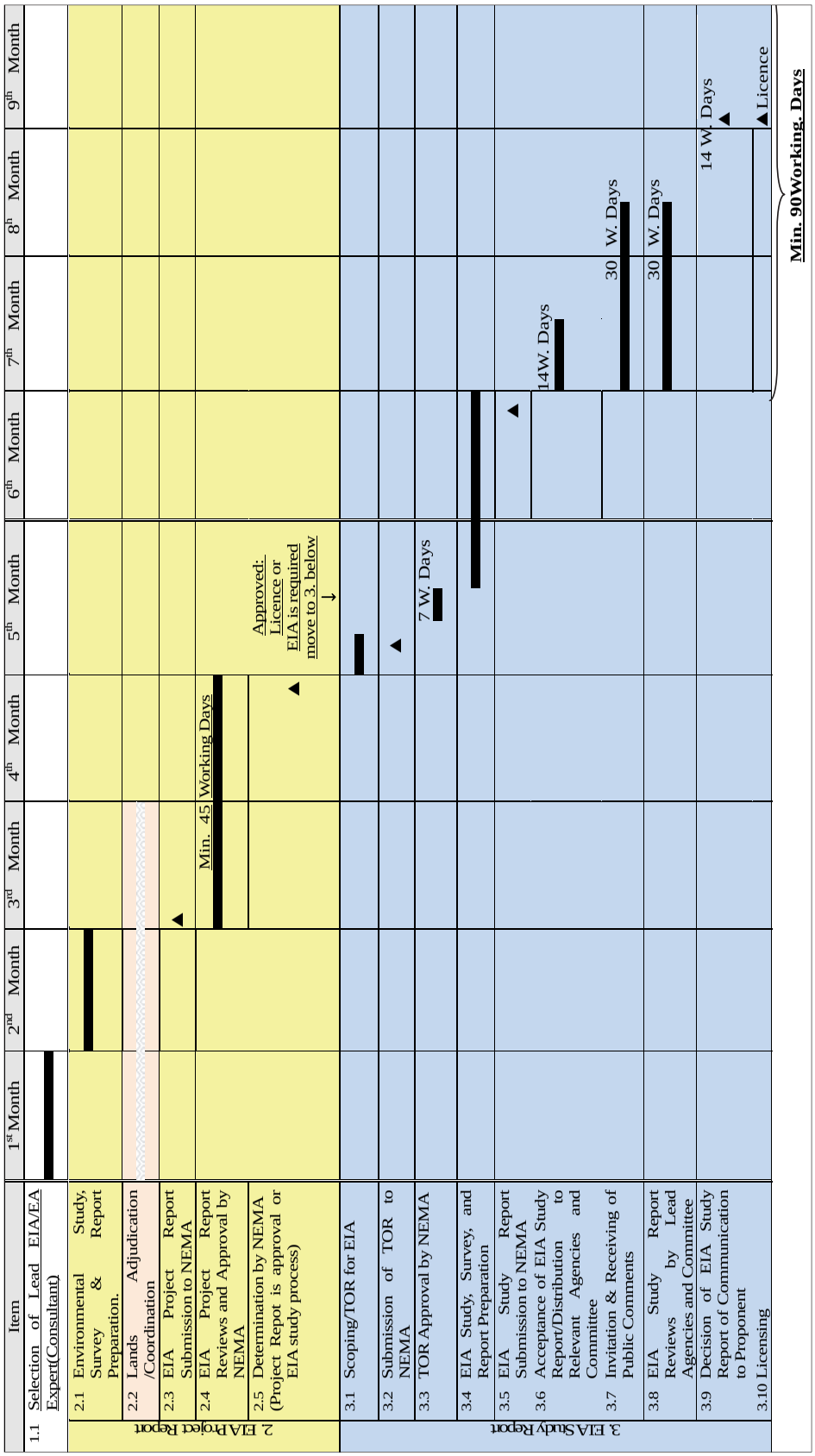

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Figure 2.13.7 EIA Study Report Review Process and Duration

2.13.6 Land Acquisition / Resettlement System in Kenya

(1) Legislative and legal framework on land acquisition and resettlement

Table 2.13.20 shows relevant acts and regulations on land acquisition and resettlement in Kenya.

Table 2.13.20 Legislative and Legal Frameworks on Land Acquisition and Resettlement

Title	Year Enacted	Outline
Land Acquisition Act	1968 (Repealed in 2012)	· An Act of Parliament to make provision for the compulsory acquisition of land for the public benefit · Commenced in 1968 and repealed in 2012, the Minister for Lands is empowered to give notification of land acquisition for public benefit · Gives direction to compensation to land earmarked for land to be put under public use
Land Act, 2012	2012	· An Act of parliament to give effect to article 68 of the constitution, to revise, consolidate and rationalize land laws, to provide for the sustainable administration and management of land and land based resources and for connected purposes · The act among other purposes prescribes the forms of land tenure which are, Freehold, Leasehold · Such forms of partial interest as may be defined under the Act and other law, including but not limited to easements and, · Customary land rights where consistent with the constitution · The Act in article 19 (1) gives the National Land Commission to make rules and regulations for the sustainable conservation of land based natural resources · The rules and regulations under sub section 1 may contain · Measures to protect critical ecosystems and habitats · Incentives for communities and individuals to invest in income generating natural resources conservation programmes · Measures to facilitate access, use and co-management of forests, water and other resources by communities who have customary rights to these resources · Measures to ensure benefit sharing to the affected communities · This Act repeals, The Way leaves Act, Cap 292 and The Land Acquisition Act, Cap 295
Land Adjudication Act (Cap 284)	1968	· An Act of Parliament to provide for the ascertainment and recording of rights and interests in Trust land · Highlights how the process of land adjudication runs
Land Consolidation Act (Cap 283)	1959	· Has similar provisions of the Land Adjudication Act but goes further to provide for consolidation land in the special areas, for the registration of title to, and of transactions and devolutions affecting, such land and other land in the special areas.
Land (Group Representatives) Act (Cap 287)	1968	· An Act provides for the incorporation of representatives of groups who have been recorded as owners of land under the Land Adjudication Act · Spells out how such groups should handle their administration issues
Trust Land Act (Cap 288)	1960	· Applies to all land that are still trust land · Trust lands are normally vested in local authorities · Spells out how trust lands may be set apart for use and occupation by the government · How licenses may be granted to any individual for purposes of grazing livestock, way leaves, taking of common minerals, removal of timber from trust land, and establishment of temporary labor accommodation.
Land Registration Act	2012	· The Act provides for revision, consolidated and rationalization of the registration of titles to land, to give effect to the principles and objects of devolved government in land registration, · Registration of interests in all public land, registration of interests in all private land, of the Constitution, registration of interests in all private land, registration and recording of community interests in land according to articles as declared by Articles 62, 64(a) and (b) respectively · This Act repeals, The Indian Transfer of Property Act 1882, The Government Lands Act, (Cap 280), The Registration of Titles Act, (Cap 281), The Land Titles Act, (Cap 282) and The Registered Land Act (Cap

Title	Year Enacted	Outline
		300).
Land Control Act (Cap 302)	1967	· An Act of parliament that provides for controlling transactions in agricultural land · Deals with sale, transfer, lease, mortgage, exchange, partition and any other form of disposal of agricultural land.
Land Dispute Tribunal Act	1990, (Repealed in 2011)	· The Act limits the jurisdiction of magistrates' courts in certain cases relating to land · Provides for establishment of Land Disputes Tribunals and defines their jurisdiction and powers
Law of Contract Act (Cap 23)	1 June 2003	· An Act of Parliament to apply the English common law of contract to Kenya, with certain modifications · Relates to dealings in land · Stipulates conditions under which suits may be brought upon a contract for the disposition of interest in land
National Land Commission Act	2012	· An Act of Parliament to make further provisions as to the functions and powers of the National Land Commission , qualifications and procedures for appointments to the Commission , to give effect to the objects and principles of devolved government in land management and administration , and for connected purposes.

Source: National Council for Law Reporting (www.kenyalaw.org), Ministry of Land official website (www.ardhi.go.ke)

Other details concerning Land Acquisition of development projects in Kenya are included in Attachment N-4 Section N-4.4.

2.13.7 Proposal for the Disposal of Equipment and Toxic Materials according to the Current Conditions and Regulations

(1) Legal bases

During operation stage of renewable energy projects, solid waste issues shall be addressed in compliance with the following laws and regulations in Kenya.

- ✓ Environmental Management and Coordination Act of 1999 (EMCA)
- ✓ Environmental Management and Coordination (Waste Management) Regulations 2006
- ✓ Guidelines for E-Waste Management in Kenya 2010

(2) E-waste

The issues of “e-waste management” are prominent. Especially e-waste components like used batteries, used fluorescent lamps and other used electrical appliances including PV solar panels, inverters and etc. are the core issues as summarized in Table 2.13.21.

Table 2.13.21 E-waste Components in Renewable Energy Projects

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

Prepared by JET

(3) Hazardous and Non-Hazardous Elements

Hazardous and Non Hazardous elements are regulated by EMCA, especially by the Guidelines for E-Waste Management in Kenya (See Table 2.13.22and Table 2.13.23).

Table 2.13.22 Hazardous Elements in Electrical and Electronic Equipment

Element	For example found in electrical and electronic equipment such as:
Americium	Smoke alarms (radioactive source)
Mercury	Fluorescent tubes (numerous applications); tilt switches (pinball games, mechanical doorbells, thermostats)
Sulfur	Lead-acid batteries
PCBs	Prior to ban, almost all 1930s-1970s equipment, including capacitors, transformers, wiring insulation, paints, inks and flexible sealants used PCBs.
Cadmium	Light-sensitive resistors, corrosion-resistant alloys for marine and aviation environments and nickel-cadmium batteries.
Lead	Old solder Cathode Ray Tube (CRT) monitor glass, lead-acid batteries and formulations of PVC.
Beryllium oxide	Filler in some thermal interface materials such as thermal grease used on heat sinks of CPUs and power transistors, magnetrons, X-ray-transparent ceramic windows, heat transfer fins in vacuum tubes, and gas lasers.
Polyvinyl chloride	PVC contains additional chemicals to change the chemical consistency of the product. Some of these additives can leach out of vinyl products e.g. plasticizers that are added to make PVC flexible.

Source: Guidelines for E-Waste Management in Kenya, December 2010, National Environmental Management Authority

Table 2.13.23 Non-hazardous Elements in Electrical and Electronic Equipment

Element	For example found in electrical and electronic equipment such as:
Tin	Solder, coatings on component leads.
Copper	Copper wire, printed circuit board tracks, component leads.
Aluminium	Nearly all electronic goods using more than a few watts of power, including electrolytic capacitors
Iron	Steel chassis, cases, and fixings.
Germanium	1950s-1960s transistorized electronics (bipolar junction transistors).
Silicon	Glass, transistor, ICs, printed circuit boards.
Nickel	Nickel-cadmium batteries.
Lithium	Lithium-ion batteries.
Zinc	Plating for steel parts.
Gold	Connector plating, primarily in computer equipment.

Source: Guidelines for E-Waste Management in Kenya, December 2010, National Environmental Management Authority

Possibility of “hazard to health and environment” caused by the hazardous elements shown in Table 2.13.22, which is one of the reasons for the necessity of e-waste management.

(4) Handling Procedure of E-waste

Not like domestic waste which is generated daily, e-waste is generated after life span of each component of the project facilities has finished.

Namely, the life span of batteries and fluorescent lamps are about two to several years as well as electrical appliances including PV solar panels, inverters and etc. are several to 10-25 years for which deposals shall be handled as summarized in Table 2.13.24.

Table 2.13.24 Handling Procedure of E-waste

Component	Possible Life Span*(years)	Handling	Remarks
Battery	3 to 8	・ In order 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 disposed them. ・ Used batteries can be sold to licensed e-waste handlers and/or battery producing companies in Kenya	・ Licensed e-waste handlers (See Table 2.13.35) or contact each NEMA county office to get more fresh information of such handlers ・ Battery Producing Companies (See Figure 2.13.9 or contact each NEMA county office) ・ Purchase Prices are subject to the market trends

Component	Possible Life Span*(years)	Handling	Remarks
Fluorescent Lamp	2 to 4	・ In order 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 disposed them. ・ Used Fluorescent Lamps shall be transported to licensed e-waste handlers in Kenya to be disposed.	・ Licensed e-waste handlers (See Table 2.13.35) or contact each NEMA county office to get more fresh information of such handlers
Light Emitting Diode (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

Prepared by JET

Other details of E-waste Management Structure E-waste Disposal System is shown in Attachment N-4 Section N-4.5.

2.13.8 Technical Cooperation on Environmental and Social Considerations

(1) Steps of Technical Cooperation

In the three-year technical cooperation project, three steps were taken for implementing Technical Cooperation (TC) in the field of Environmental and Social Considerations to REA as summarized in Table 2.13.25.

Table 2.13.25 Steps of Technical Cooperation on Environmental and Social Considerations

Step	Term	Principal Activities	TC Level	Remarks
First	2012	・ Review of Environmental Management legislation and EIA Systems ・ Review of Natural and Social Environment in Kenya ・ Site Surveys, impacts predictions and necessary actions on environmental permissions and JICA Screening formats for Lot 1 Pilot Project	Organization Level of REA	・ One specific REA staff in the field of environment was recruited and then assigned as the C/P for Environmental and Social Considerations at the end of 2012. ・ By that time a person of REA was concurrently served as a temporally C/P.
Second	2013	・ Site Surveys, impacts predictions and necessary actions on environmental permissions and JICA Screening formats for Lot 2 Pilot Project ・ Preparation of Guidelines and Manuals of environmental portion for renewable energies	Individual Level of C/P	・ Practical TC was implemented to the REA C/P in the field of environment.
Third	2014	・ Necessary procedures and actions on environmental and social considerations were taken to implement the pilot projects ・ Finalization of Guidelines and Manuals of environmental portion for renewable energies	Organization Level of REA and Individual Level of C/P	・ Based on TC in 1st and 2nd steps, REA and C/P initiated relevant actions for environmental and social considerations for the pilot projects such that REA and C/P asked contractors for making sure their compliance with the environmental and social considerations for the Pilot Projects

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(2) Core Aspects of Technical Cooperation

Core aspects for Technical Cooperation (TC) on environmental and social considerations for REA are summarized in Table 2.13.26.

Table 2.13.26 Core Aspects of Technical Cooperation

Technical Cooperation (TC) on Environmental and Social Considerations	Relevant Sections in this Report
a) "Overlay mapping" to acknowledge possible environmental/social impacts	Section 2.2.5
b) "Matrix" methods to predict possible environmental/social impacts	Section 2.4.1
c) Preparation of "Project Description Report for Lot1 & 2	Section 2.4.1
d) Preparation of JICA's "screening formats" for Lot 1 & 2	Section 2.4.1
e) Recommendations for environmental and social consideration for Lot 1 & 2	Section 2.4.1
f) Necessary procedures to be taken for the modification of PV sizes of Lot 1 & 2	Section 2.4.1
g) Actions to be taken for environmental and social considerations for Lot 1 & 2	Section 2.4.1
h) Preparation for Manuals in the part of environmental and social considerations	Attachment F-3

Prepared by JET

(3) Regular Meetings for Technical Cooperation

As one of the TC activities, regular meetings between C/P in charge of environment of REA and the JICA expert for Environmental and Social Considerations were held (especially during the assignment period of the JICA expert in 2nd Project year of 2013) to discuss relevant agendas as summarized in Table 2.8.27.

Minutes of Meeting (Meeting memos) for each meeting result were prepared and shared between REA and the JICA Expert Team.

Table 2.13.27 Regular Meetings with REA on Environmental and Social Considerations (in 2013)

Date	Leading Agendas/ Points Discussed
12 Jun. 2013	1. Self-introduction(Kick-off Meeting)* 2. Environmental and Social Considerations for Lot 2 3. Result of the stakeholder meetings of Lot 1 and future plan of training and monitoring
14 Jun. 2013	1. Familiarization with the work plan (Environmental & Social Considerations) 2. Possibility of legislative changes on laws & regulations governing EIA process in line with the new constitution 3. Appointment with NEMA's EIA section to explain the projects and enquire about item 2 above
21 Jun. 2013	1. Review of items of the previous meetings 2. Follow up on review of EIA laws and regulations/meeting with NEMA officials 3. Progress on Lot 2 sites selection and subsequent site visits 4. Manuals for solar, mini hydro, wind and bio-gas power 5. Changes in the solar capacity of lot 1 sites
28 Jun. 2013	1. Reconfirmation of Lot 1 project components for necessary further actions to be taken 2. Lot 2 sites' selection progress 3. Stakeholder meetings for each Lot 4. Preparation of manual for each renewable energy component
12 Jul. 2013	1. Necessary actions on Environmental and Social Considerations for Lot 1 projects 2. Survey results for Lot 2 project sites and preparation of Project Description Report for EIA NEMA procedures 3. Preparation of the JICA screening formats for Lot 2 4. Manual preparation for mini hydro, wind and bio-gas power
22 Jul. 2013	1. Final coordination on the necessary actions on Environmental and Social Considerations for Lot 1 projects 2. Final confirmation on the necessary actions on Environmental and Social Considerations for Lot 2 projects including preparations for Project Description Report, REA letter to NEMA on EIA/EA procedures, JICA Screening formats for Lot 2 projects. 3. Basic idea of table of contains in the field of environmental and social considerations to be discussed in the manuals of mini hydro, wind and bio-gas power.
27 Nov. 2013	1. Preparation for site survey visits for new Lot 2 sites

Date	Leading Agendas/ Points Discussed
	2. Preparation of the JICA screening formats for the new Lot 2 sites 3. Progress of the manuals(Guidelines)for mini hydro, wind and bio-gas power
06 Dec. 2013	1. Survey results for the new Lot 2 project sites and preparation of Project Description Report 2. Scheduling for preparation of Project Description Report for the new Lot 2 sites and NEMA applications by REA as well as JICA formats 3. Progress of the manuals (Guidelines) for mini hydro, wind and bio-gas power

*Note: A new REA counterpart in the field of environmental and social consideration was assigned in the December 2012.

Prepared by JET

2.14 Strengthen the Academic-Private Platform

To initiate and strengthen the concept of Academic-Private Sector Platform in collaboration with JICA experts of "the Project for Capacity Development for Promoting Rural Electrification Using Renewable Energy", following activities were conducted.

2.14.1 Presentation at Seminar in JKUAT Conference 2013

Small-scale Wind Energy System Workshop was held in the eighth JKUAT scientific, technological and industrialization conference on 15 November 2013 at JKUAT. Following presentations was made at the workshop. For the presentation of JICA/REA project, Japanese expert introduced about the project activities then Mr.Hannington Gochi, a C/P of REA explained about analysis of wind energy and current situation of Wind-PV-Diesel Hybrid generation system in Habaswein.

1. KEYNOTE SPEECH: Professor Izumi Ushiyama, President of Ashikaga Institute of Technology

   Topic: Small-scale Wind Energy Systems in Japan; Current trends and Problems

2. Dr. Tsutomu Dei, Consultant on Wind Power Generation, JICA/REA Project.

   Topic: Analysis of Wind Energy Data.

3. Mr. F. X. Ochieng, Research Fellow at IEET, JKUAT

   Topic: Development of a low-cost, Kenyan made efficient rotor blade for a small wind turbine.

4. Energy Consultant (To be Identified)

   Topic: Training needs on small-scale wind energy systems

5. Businessman (Local Small-scale Wind Installation Company Representative)

   Topic: Current trends and Problems facing Small-scale Wind Energy Systems in Kenya

2.14.2 Participation in the PV Technical Seminar organized by BRIGHT Project

BRIGHT Project aims to develop capacity for promoting rural electrification using renewable energy, and it is conducted concurrently with the Project for Establishment of Rural Electrification Model using Renewable Energy. Therefore, it is essential to cooperate with BRIGHT Project in order to strengthen the concept of academic-private sector platform.

As part of project activities, BRIGHT Project conducted solar PV trainings. The Project for Establishment of Rural Electrification Model using Renewable Energy has MoH/County Health Offices and MoEST/County Education Offices as beneficiaries as well as responsible organizations for maintaining the installed solar PV systems. Therefore, upon communication between the two projects, BRIGHT Project allocated seats for the officials from these organizations for two solar PV trainings of trainers outlined in Table 2.14.1. JET inquired each organization to seek potential participants.

Table 2.14.1 Participation in Solar PV Training of Trainers Courses

1)	Name of Course	4th Solar PV Training of Trainers Course	
	Period	7th-17th April 2014	
	Participant	Mr. Isaac Tuukuo, Medical Engineering Technician, County Health Office (Kajiado)	
2)	Name of Course	5th Solar PV Training of Trainers Course	
	Period	18th-29th August 2014	
	Participants	Mr. Daniel Tubei, Senior Technician, County Health Office (Narok)	
		Mr. Peter Kilel, Senior Medical Engineer, County Health Office (Narok)	
		Mr. Patrick Wanjohi, Engineering Technologist, County Health Office (Samburu)	
3)	Course Contents (same for both courses above)	1. Introduction to ERC Regulations	10. Lighting
		2. DC Basics	11. Appliances
		3. Introduction to Solar PV Systems	12. Wiring
		4. Solar Energy	13. End User Education
		5. Measuring Instruments	14. System Behaviours
		6. Solar PV Modules	15. System Sizing
		7. Batteries	16. System Installation
		8. Charge Controllers	17. Commissioning
		9. Inveters	18. Troubleshooting and Maintenance

Prepared by JET

Due to budget issues, Education officials were not able to participate in this particular training. However, if MoEST can prepare budget for the training, BRIGHT Project or JKUAT can consider the arrangement of training opportunities for them in the future.

2.14.3 Presentation of the Simple Pre-feasibility Studies in JKUAT Conference

JET proposed to REA to present the simple pre-feasibility studies of MHP, Biogas and Wind technologies in the JKUAT Conference 2014 as one of the opportunities to present the outcomes of the technical transfer activities. REA agreed it in the monthly meeting in 10 June 2014.

Each WG prepared abstracts for JKUAT Conference and submitted those to the executive office of JKUAT by 24 July 2014. All of three (3) abstracts were adopted. Each WG prepared full papers with support of JET and submitted those to the executive office of JKUAT by 29 September 2014.

The JKUAT Conference 2014 was held as follows:

Name: The Ninth JKUAT Scientific, Technological and Industrialization Conference
Theme: Science, Technology, Innovation and Entrepreneurship for Sustainable Development
Venue: JKUAT Main Campus, Juja
Date: 13 and 14 November 2014

Summary of each presentation is briefly explained hereinafter.

(1) Presentation of MHP

The presentation of MHP focused on the hydrological analysis of the simple pre-feasibility study for Asurur MHP.

Evaluation of river discharge is vital for the proper planning of hydropower development. However, discharge data at candidate sites of MHP is generally not available or limited.

In the Asurur study, hydrological analysis was carried out by use of three (3) kinds of data, i.e., i) Discharge data from Water Resource Management Authority (WRMA), ii) rainfall data from Kenya Metrological Department KMD, and iii) measured discharge data at the site by WG. Discharge data of WRMA is fortunately available at downstream of the Asurur MHP site. However, it was confirmed through the hydrological analysis in the study that the reliability of the discharge data is low. WG,

therefore, adopted the simulated discharge data by National Water Master Plan 2030 (NWMP 2030) in order to examine the reliable discharge by several data sources, and defined the design discharge for the planning.

The problem faced in the Asurur study is considered to be common in other MHP planning. Therefore, it was decided to present the experience of hydrological analysis in the simple pre-feasibility study in the JKUAT Conference.

An executive office of JKUAT Conference classified the presentation of MHP into poster presentation. The materials of presentation for the JKUAT Conference, i.e., full paper and poster, are attached as Attachment K-4.

REA personnel of WG is explaining to visitors in the JKUAT Conference

(2) Presentation of Biogas

Simple Pre-feasibility studies for biogas systems in six schools were conducted in Nyeri, Western and Nyanza regions by REA with support of JET. The objective was to plan optimum biogas system for the public school and clarify economic feasibility.

In the study, survey was conducted in six schools. Information of available feed stock (cow dung and human waste) was collected and possible amount of gas production and energy generation were estimated. Basic design of the bio-digester and generator was prepared. In this study, benefit and cost was estimated and financial evaluation was conducted considering tariffs and fuel price. Economic benefit was also assessed considering carbon absorption and forest preservation values. Financial efficiency of systems was compared with/without generator for Nyeri High School (HS) as a case study.

The result of the study shows the financial return for electricity and cooking fuel from the same amount of gas is almost the same at the present electricity tariff rate and fuel wood price in case of Nyeri HS. Meanwhile, initial cost of biogas system with generator was 32% higher compared with biogas system without generator. In addition the maintenance cost of biogas generation system is much higher than that of biogas systems without generator. Thus, it was concluded that to utilize all biogas for fuel wood replacement is more financially feasible than to supply biogas for electricity generation in the case study.

The presentation was originally adapted as oral presentation, and was changed to poster presentation due to the convenience of REA and the executive office of JKUAT. The full paper and poster presentation material are attached in Attachment L-4.

(3) Presentation of Wind

The results of simple pre-feasibility study on wind - diesel hybrid power generation system at Baragoi, Samburu County in Kenya was presented at the JKUAT conference.

in the JKUAT Conference

At Baragoi, wind speeds and directions have been monitored at 20 meters and 40 meters above ground level respectively by Ministry of Energy and Petroleum. In this study, wind characteristics such as frequency of wind speed and wind direction were examined based on the data monitored for a year. In addition, power output from a wind turbine is estimated using monitored data. Site survey at Baragoi diesel power station and wind monitoring system was conducted. The autonomous diesel power station in Baragoi supplies electricity to customers in the area. The capacity of the existing diesel generator is 300 kVA. Operational data of the diesel power station was summarized and analyzed in the study. Furthermore, economical aspect

of the project was evaluated. The collected data enabled estimation of potential power output from wind turbine. In addition, the conceptual design of hybrid system with existing diesel power station was studied.

At the conference, the result of the simple pre-F/S was presented by a C/P of REA. The full paper and presentation materials are attached as Attachment M-4.

2.15 International Workshop

(1) Guests from Greater East Africa

Officers in charge of rural electrification with renewable energy were invited from four countries of greater East Africa[27] (Burundi, Ethiopia, Rwanda, and Uganda) to exchange information about policy and their experiences in the workshop. The officers also visited a pilot project site to see outcomes of the project. The details of the guests are as follows.

1. Burundi: Mr. Aloys Ndugaritse, Senior Advisor to Minister of Energy and Mines

2. Ethiopia: Mr. Girma Welkeba, Manager, Ethiopia Electric Power

3. Rwanda: Mr. Blaise Munyemana, Chief Officer, Ministry of Infrastructure

4. Uganda: Mr. Benon Bena, Manager Off-Grid Renewable Energy Development, Rural Electrification Agency(2) International Workshop

The Project held International Workshop on 3rd February 2015 in Nairobi. The objectives of the workshops are as follows.

- To summarize the model and output of the Project and share the outcome among the participants
- To share the experiences of rural electrification using renewable energy in Kenya and greater East African countries among participants from universities, companies, and related organizations
- To exchange information about policy, challenges, and lessons learnt about renewable energy and rural electrification, and find the way forward

In total, 75 participants including JICA, JET, REA, MoE&P, officers from greater East Africa, JKUAT and other three universities, KEREA, The Energy and Resources Institute (TERI), and related institutions and private companies attended the workshop.

Guests from greater East African countries presented presentation materials about the policy, current status, ongoing projects, and challenges for rural electrification and renewable energy in respective countries. REA counterpart staffs made presentations on the model including charging services by PV system, and summarized the result of Pre-F/S and contents of technical guidelines of wind, MHP, and biogas. In addition, TERI from India presented experiences on renewable energy introduced in India and African countries.

In the last session, the panelists comprised of greater East African guests, JICA officers, REA, TERI, and JET members exchanged discussions with the other participants.

The key points made in the discussion were as follows.

- Needs for training and educational mechanism in greater East Africa for renewable energies, such as higher education of engineers and lower education of technicians in Uganda

[27] Originally, the Project planned to invite from six countries including South Sudan and Tanzania. However, there was no participant from those two countries, since South Sudan replied that they could not dispatch the participant and Tanzania canceled participation due to other urgent business.

- Strategy for rapid increase of rural electrification rate with an intensive programme, such as Electricity Access Roll out Program in Rwanda
- Current challenges of low sustainability of PV system and needs for enhancement of contractor's quality
- The period of availability of guidelines and needs of continuous update by REA staffs
- Needs for marketing in villages with household profiling for PV to household level, such as seasonal cash flows analysis of households
- Pointing out the weakness of reliability of large scale renewable energy application in the national grid operation

Photo taken by JET

Figure 2.15.1 Photo of International Workshop, JET and Counterparts

Soft copies of five guidelines of solar PV (for schools and health institutions), MHP, biogas and wind prepared in the Project and presentation materials were recorded in the CD-ROM and distributed to all participants.

The minutes of meeting of the International Workshop and presentations made by the participants (greater East African guests, JICA, TERI, and REA counterpart staffs) are attached in Attachment O.

The schedule of the visit is shown in the table below.

Table 2.15.1 Schedule of Visit of Officers from Greater East Africa

Date	Stay	Activities
2nd February 2015 (Mon)	Nairobi	Arrival of officers from Easterm Africa in Kenya
3rd February 2015 (Tue)	Nairobi	International Workshop
4th February 2015 (Wed)	Naivasha	Visit to Lot 1 Pilot Project site (Iltumtum)
5th February 2015 (Thu)	Nairobi	Visit to Olkaria Geothermal Power Plant
6th February 2015 (Fri)	-	Departure of officers from Easterm Africa

Prepared by JET

(3) Visit of Pilot Project Site

The greater East African guests and JET visited the pilot project site, to share the example of PV system installation and charging business model and to attend the hand-over ceremony held by JICA, as in Section 2.5.6. Iltumtum was selected due to the accessibility and high achievement of charging service.

Management committee declared their responsibility of O&M in the ceremony. Chief administrator of the county also attended and showed his expectation in PV system for the improvement of educational condition and academic performance of students.

The PV systems installed in 10 Pilot Projects were handed over from JICA to REA officially in this ceremony on 4 February 2015.

(4) Visit of Olkaria Geothermal Power Station

As the supplemental program, guests from greater East Africa with a REA staff and JET members visited Olkaria geothermal power plant owned and operated by KenGen on 5 February 2015.

Photo taken by JET

Figure 2.15.2 Photos of Test Drilling Well and Control Room in Olkaria Geothermal

Greater East African guest expressed keen attention to the technical and financial aspects of geothermal development. They observed power station, well head mobile generation system, drilling, test drilling wells, pipelines, and condensation facility. They questioned and exchanged views and information with the KenGen officers including the following items.

- Possibility of coexistence of hydrocarbon and geothermal potential
- Temperature and pressure condition, and drilling depth of geothermal reservoir
- Safety of steam treatment including chemical component such as H_2S
- Long term development period and large investment requirement due to drilling
- Requirement of 3D modeling for analysis of drilling
- Investment cost and price of unit energy by geothermal power
- FIT availability for small scale (<20 MW in Kenya) and possibility of private sector participation in geothermal development
- Method for training of geothermal engineer. KenGen offers annual geothermal training program for greater East African applicants.

CHAPTER 3 ISSUES ON PROJECT MANAGEMENT, BEST PRACTICES AND LESSONS LEARNT

3.1 Effective Measures on Information Sharing

Information sharing among concerned institutions is important for effective implementation of the project and is enabled by shared office facilities. However, due to constraints in available office space, JET working within close proximity to REA's project manager and MoE&P was not possible. The project office assigned to JET was located at the outskirts of Nairobi County, while REA and MoE&P offices are located in the Nairobi central business district. To improve information sharing for better project management, the following activities were conducted:

- Management Meetings
- Monthly Meetings
- Weekly Emails

Management meetings were held by REA's project manager, MoE&P and JET leader mainly to discuss the cancellation of pilots using MHP, biogas and wind. At the 2nd JCC meeting, a recommendation to hold monthly meetings chaired by the CEO of REA was adopted, and subsequently implemented. In the monthly meetings, participants shared information on the project and discussed issues arising in the project's implementation. Further, an additional recommendation to share updates on basic information such as the project schedule through weekly emails was adopted and implemented. It was noted that monthly meetings and weekly emails improved communication and information sharing between JET and C/Ps.

3.2 Effective Measures on Technology Transfer

Due to the limitations of separate office facilities in this project, opportunities for JET and C/Ps to work together were limited. Additionally, REA staff had numerous work assignments which posed a challenge in scheduling technical transfer activities with due consideration of time constraints.

Despite these challenges, the following effective measures on technical transfer were jointly implemented by JET and REA, in the project:

(1) Site Surveys and Works

Site surveys and works provided an ideal avenue for technology transfer as JET and C/Ps were able to concentrate on the tasks at hand by committing and schedule time in advance. Communication and joint planning of site visits by JET, REA and MoE&P maximized the participation of C/Ps.

(2) Preparation of Presentation Materials and Presentations by Counterparts

JET provided opportunities for counterparts to prepare and give presentations as part of the technical transfer activities. Counterparts gave presentations in various forums, an assignment which encouraged them to take the initiative to prepare materials and enhance their understanding of issues in rural electrification.

(3) Counterpart Training in Japan, India and Thailand

JET planned and coordinated counterpart training programmes in Japan, India and Thailand. The training programmes in India and Thailand offered opportunities for C/Ps to learn from the practical experiences of countries which have conducted rural electrification using renewable energy extensively and through holistic country development programmes. The training in Japan provided a practical introduction to cutting-edge renewable energy technologies, applications, developments and techniques, and inspired the trainees in terms of innovation. In total, 10 counterparts participated in the training programmes.

(4) Provision and Application of Technical Equipment in Technical Transfer

During the project, JET sought and secured JICA's approval to provide technical equipment to REA. The request was in recognition of an increasingly pressing need to show counterparts how to use relevant equipment. Provision of equipment and tools, and demonstration of their use by JET provided a practical opportunity for technical transfer and enhanced the level of understanding and skills of counterparts. This approach was especially helpful in technical transfer on activities such as site survey, inspection, and monitoring.

3.3 Cancellation of Pilot Projects for Business/Industrial Facilities

In the 1 year of the project, Output 3 was revised due to the cancellation of pilot projects for business industrial facilities as follows:

> (Original)
>
> A practical model for the electrification of business/industrial facilities using renewable energy is developed through pilot projects.
>
> (Revised)
>
> The Capacity of REA/MoE&P to undertake projects using MHP, biogas and wind technologies is enhanced.

The above change was informed by the challenge of engaging with UNIDO for the establishment of a practical business pilot model within the limited implementation period of the project. Additionally, it was informed by the results of a survey of energy kiosks and discussions between JICA and REA.

As a result, the project component for output 3 was revised to concentrate on building the capacity of REA. While the change caused loss of project implementation time, the methodologies applied to formulate plans for the pilots as described in Section 2.9 are a resource which have been developed and can be referred to for renewable energy projects.

3.4 Challenges in Site Selection for Pilot Projects

In the initial project plan, Lot 1 pilot sites could be chosen from 20 candidate sites identified in "Preparatory Surveys for Renewable Energy Promotion in Africa, Public Facility Electrification", conducted from April to November 2009. The preparatory survey team obtained a list of 30 candidate sites from REA and highlighted 6 sites, from which 3 sites were recommended for the pilot projects. The selection criteria applied were as shown below:

- Considerable distance from the existing grid line
- Not owned by private entity, organization or mission
- Not overlapping with candidate sites of other donors
- Confirmed to be a reasonably safe and secure environment

In 2012, the project team visited the three (3) sites and found that two (2) had been electrified, which was indicative of the rapid speed of electrification by grid extension in Kenya. Subsequently, most of the candidate sites identified were electrified by the time preparatory surveys were undertaken by JET. In addition, a database of un-electrified public facilities compiled by REA and MoE&P was not available. Identifying candidate sites on the basis of un-electrified geographical areas was also difficult as these were mostly located in Northern parts of Kenya where security is a concern for JICA and JET. Site selection would therefore have been more effective if the following were available:

- Updated database of un-electrified public facilities and data on grid extensions
- Preliminary data collected on pilot sites including information on the security status for consideration by JET

3.5 Measures on Safety and Security Issues

(1) Project Office

The project office was located within the same compound as REA's warehouse. There was an armed robbery at the warehouse on the night of 26 September 2014, fortunately, without casualties. However, this is not an isolated incidence for an office located in the warehouse as it is not rare in Nairobi. The armed robbers entered the warehouse, threatened security officers with automatic rifles, and stolen valuable equipment.

JET requested security countermeasures to REA which can be put in place. The countermeasures which proceeded for the budget approval include:

i) Hiring armed administration police officers
ii) Supplying electricity to the existing electric fence
iii) Increasing the height of the electric fence

In addition to above, it may be advisable to avoid selection of project offices in such locations, if possible.

(2) Site Surveys

1) Police Escort

Lot 2 sites are located in Samburu County, where police escort was required for movement of JET. JET had discussions with police stations in Samburu County and signed an agreement to procure escort services at a fee, on 15 October 2013.

2) Roadblocks by Residents

These were encountered in Samburu County, where residents sought to obtain bottles of water and would effectively block the road if displeased. This behaviour potentially posed a threat, but was mitigated as JET would give out their extra bottles of water, resolving the situation amicably.

3) Poor Mobile Communication Network

The mobile communication network was relatively poor in some project sites, especially in Samburu County. JET would therefore ensure additional SIM cards to be carried during site visits in order to identify and use the most appropriate network provider on site. Further, JET availed satellite phones for emergency communication in areas where mobile communication networks were unavailable.

4) Commonplace Car Break-ins

During site surveys and daily transportation within Nairobi, JET exercised caution in the use and operation of JICA's vehicles, due to possible exposure to commonplace car break-ins. An additional measure was the application of window films (tinting) to the vehicles.

(3) Casualty to the Project

The project experienced the death of one member of staff through a road accident on 15 May 2013. The local assistant for Community Development/ Community Monitoring was a casualty of a road accident while commuting to the project office. JET sought to increase staff awareness on road safety and maximize caution in staff transportation through internal meetings, and engaged with the family.

3.6 MOUs by Government Institutions

The overall objective of MOUs is to state the terms and conditions under which REA, in conjunction with MoH and MoEST, will implement solar PV projects. It incorporates aspects of design, supply,

installation, commissioning, operation and maintenance, and replacement of components of solar PV systems in public health facilities and schools..

JET supported REA in the preparation of MOUs and a draft prepared by REA was submitted to MoH on 10 November 2014. MoH subsequently submitted the draft to the Office of the Attorney General and is awaiting feedback as of January 2015.

A MOU with MoEST was not pursued to fruition as the policy for O&M budget allocation for solar PV systems installed at public schools has not yet been finalized. REA is expected to install solar PV systems in about 3,000 primary schools under the laptop programme by the end of FY 2014/2015. Securing the sources and allocation of O&M budgets is therefore amongst the most important issues for successful operation and sustainability of the laptop programme. .

Lessons learnt from the preparation of MOUs are as follows:

(1) The process of entering into MOUs by government institutions in Kenya is lengthy.

(2) It is therefore essential that establishment of a MOU is undertaken at the initial stage of the project. However, the MOU can be prepared based on the results of the pilot test.

(3) It is difficult to enter into MOUs relating to new and ongoing national projects such as the laptop programme where concerned ministries are still in discussions on the allocation of O&M budgets.

3.7 Challenges in Project Office Operations

The project office was located at the outskirts of Nairobi County and a significant distance from REA and MoE&P head offices where the majority of C/Ps were operating. Further, space at all the offices was also limited throughout the project period and it was not possible to relocate the project office. This made technical transfer between JET and C/Ps challenging, a concern which was noted by REA at the onset of the project.

The location of the project office also posed an additional challenge of poor mobile network connectivity which brought about delays in communication and caused inefficiencies in the project works. It is advisable that JICA approves JET’s selection of a project office within close proximity to C/Ps in instances when C/Ps are unable to provide appropriate office facilities.

CHAPTER 4 ACHIEVEMENT OF PROJECT PURPOSE

4.1 Mid-term Evaluation Results

Mid-term evaluation of the project was carried out from 16 September to 6 October 2013. The results of the evaluation are summarized in this section.

4.1.1 Results of Evaluation by Five Criteria

(1) Relevance

The relevance of the project is high. Since the policy framework explicitly states the targets for rural electrification, such as Vision 2030 (electrification of all households in Kenya by 2030) and Rural Electrification Master Plan (40% rural electrification rate by 2020), the demands of rural electrification are significant for these goals to be attained.

(2) Effectiveness

Effectiveness is moderate according to the current achievement of the outputs. Since the achievement of all outputs is halfway, evaluation includes certain forecasts. In order to enhance the effectiveness, the correlation and causality between the project purpose and Output 3 need to be clarified. It is necessary to revise the project purpose and/or at least include some indicators correlating to Output 3.

(3) Efficiency

The efficiency of the project is low to moderate. As previously described, a significant delay (11 months) in selection of Lot 2 sites risks the implementation of activities to achieve Outputs 1 and 2. Even though unexpected governmental structure and policy changes happened after the commencement of the project, such as the rapid execution of grid extension due to the laptop programme; more fundamental information should have been collected from relevant government institutions in order to cope better with such changes.

(4) Impact

It is too early to evaluate the impact as the project purpose is underway and is yet to be achieved fully. Due to the close correlation between the project purpose and the overall goal, the overall goal is likely to be achieved once the project goal is attained. The risk which may impede the achievement of the overall goal is that the value of off-grid electrification may decrease in the near future due to rapid grid extension.

(5) Sustainability

The key actors to secure the sustainability of the model are C/Ps (REA and MoE&P). Since technology transfer and capacity enhancement activities for C/Ps have just started, it is too early to evaluate their competency to sustain the model. Since JET has focused on the installation of Lot 1 and capacity development of stakeholders of the facilities; JET should put more effort to involve C/Ps in monitoring of Lot 1 and installation of Lot 2.

4.1.2 Conclusion

The relevance of the project is high due to the significant demands for rural electrification, and the policy trend towards focusing on renewable energy, such as the new energy policy (draft). Effectiveness is moderate according to the current progress of outputs. In terms of impact and sustainability, it is too early to evaluate at this point but the necessity of C/Ps' active involvement and

ownership of the project has been confirmed for project implementation in an effective, efficient and sustainable manner.

Efficiency needs to be improved in order to achieve all outputs as well as the project purpose by the end of the project period. Since the activities for both Outputs 1 and 2 have been significantly delayed, close communication and information sharing among C/Ps, JET and other target group members are necessary not only to catch up on the schedule but also to implement appropriate planning, design, procurement, and monitoring. Since fruitful discussions and information sharing have been conducted in the course of this mid-term review, such active interaction should be maintained among C/Ps, JET and other target group members for the achievement of the outputs and the project purpose.

4.1.3 Recommendations and Lessons Learnt

(1) Recommendations for the Project

Based on the results of the mid-term review, the review team would like to propose several recommendations to be considered and carried out in the remaining period of the Project as follows:

1) To establish an institutional system to promote information sharing
   - Weekly Project Status Reports (E-mail) issued by Counterparts (C/Ps) at REA and MoE&P, and Japanese Experts (JEs)
   - Monthly Project Meetings chaired by CEO of REA
   - Information and progress sharing with relevant organizations

2) Countermeasures for future grid extension to the sites of installed PV systems through the proposed model.
3) Considerations for the management of the project schedule
4) Revision of the PDM and PO

(2) Lessons Learnt

Capacity and needs assessment for counterparts can be conducted in a more detailed and consultative manner with sufficient time prior to the commencement of the project. By doing so, appropriate and feasible contents for the project will be designed, for C/P's active involvement. Similar assessments and consultations can milestones, such as major organizational transformation of C/P's, to meet needs and expectations of C/Ps in an appropriate and timely manner.

4.2 Terminal Evaluation Results

Terminal evaluation was carried out from 30 September to 14 October 2014. Results of the mid-term evaluations are summarized below.

4.2.1 Results of Evaluation by Five Criteria

(1) Relevance

Relevance is relatively high. The project is well aligned with Kenya's development priorities as well as Japan's Official Development Assistance (ODA) policy for Kenya. The project is also appropriately responding to the needs of the target group, especially the needs of public facilities in non-electrified areas; by mobilizing Japan's comparative advantage of expertise in renewable energy, community participation, O&M, and business analysis. On the other hand, Kenya has been seeing rapid grid extension in recent years and some of the sites selected for the pilot project have become covered by the grid. Such a situation could have been avoided if strategic and systematic planning of rural electrification had been in place at REA/MoE&P before the commencement of the Project.

(2) Effectiveness

Effectiveness is fair at present. Although the project purpose is expected to be achieved to a relatively high degree by the end of the planned period, there is still uncertainty regarding the achievements of all the Outputs, from Output 1 through to 4. If ongoing activities are completed smoothly and effectively and the concerned institutions take action in accordance with the recommendations to the Project specified in this report, effectiveness is expected to be higher at the completion of the Project.

(3) Efficiency

Efficiency is fair. Inputs from both Japanese and Kenyan sides are basically provided as planned. However, the C/Ps, having many other duties, are not able to spend sufficient time on project activities. This was especially the case before the mid-term review, hence lowering the level of technical transfer from JET to C/Ps. The plan for pilot projects at industrial facilities was cancelled in the first year and it took time to rearrange the project framework. Various key activities were delayed due to reasons such as solar PV pilot site re-identification to avoid grid extension, solar PV system challenges and location of Lot 2 in a remote area. Furthermore, Kenya's transition to the county government system around mid-2013 required time to identify stakeholders and clarify their roles and responsibilities regarding O&M of solar PV systems. On the other hand, collaboration with JKUAT and BRIGHT Project is contributing to increased efficiency to a certain extent.

(4) Impact

Impact is fair. The achievement level of the Overall Goal will largely depend on the achievement of the Project Purpose. It will also depend on the practicality and replicability of the rural electrification models to be finalized in the remaining project period. Since there is a certain level of uncertainty regarding the achievement of the Project Purpose at the moment, the Overall Goal is also subject to uncertainty.

Positive impacts of the Project are: (1) Stakeholders of renewable energy increased their awareness regarding the high O&M cost and (2) Likelihood that REA will discuss O&M issues with potential facilities owners/users in future implementation of renewable energy installation projects. There are also impacts at the community level which have improved the daily lives of the community members following the installation of solar PV systems at pilot sites. For instance; the personal security of female pupils and staff has improved with lighting at evening and night time, community members - particularly women and children- are now enjoying improved quality of public health services such as provision of better care during delivery at night and immunizations at local dispensaries. On the other hand, REA could not adopt some specifications suggested by the Project regarding the solar PV systems design for the Laptop Programme due to time constraints. If the Laptop Programme is realized, it may have a remarkable impact affecting as many as 3,000 primary schools in Kenya.

(5) Sustainability

Sustainability is fair. Presently, the level of policy and institutional sustainability is difficult to judge since REA is earmarked for transformation into the National Electrification and Renewable Energy Authority (NERA) by 2017. However, if the suggestions from the Project are incorporated into the current policies on renewable energy, policy sustainability will be high in the future. The roles and responsibilities in regards to O&M of solar PV systems need to be further clarified and ensured among the national and county governments for better institutional sustainability. Technical sustainability is a challenge because C/Ps' practical skills in all four renewable energy technologies still have room for improvement when compared to their theoretical knowledge. Financial sustainability also needs to be improved, particularly for appropriate O&M of solar PV systems, as the governments' budgets to push forward with dissemination of the model are yet to be secured.

4.2.2 Conclusion

At the time of the terminal evaluation, the achievement level of the Project Purpose was fair. However, the achievement level will be higher if the remaining activities are completed successfully without delay within the remaining project period and appropriate action is taken in accordance with the recommendations proposed in this report.

The project team has been conducting planned activities despite multiple challenges and adversities which contributed to lowering efficiency. There are still many issues to be addressed in the remaining implementation period until the Project presents practical and sustainable models. In particular, presenting optimal O&M mechanisms for solar PV systems requires obtaining the understanding and agreement of relevant organizations. The Project will then need to provide effective recommendations to C/P institutions, authorization and endorsement of which will ensure that the models take root at the C/P institutions. If these issues are addressed properly, the achievement level of the Project Purpose will be much higher.

The Project is advised to take the actions explained above as well as to follow the recommendations presented in the next section. The Project should be completed in February 2015 as originally planned.

4.2.3 Recommendations and Lessons Learnt

(1) Recommendations to the Project (To be addressed in the remaining project period)

1) Ensuring sustainability by establishing the O&M models

The Project should continue discussing the O&M models for solar PV systems with relevant institutions including MoH, MoEST, county governments and so forth to ensure sustainability of the solar PV systems. Having high-level dialogues and subsequently entering into MoUs with relevant institutions is strongly recommended since it would officially promise institutional and financial commitment to the O&M models. Providing quantitative data on projected annual O&M cost, both total and itemized, by the Project to the prospective signatories of the MOUs would facilitate informed decision-making by the signatories.

With regard to MoEST's institutional framework for O&M, an option such as giving a stronger facilitation role to County Education Offices should be considered. The offices could then effectively link the solar PV-installed schools and MoEST when the schools are in need of financial resources for O&M of their solar PV systems.

Furthermore, appropriate management and handling of cash generated from the charging services business need to be discussed in order to prevent possible misconduct at the facilities.

The proposed O&M models, on the other hand, should be authorized by the C/P institutions. Departments/persons responsible for continuous improvement of the models should also be identified and appointed.

2) Conducting and presenting a quantitative analysis on applicability of the models

It is recommended that quantitative analysis on applicability of the proposed models is conducted and presented to REA/MoE&P. It is beneficial for the C/P institutions to be equipped with quantitative information on, but not limited to, (1) a projected scope of applicability of the proposed models to future rural electrification plans, (2) the estimated number of applicable cases, and (3) required O&M costs. When conducting the quantitative analysis, site-selection criteria for charging services stations need to be clarified as well. Thus, the Project is advised to build upon the knowledge it has acquired through experience on pilot implementation activities, and propose the most appropriate criteria.

3) Formulating realistic policy recommendations

In order to complete the work for Output 4, which is about proposing recommendations on policy and institutional frameworks for rural electrification using renewable energy, the Project is advised to have close dialogues with relevant institutions regarding the proposed solar PV models. The Project should thereafter formulate realistic policy recommendations and garner support for the implementation of the recommendations by the concerned institutions. Furthermore, in order to facilitate the active adoption of the proposed models by REA in future, it is advisable that application of the models is specified in REA's "Annual Renewable Energy Work Programme (Performance Contract)" as well as " Rural Electrification Master Plan (REMP)" at the time of updating. The Project, JET and C/Ps are encouraged to work on this issue before termination of the project.

4) Working on intensive technical transfer with strong participation from C/Ps

In order to fill the knowledge/skills gap, it is advised that technical transfer from JET to C/Ps be undertaken actively during the remaining project period. Strong participation from C/Ps in technical transfer activities is key to attainment of satisfactory levels of technical transfer in each renewable energy technology field. C/Ps' participation includes, but is not limited to, preparation and presentation of papers to be presented at the international workshop to be held in February 2015.

5) Recording the achievement of the Objectively Verifiable Indicators, challenges and recommendations

At the time of the terminal evaluation, some of the key Objectively Verifiable Indicators in PDM had not reached their targets. However, they are expected to be attained in the next few months as the Project progresses. When writing the Project Completion Report to be submitted in February 2015, the achievement levels of those indicators should be written clearly so that an objective judgment of project performance can be made easily. Furthermore, any remaining challenges and/or measures to be undertaken to increase sustainability should be discussed with C/Ps and other related institutions, and the results of the discussions delineated in the Project Completion Report.

(2) Recommendations to the C/P institutions (To be addressed as medium to long term measures)

1) Utilizing and improving the proposed models continuously

It is recommended that C/P institutions continue utilizing and improving the solar PV models proposed by the Project. Delegation of departments/persons responsible for coordination with relevant institutions is also recommended as an institutional effort to improve the models.

2) Utilizing and revising the guidelines continuously

As for MHP, biogas and wind technologies, pilot project implementation was cancelled in the first year of the project. Thus, C/Ps did not have a chance to experience the whole cycle of planning, analysis, system designing, installation and monitoring which are necessary to carry out activities on the ground. The Project, instead, conducted intensive training of C/Ps and is developing guidelines for future use. It is strongly recommended that C/Ps build on their training experience in the Project and leverage their increased knowledge by actually implementing of MHP, biogas and wind technologies in the field. In doing so, utilizing and revising all the guidelines should also be conducted continuously and REA should be responsible for revising and updating the guidelines.

3) Improving database in the Rural Electrification Master Plan (REMP)

The current database for the REMP needs to be improved and to make use of Geographical Information System (GIS). The improvement will help relevant organizations including development partners to avoid duplication or overlap of future project sites. It will also facilitate easier decision-making concerning locations of future development.

4) Exchanging knowledge and human resources with JKUAT

REA's and MoE&P's knowledge sharing and exchange with JKUAT have been proved to be beneficial. Continuous exchange of knowledge and human resources with JKUAT is advisable for strengthening of REA's and MoE&P's capacity in renewable energy technology. Such knowledge exchange includes, but is not limited to, sharing REA's guidelines and other documents produced by the Project so that JKUAT can utilize them in their training courses. With regard to JKUAT's trainings on solar PV systems, regular attendance of such trainings by MoH, MoEST, and county governments should be ensured.

5) Improving basic skills for installation work of electrical facilities

It was observed that the quality of basic installation works for wiring, switches, breakers, etc. was rather low. Thus, the responsible expert became fully occupied with fixing the poor installations. Without the supervision of the expert, most solar PV systems installed by local contractors may soon experience faults and malfunctions. In order to improve the quality of basic installation works, it is important for REA to compile detailed appropriate designs, and rigorously supervise/ inspect the contractors' job accordingly.

(3) Lessons Learnt

1) Taking appropriate measures to minimize negative factors before and during the Project implementation

There is no doubt that the current delay in producing sufficient outputs is largely attributable to the many negative factors identified earlier in the terminal evaluation. There are eight internal and external factors which have been negatively influencing the Project throughout its implementation. The Project implementers should have made more effort to identify and tackle these critical issues before and during the project implementation period to minimize unfavourable ramifications. In some cases, drastic modifications of project design and modalities, including revisions of project scope and changes in the mode of experts dispatch, to name a few, could have been considered so as to address the major issues in the best ways.

4.2.4 Activities after Terminal Evaluation

Table 4.2.1 summarizes the activities to be undertaken in order to achieve the recommendations written in the preceding sections. These activities are carried out following the terminal evaluation (14 October 2014 to 28 February 2015).

Table 4.2.1 Activities after the Terminal Evaluation

Recommendations in Terminal Evaluation Report	Activities
1. Ensuring sustainability by establishing the O&M models	
(1) Having high-level dialogues and then entering into MOUs with relevant institutions is strongly recommended. (2) With regard to MoEST's institutional framework for O&M, an option such as giving a stronger facilitation or role to County Education Offices is to be considered. The offices could then effectively link the solar PV-installed schools and MoEST when the schools are in need of financial resources for solar PV O&M.	(1) (2) JET convened the Progress and Information Sharing Meeting with high level officers at MoH and MoEST headquarters on 19 January 2015. In the meetings, JET explained the results of the pilot project as well as the challenges of sustainability of the solar PV system. JET requested MoH and MoEST to take direct responsibility for the sustainability of the systems in terms of technical and financial support and human resource allocation. JET also requested the ministries to instruct county offices to implement periodic monitoring of machinery and charging services, and prepare annual budgets for future replacement of batteries, inverters and controllers. Though MoEST has no special budget for infrastructure management at this moment, the explanation was understood.
(3) Furthermore, appropriate management and handling of cash generated from the battery charging business needs to be discussed in order to prevent possible misconduct at the facilities.	(3) JET conducted the Progress and Information Sharing Meetings with MoH and MoEST county offices of Kajiado, Narok and Samburu Counties in November 2014 and January 2015. In the meetings, JET explained the progress and results of the pilot project as well as the challenges of the sustainability of solar PV systems. JET requested MoH and MoEST county offices to take direct responsibility for the sustainability of the systems in terms of technical and financial support and human resource allocation. JET also requested the ministries' county offices to implement periodic monitoring of machinery and charging services, and prepare annual budgets for future replacement of batteries, inverters and controllers. Though MoEST has no special budget for infrastructure management at this moment, the explanation was understood.
(4) The proposed O&M models, on the other hand, should be authorized by the C/P organizations. Departments/persons responsible for continuous improvement of the models should also be identified and appointed.	(4) JET identified the Director of REA's Renewable Energy Department as the responsible person for authorization of the JICA Model.
2. Conducting and presenting a quantitative analysis on applicability of the models	
(1) A quantitative analysis on applicability of the proposed models is recommended to be conducted and presented to REA/MoE&P. 1) A projected scope of applicability of the proposed models to their future rural electrification plans, 2) Estimated number of applicable cases. 3) Required O&M costs.	(1) Quantitative analysis was explained and adopted at the fourth (4th) JCC. 1) Summarized in Chapter 2.6.6. 2) Summarized in Tables 2.6.26 and 2.6.27 in Chapter 2.6.6. 3)Summarized in Guidelines' Chapter 4 on Financial System (Schools & Health Institutions)
(2) Project is advised to build upon its knowledge acquired through its experience on the pilot activities and propose most appropriate criteria.	(2) The criteria is written in Project Completion Report Chapters 2.6.3, and 2.6.4.

Recommendations in Terminal Evaluation Report	Activities
3. Formulating realistic policy recommendations (1) For Output 4, Project is advised to have close dialogues with relevant institutions regarding the proposed solar PV models. (2) The Project should formulate realistic policy recommendations and garner support for their implementation by the concerned institutions. (3) Furthermore, in order to facilitate active adoption of the proposed models by REA in future, application of the models is advised to be specified in REA's "Annual Renewable Energy Work Programme (Performance Contract)" as well as in the "Rural Electrification Master Plan (REMP)" at the time of updating. The Project and REA are encouraged to work on this issue before the Project terminates.	(1) A meeting was convened with REA and MoE&P to discuss the recommendations. (2) Recommendations were compiled and explained at the fourth (4th) JCC. (3) In the project, JET has proposed to install 48 V systems for laptop power sources in primary schools. REA has installed and commissioned two (2) 48 V systems at Kapgemui Primary School and Kamugei Primary School in Baringo Central Constituency. The recommended policies will be included in Performance Contract 2015/16.
4. Working on intensive technical transfer with strong participation from the C/Ps In order to fill the knowledge/skills gap, it is advised that technical transfer from the Experts to C/Ps be undertaken actively during the remaining project period. The C/Ps' participation includes, but not limited to, preparation and presentation of papers for the iInternational Workshop to be held in February 2015.	Counterparts made presentations at The Ninth (9th) JKUAT Scientific, Technological and Industrialization Conference held on 13 and 14 November 2014. They also made presentations and shared their experiences of the works conducted under REA/JICA project at an international conference which held at Panafric Hotel on 3 February 2015.
5. Recording the achievements of the Objectively Verifiable Indicators, challenges and recommendations At the time of the terminal evaluation, some of the key Objectively Verifiable Indicators in PDM have not reached their targets. They are expected to be attained in the next few months as the Project progresses. When writing the Project Completion Report to be submitted in February 2015, the achievement levels of those indicators should be clearly written. Furthermore, remaining challenges and measures to be taken for raising sustainability should be discussed with the C/Ps and other related organizations and the results of the discussions should be delineated in the Project Completion Report.	Progress of PDM activities and Objectively Verifiable Indicators were written in Chapter 2; Table 2.1.1 Objectively Verifiable Indicators and Achievement in PDM and Table 2.1.2 Activities in PDM respectively.

Prepared by JET

CHAPTER 5 RECOMMENDATIONS FOR OVERALL GOAL

5.1 Recommendations for Rural Electrification using Renewable Energy

Recommendations for rural electrification using renewable energy; namely solar PV, MHP, biogas and wind are summarized in this section.

5.1.1 Renewable Energy

(1) Rural Electrification Master Plan for Renewable Energy

In the project, obtaining sufficient and up to date information on the status of the electricity grid was a challenge which also affected the selection of candidate and final pilot sites. Furthermore, in most instances where information was available, such as the Rural Electrification Master Plan (REMP) formulated in 2009, updates to the original work were limited and data accessibility was low because updates are primarily in the form of spread sheets which do not incorporate updated geographical information.

Insufficiency of the information therefore causes inefficiencies in rural electrification works. The development of a master plan for renewable energy, for integration into REMP, is required to avoid duplication of works between grid and off-grid electrification programmes.

Such a master plan, indicating the direction of renewable energy development in both grid and off-grid areas, is desirable and indispensable to the acceleration of rural electrification. . Additionally, the creation of the master plan would facilitate the promotion of rural electrification projects to other donors as well, with reference to a database of un-electrified public facilities summarized in the master plan. It is therefore recommended that REA and MoE&P jointly to prepare a master plan for rural electrification using renewable energy.

(2) Application of a Geographical Information System (GIS) database for rural electrification projects

1) REA establishes an institutional framework to set up a GIS database for rural electrification.

Currently, GIS databases relating to electric facilities are prepared piecemeal by the relevant institutions. Examples include data on existing distribution lines by KPLC and Hydro Power by MoE&P respectively. Creation of a new GIS database and integration of data from old databases into it is necessary for planning of rural electrification using renewable energy, especially for off-grid. .

2) REA develops a GIS database for rural electrification using renewable energies

Information on the existing power grid, isolated power supply systems, future extension plans, and the potential for application of renewable energy, are essential for promotion of projects to the government as well as international institutions and private donors. This information can be used to estimate power output and financial feasibility of projects.

REA and KPLC should coordinate to develop a GIS database for distribution lines and related power facilities, and REA should prepare GIS databases for the following:

- Un-electrified public facilities
- Existing isolated power systems (diesel, solar PV, MHP, biogas and wind)
- Renewable energy potential (MHP, biogas and wind)

3) REA establishes working groups to ensure database is updated

REA should establish working groups with other relevant agencies related to renewable energy and rural electrification, such as MoE&P, KPLC and KETRACO to ensure the rural electrification database is updated.

4) GIS database is made accessible to donors and investors

The renewable energy and rural electrification database should be made accessible to institutions such as MoH and MoEST which are interested in electrification of public facilities in rural areas. Such access will attract funding from donors and investors for rural electrification using renewable energy in off-grid areas, and further facilitates the overall success of off-grid programmes.

5) REA incorporates GIS database into the Master Plan for Rural Electrification Using Renewable Energy

The GIS database should be incorporated into the master plan for rural electrification using renewable energy discussed in preceding sections.

(3) Continuous Capacity Enhancement of REA's staff

1) Participation in Technical Training, Seminar and Conferences

REA should arrange for staff to participate in technical training, seminars and conferences to continuously enhance their capacity. There are some institutions conducting training programmes, such as the "solar PV course for professionals" by JKUAT, and it is recommended that REA's technical staff participate in such training programmes.

2) Staff in Charge of Environment and Socio-economics

REA has limited staff in charge of environment and socio-economics for purposes of planning and monitoring. Meanwhile, proponents of all development projects, including government institutions, are required to undertake environmental procedures and obtain the environmental clearances. In addition, it is necessary to conduct socio-economic data collection, involvement of communities and financial management of facilities' owners in the process of planning and monitoring, to enhance sustainability.

For smooth implementation of EIA/EA procedures, accumulation of such experiences, and fostering the relationship with NEMA for future implementation of renewable energy projects; it is recommendable to hire new staff or enhance the capacity of existing staff, and set up an social and environmental function (section or unit).

(4) Enhancement of Kenyan Private Sector

In order to ensure installation, construction and O&M of power generation systems using renewable energy such as solar PV, MHP, biogas and wind is accelerated, enhancement of private companies and industries in Kenya is important. It is necessary to create and provide training opportunities for capacity enhancement of technical human resources of private companies and industries.

There are some private companies manufacturing renewable energy technologies and power generation systems in Kenya. By providing governmental support, REA and MoE&P can enhance private sector participation in rural electrification using renewable energy in Kenya.

It is necessary to strictly specify the qualifications of contractors including licensing and training requirements for the contractor's manager(s) and technician(s). REA should strictly conduct inspection of equipment both at acceptance check and commissioning, and sufficient time should be spared for thorough checking.

(5) Quality Control by Construction Supervision

Renewable energy installation works include civil and electrical works. Poor quality of work undertaken by a contractor will spoil the overall quality of the project. A full-time engineering staff or consultant should be assigned for construction supervision and management. A budget for this purpose needs to be secured in public projects. Construction works, testing and commissioning, and user training should be supervised by the engineer to ensure quality of works. Safety arrangements to prevent fire, electric shock, and any other accidents should carefully be made.

5.1.2 Solar PV

(1) Securing Budget for O&M

In the models, the profit from the battery charging service will be allocated to party contribute to the O&M budget. Based on results from monitoring, it is difficult to obtain adequate income for O&M from charging services due to the market size and existence of competitors. Furthermore, once the grid is extended to the area covered by the charging service, income from the charging service will decrease. To compensate for deficiencies in the O&M budget, the budget can partially be allocated from other financial sources such as HSSF, FPEF and county government budgets. Therefore, it is recommended that REA prepares a system for securing O&M budgets, based on REA's budget allocation or MoUs between counties.

However, in future, O&M budgets for solar PV systems should be prepared under each county government's budget.

(2) Establishment of County-based O&M structure

There are many solar PV facilities which are not functioning well because appropriate O&M has not been conducted, resulting in issues such as failure of controllers, deterioration of batteries, and so on. It is recommended that each county conducts O&M of solar PV systems installed at public facilities in the future. Therefore, it is also necessary to develop the following structures:

1) Health Institutions

- REA/MoE&P staff give technical guidance on O&M to engineers from the County Health Offices. It is also recommended that county health officers are given the opportunity to undertake training, for instance Training of Trainers (TOT) at JKUAT.
- Engineers from County Health Offices train operators in O&M of solar PV systems for public facilities and their daily inspection.

2) Schools

- MoEST HQ should assign more competent County Education Officers to supervise management of educational infrastructure. Further, officers should also be given the opportunity to receive training, for instance TOT at JKUAT, and proper budget allocations are made for monitoring of solar PV systems in all schools in non-electrified areas.
- REA/MoE&P staffs give technical guidance on O&M to designated officers from the County Education Offices.
- County Education Officers train operators in O&M of solar PV systems for public facilities and their daily inspection.

5.1.3 MHP

(1) Preparation of Specification Standards

MoE&P is currently preparing the "Guideline Specification Standard for Development of Micro/ Small Hydropower in Kenya (scheduled to be KS1859)" with KEBS scheduled to issue the standard by 2015. It is very important to accelerate rural electrification through micro and small hydro power development and continuation of these activities is commendable and should be ensured in future.

(2) Grid Connected Small and Medium Scale Hydro Power Development

The potential areas for hydro power development are limited to areas around Mt. Kenya and the Western Kenya region. Both of those areas overlap with many potential target facilities earmarked for grid electrification in the Rural Electrification Master Plan 2009. It is likely that projects for rural electrification by MHP will ultimately be connected to the main grid in the medium to long term, even if they are developed as off-grid systems in the shortf to medium term.

It is therefore recommended that MHP projects are planned with a view to becoming grid in future, and development of small and medium scale of hydro power is prioritized over MHP in view of the merits of scale and influence to ecology.

(3) Coordination with other Water Resources Development Plans

Water resources are precious natural resources for Kenya. Therefore, MHP development should be considered as one of the water resources utilization. It is therefore recommended that coordination with Ministry of Environment, Water and Natural Resources, and WRMA is strengthened in order to harmonize MHP development plans with other water resources development plans.

(4) Sharing of Hydrological Data with WRMA

Evaluation of river discharge is vital for proper planning of not only hydro power development but also all water resources development. WRMA is the executing agency responsible for discharge measurement and compilation of river discharge information. However, their recorded observed data has uncertainties including many periods for which data is missing. It is therefore recommended that hydrological data is shared between REA and WRMA, and WRMA enhances the accuracy of measurement.

5.1.4 Biogas

(1) Selection of Optimal System by conducting Feasibility study

Not all feedstock available in a facility can be utilized in biogas production in relation to feedstock collection. Transportation of feedstock is costly in O&M and increases the burden on users. Considering existing facilities such as location of septic tank, toilet, cowshed, etc., optimal layout and feedstock should be arranged to minimize users' O&M and maximize economic benefit. Depending on the situation, power generation can be excluded from the project scope and all produced biogas can be used exclusively for cooking, to simplify the system, minimize cost, and maximize benefit. For such assessment, a feasibility study should be conducted for biogas projects.

(2) Update of Guidelines

Update works for guidelines should be undertaken in accordance with the current country situation. Kenya Bureau of Standards is currently preparing biogas standards. When it becomes effective, it is necessary to incorporate the contents into the "Guidelines for Biogas Generation".

(3) Conducting Overall Monitoring of Existing Biogas Systems

Many of the existing biogas systems implemented by various institutions have experienced difficulties in operation due to lack of training and skilled operators, poor quality of construction, production of decreased amounts of biogas, and inappropriate feedstock types. It is therefore recommendable to conduct monitoring of existing biogas systems in order to identify issues and challenges, and obtain the feedback necessary to increase efficiency of operation and optimize design of future biogas projects. Furthermore, such findings should be shared among relevant organizations.

(4) Biogas Generation in Off-grid Areas

Feedstock production is inherently small and dispersed, and finding a skilled people to operate the biogas generation system in off-grid areas is a challenge. A biogas generation project in an off-grid area should therefore be promoted only if sufficient feedstock and a skilled operator are available in the target area. Sufficient potential and feasibility studies should be conducted to assess sustainability. Biogas simply as a cooking fuel might be the only or most appropriate option, which should also be considered in feasibility study

(5) Enhancement of the Capacity of Counties and Sub-Counties to Plan, Implement, and Monitor Biogas Projects

Participation of County Governments in project formulation, planning, design, supervision and monitoring is necessary following devolution of mandates to counties. Capacity enhancement of

County and Sub-County government institutions and human resources is necessary for sustainable biogas promotion and implementation.

(6) Interministerial Coordination and Donor Knowledge Sharing

Biogas concerns multiple sectors including energy, agriculture, and environment. Lack of coordination among various promoters of biogas may be an obstacle to sufficient information sharing among ministries and donors. This will cause duplication of roles and objectives, and coordination among ministries and donors is therefore necessary for efficient project implementation.

5.1.5 Wind

(1) Accumulate Experience of Wind Projects

REA lacks extensive experience in wind power projects. It is therefore necessary to implement projects to accumulate experience. Estimation of accurate wind speed, wind turbine properties, and power output are the most important considerations for wind power development. Except for energy estimation, the process of small wind power development is similar to that of solar PV projects for public facilities. Therefore, through implementation of small scale wind projects, experience of wind power development and wind data have to be accumulated. Subsequently, projects using middle class wind turbines or diesel-wind hybrid systems can be implemented easily using the same procedures used in the power output estimation.

For possible energy generation assessment, wind energy assessment software should be introduced and REA staff should be trained in using it.

(2) Establishment of O&M structure

Wind turbines interconnected with diesel generators are being operated and maintained by the staff of diesel power stations. However, O&M of small wind turbines installed at public facilities has to be conducted properly. It is therefore recommended that REA applies the O&M structure of solar PV systems to the O&M of small wind projects.

5.1.6 Grid Extension

(1) Policy and Standards Formulation for Grid Connection of Small Scale PV Systems

Following grid connection of public facilities, it is possible to continue to utilize the existing PV system and reduce the power tariff of users, with installation of simple change over switches.

In case of reverse flow, the current FIT applies to solar PV systems above 500 kW, which is far larger than off-grid solar PV systems for public facilities. A net metering policy, which may be applicable to reverse flow from small scale PV systems, is under formulation and has not yet been enforced. It is expected that several hundred off-grid PV systems will be connected to the grid in the future. Although guidelines for grid connection were published by MoE&P, it is necessary for MoE&P to additionally establish regulations and technical standards for grid connection including reverse flow for small PV systems in off-grid areas, in collaboration with KPLC. Furthermore, a corresponding O&M structure is also necessary.

(2) Official Support for Grid Connection

Grid connection with reverse flow is not financially feasible for private businesses, and users cannot provide initial investment for required equipment. Accordingly, it is necessary for the works to be conducted as public or donor projects. It is further recommended that bulk procurement of equipment is conducted in order to reduce the cost.

(3) Database for PV Grid Connection

In relation to Section 5.1.1, REA should establish the GIS database of existing off-grid solar PV systems, current status of grid connection and future plans with georeference information, and manage works to update the database works. This work will be the basis for the works as mentioned in (2) above.

5.2 Recommendations for Dissemination of Rural Electrification Models

Models for rural electrification using renewable energy were developed by the Project. The model for rural electrification using solar PV should be applied and disseminated by C/Ps according to the recommendations summarized in this section.

5.2.1 Revision of the Models

(1) Developed models revised by Renewable Energy Department of REA.

At the end of the project, there was an indication that REA may obtain O&M budgets for solar PV systems in the near future. REA should therefore revise the O&M structure in the model in the event that anticipated changes are enforced.

(2) REA conducts continuous monitoring

REA should continuously monitor the status of operation and maintenance of solar PV systems, through MoH and MoEST, in order to upgrade the model.

(3) REA applies the models to other public institutions in rural areas

REA has been promoting electrification of secondary schools, polytechnics, health centres and other institutions, in addition to primary schools and dispensaries. It is recommended that REA considers application of the model to other existing public facilities. According to the updated master plan mentioned in Section 5.1.1, potential target areas and facilities for application of the model should be selected. In addition, REA should coordinate and provide information to other donors and organizations so that the models can be applied to projects funded by them.

5.2.2 Distribution of Guidelines

The models were summarized in “Guidelines for Solar PV Systems in Schools” and “Guidelines for Solar PV Systems in Health Institutions”. Distribution of the guidelines to the concerned county governments and institutions through MoH and MoEST should be undertaken by REA.

5.2.3 Cooperation with Other Relevant Institutions

The recommendations for County Governments, MoH, and MoEST are as follows:

(1) County Governments

1) REA coordinates technical assistance to county governments including staff training in concerned public health institutions and schools to enable them operate solar PV systems.
2) REA coordinates the opportunity of TOT training for county officers in concerned public facilities in the financial management of charging services accounts, in cases where the target facilities meet the required conditions of the charging service, to enable them operate solar PV systems in a sustainable manner.
3) REA shares solar PV training information with concerned county governments; such as the TOT conducted at JKUAT.
4) REA prepares and arranges to sign agreements with concerned County Health Offices delineating the responsibilities of each party in O&M of the solar PV systems.

(2) MoH

1) REA prepares a list of un-electrified public health institutions in the entire country in consultation with MoH.
2) REA conducts socio-economic surveys to identify health institutions for application of the charging service model in accordance with guidelines and in consultation with MoH.
3) REA prioritizes public health institutions in the preparation of plans to apply the charging service model.
4) REA distributes “Guidelines for Solar PV Systems in Health Institutions” to the County Health Offices through MoH.

(3) MoEST

1) REA conducts socio-economic surveys to identify schools for application of the charging service model in accordance with guidelines and in consultation with MoEST.
2) REA prioritizes schools in the preparation of plans to apply the charging service model.
3) REA distributes “Guidelines for Solar PV Systems in Schools” to the County Education Offices through MoEST.