No.

PREPARATORY SURVEY ON RENEWABLE ENERGY PROMOTION PROGRAM IN AFRICA (2)

FINAL REPORT

SUMMARY

JUNE 2010

JAPAN INTERNATIONAL COOPERATION AGENCY

NIPPON KOEI CO., LTD.

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LOCATION MAP

ABBREVIATIONS

Abbreviations	Description
BCS	Battery Charging Station
CBO	Community Based Organization
CDF	Constituency Development Fund
CREEC	Center for Research in Energy and Energy Conservation
CSS	Community Solar System
ERT	Energy for Rural Transformation
GNI	Gross National Income
GTZ	Deutsche Gesellschaft fur Technische Zusammenarbeit
IFC	International Finance Cooperation
JICA	Japan International Cooperation Agency
KenGen	Kenya Electricity Generating Co. Ltd.
KPLC	Kenya Power and Lighting Co. Ltd.
Ksh	Kenya Shilling
LED	Light Emitting Diode
MOE	Ministry of Energy
MoMS	Ministry of Medical Service
NFE	Non Formal Education
NGO	Non-Governmental Organization
ODA	Official Development Assistance
PSDC	Private Sector Development Center
PV	Photovoltaic
REA	Rural Electrification Authority
REF	Rural Electrification Fund
REM	Rural Electrification Master plan
SHS	Solar Home System
TICAD	Tokyo International Conference on African Development
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
US$	US Dollar

Electrical Terminology

• V (Volt)	Unit of voltage
• kV (kilovolt)	1,000 volts
• W (Watt)	Unit of active 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 output
• kWp (kirowatt-peak)	1,000 Wp
• MWp (Megawatt-peak)	1,000 kWp

Exchange rate as of March 2010: US$1.00 = Ksh 77.2500 = JPY 93.04

Preparatory Survey on Renewable Energy Promotion Program in Africa (2)

Draft Final Report

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Chapter 1 Introduction

1.1 Background

In Kenya, rural electrification was done under the Ministry of Energy (MOE). The Rural Electrification Authority (REA) was established in 2007, and at present, carries out full-scale operation of projects since early 2009. It was found that the power grid covers 63% of the population in Kenya. However, there is only 10% electrification ratio on households in the rural areas, and the gap of public service level widens between the rural area and urban area. Furthermore, the extension of the electric power system from the urban area toward the rural area is inefficient due to broad stretch of land and dispersed villages. Consequently, it will take a long time to connect such villages in the rural area with electric power system. Therefore, it is considered that an off-grid electrification system which is either by photovoltaic (PV) or mini-hydropower will be suitable for the electrification of the rural area.

Under such condition, the Japan International Cooperation Agency (JICA) conducted “Dissemination of Renewable Energy into Rural Communities: Study on Photovoltaic and Small-hydro Projects in East Africa” for Kenya and Uganda from July to November 2008.

Furthermore, JICA conducted the “Preparatory Survey for Renewable Energy Promotion Program in Africa -Business Promotion and Financial Mechanism-” and “Preparatory Survey for Renewable Energy Promotion Program in Africa -Public Facility Electrification-” from April to November 2009. In the preparatory study, the new idea of combining a PV institutional system for the electrification of public facilities such as health centers and schools, with a battery charging system, which is open to the people of Kenya, was recommended as a Community Solar System (CSS). The purposes of the CSS consist of i) electrification of public facilities with provision of battery charging service, ii) formulation of sustainable maintenance system with earning and iii) educational campaign of rural electrification. The conceptual design of CSS was carried out in the same survey.

On the basis of the results of the preparatory survey, JICA, REA and United Nations Industrial Development Organization (UNIDO) concluded the Letter of Understanding (LOU) aiming to sort the cooperation framework. In the LOU, it was envisaged that JICA would focus on electrification mainly through PV, targeting public facilities in rural communities, while UNIDO would extend its “Energy Kiosk” concept, focusing on industrial development in rural communities, mainly through mini-hydropower and biomass energy based approaches. The joint implementation of the pilot project by JICA and UNIDO was also proposed. Furthermore, it was confirmed that REA would study the criteria for selecting the candidate sites for the pilot project and prepare the list of public facilities.

JICA decided to conduct this preparatory survey to gather additional information required for the implementation of the pilot project, and to carry out a basic design for CSS at three candidate sites most suitable for the pilot project.

1.2 Objectives of the Preparatory Survey

The objectives of the preparatory survey are as follows:

- To collect and analyze information about the candidate sites for the pilot project on CSS considering prioritization

  * CSS is a new idea of combining a PV institutional system with a battery charging system

- To perform basic design of CSS for three candidate sites which have high priority as a pilot project
- To recommend formulation of management system for CSS

Chapter 2 Present Condition of Rural Electrification

2.1 Rural Electrification Policy and Achievement of Government of Kenya

(1) Rural Electrification Policy of Kenya

REA is planning to discuss with concerned agencies about the implementation of the pilot project on rural electrification with off-grid PV electrification, aiming the following targets:

- To improve the electrification coverage ratio from 63% to 100% by 2012.
- To increase the rural electrification ratio from 10 % to 100 % by 2030.
- To improve the electrification ratio for public facilities, such as trading centres, schools, health facilities, public water supply facilities, and administrative offices, to 100% by 2012.

The final Rural Electrification Master Plan (REM) was submitted in May 2009. It shows a 10-year plan from 2009 to 2018 and a detailed action plan for five years from 2009 to 2013, or the first half of the 10-year plan. According to the action plan, the targets for 2013 and 2018 are to improve the rural electrification ratio including off-grid electrification system, from the present 10% to 20% and 33%, respectively.

(2) Administrative Units in Kenya and Electrification Ratio in Rural Areas

Administrative units in Kenya consists of eight provinces (Central, Coast, Eastern, Nairobi, North Eastern, Nyanza, Rift Valley and Western), with 254 districts. Division, location, sub-location, and village are the lower level units.

Table 2.1.1 summarizes the target of electrification ratio for public facilities, such as district headquarters, towns and trading centers, public schools, and public health centers located in each province as mentioned in the REM 2009.

Table 2.1.1 Electrification Ratio of Public Facilities in Kenya

District Headquarters

Province	Electrified (No.)	Non-electrified	Unknoun (No.)	Total (No.)	Non-Electrified	REM 2009		Non-Electrified after REM2009
						Off-grid	Grid extension	
Coast	11	0	0	11	0.0%	0	0	0.0%
North Eastern	7	4	0	11	36.4%	4	0	0.0%
Eastern	25	4	0	29	13.8%	2	2	0.0%
Nyanza	21	0	0	21	0.0%	0	0	0.0%
Rift Valley	39	4	0	43	9.3%	2	2	0.0%
Contral	11	0	0	11	0.0%	0	0	0.0%
Western	19	0	0	19	0.0%	0	0	0.0%
Total	133	12	0	145	8.3%	8	4	0.0%

Towns & Trading Centers

Province	Electrified (No.)	Non-electrified	Unknoun (No.)	Total (No.)	Non-Electrified	REM 2009		Non-Electrified after REM2009
						Off-grid	Grid extension	
Coast	261	350	10	621	56.4%	12	186	24.5%
North Eastern	25	162	0	187	86.6%	66	0	51.3%
Eastern	973	1378	32	2383	57.8%	32	720	26.3%
Nyanza	780	832	11	1623	51.3%	0	563	16.6%
Rift Valley	913	1224	20	2157	56.7%	58	948	10.1%
Contral	1520	720	12	2252	32.0%	0	328	17.4%
Western	625	355	2	982	36.2%	0	286	7.0%
Total	5097	5021	87	10205	49.2%	168	3031	17.9%

Public School

Province	Electrified (No.)	Non-electrified	Unknoun (No.)	Total (No.)	Non-Electrified	REM 2009		Non-Electrified after REM2009
						Off-grid	Grid extension	
Coast	130	82	1	213	38.5%	7	29	21.6%
North Eastern	35	71	0	106	67.0%	21	0	47.2%
Eastern	598	827	6	1431	57.8%	12	396	29.3%
Nyanza	709	803	3	1515	53.0%	0	388	27.4%
Rift Valley	774	998	77	1849	54.0%	20	379	32.4%
Contral	737	278	4	1019	27.3%	0	180	9.6%
Western	420	265	8	693	38.2%	0	184	11.7%
Total	3403	3324	99	6826	48.7%	60	1556	25.0%

Public Health Facilities

Province	Electrified (No.)	Non-electrified	Unknoun (No.)	Total (No.)	Non-Electrified	REM 2009		Non-Electrified after REM2009
						Off-grid	Grid extension	
Coast	120	157	0	277	56.7%	11	75	25.6%
North Eastern	13	91	0	104	87.5%	50	0	39.4%
Eastern	253	323	0	576	56.1%	29	162	22.9%
Nyanza	320	260	4	584	44.5%	0	135	21.4%
Rift Valley	488	543	74	1105	49.1%	32	294	19.6%
Contral	332	146	0	478	30.5%	0	56	18.8%
Western	173	45	4	222	20.3%	0	46	0.0%
Total	1699	1565	82	3346	46.8%	122	768	20.2%

Note: Non-electrified (%) is estimated with assumption of that the numbers of fadilities of unknown is counted as electrified.

Source: Rural Electrification Master Plan, Final Report, May 2009

(3) Electrification of Public Facilities by Solar PV in Kenya

According to the data from the MOE in Kenya, the installation of a large-scale solar PV system for schools and health facilities located in un-electrified area from fiscal year 2005/06 was put on hold. From fiscal year 2005/06 to 2007/08, the targets of the program were senior high schools and boarding primary schools, and the scale of solar panel was determined to be 4 kW to 5 kW based on the size of school. After 2008/09, health centers and dispensaries were included in the target for electrification.

For dispensaries, the scale of solar panel was relatively small, which ranged from 400 W to 600 W. The total number of public facilities to be electrified for 2009/10 is 233. The actual achievement of rural electrification by MOE is shown in Table 2.1.2 to 2.1.5. According to MOE, security offices shall be included in the targets of rural electrification by solar PV system in the future.

Table 2.1.2 Actual Achievement of Rural Electrification by the MOE (Total)

Total

	No. of Sites Installed with PV System (1)	Total Cost (Ksh) (2)	Average Cost (Ksh/Site) (3)=(2)/(1)	Total PV Capacity (W) (4)	Average PV Capacity (W/Site) (5)=(4)/(1)
FY2005-2006	16	51,262,682.00	3,203,917.63	39,530	2,471
FY2006-2007	40	170,381,288.62	4,259,532.22	158,160	3,954
FY2007-2008	40	181,962,301.47	4,549,057.54	158,510	3,963
FY2008-2009	54	83,323,086.00	1,543,020.11	64,560	1,196
FY2009-2010	73	191,423,769.31	2,622,243.42	153,462	2,102
Total	223	678,353,127.40	3,041,942.28	574,222	2,575

Source: MOE

Table 2.1.3 Actual Achievement of Rural Electrification by the MOE (School)

School

	No. of Sites Installed with PV System (1)	Total Cost (Ksh) (2)	Average Cost (Ksh/Site) (3)=(2)/(1)	Total PV Capacity (W) (4)	Average PV Capacity (W/Site) (5)=(4)/(1)
FY2005-2006	16	51,262,682.00	3,203,917.63	39,530	2,471
FY2006-2007	40	170,381,288.62	4,259,532.22	158,160	3,954
FY2007-2008	39	181,287,960.47	4,648,409.24	157,960	4,050
FY2008-2009	5	16,403,027.00	3,280,605.40	13,130	2,626
FY2009-2010	42	143,064,693.85	3,406,302.23	116,475	2,773
Total	142	562,399,651.94	3,960,560.93	485,255	3,417

Source: MOE

Table 2.1.4 Actual Achievement of Rural Electrification by the MOE (Health Facilities)

Medical Institutions (Dispensary, Health Center, Hospital)

	No. of Sites Installed with PV System (1)	Total Cost (Ksh) (2)	Average Cost (Ksh/Site) (3)=(2)/(1)	Total PV Capacity (W) (4)	Average PV Capacity (W/Site) (5)=(4)/(1)
FY2005-2006	0	0.00	0.00	0	0
FY2006-2007	0	0.00	0.00	0	0
FY2007-2008	1	674,341.00	674,341.00	550	550
FY2008-2009	49	66,920,059.00	1,365,715.49	51,430	1,050
FY2009-2010	29	37,518,202.46	1,293,731.12	26,867	926
Total	79	105,112,602.46	1,330,539.27	78,847	998

Source: MOE

Table 2.1.5 Actual Achievement of Rural Electrification by the MOE (National Park)

National Park

	No. of Sites Installed with PV System (1)	Total Cost (Ksh) (2)	Average Cost (Ksh/Site) (3)=(2)/(1)	Total PV Capacity (W) (4)	Average PV Capacity (W/Site) (5)=(4)/(1)
FY2005-2006	0	0.00	0.00	0	0
FY2006-2007	0	0.00	0.00	0	0
FY2007-2008	0	0.00	0.00	0	0
FY2008-2009	0	0.00	0.00	0	0
FY2009-2010	2	10,840,873.00	5,420,436.50	10,120	5,060
Total	2	10,840,873.00	5,420,436.50	10,120	5,060

Source: MOE

According to the technical specifications for the solar PV system of MOE, generated electricity shall be converted to the 240 V AC to enable direct connection with the typical electrical equipments, such as fluorescent lights, TVs and personal computers. However, occurrence of overload will damage the battery. Furthermore, there are other problems, such as energy loss through AC conversion, and increase of cost of equipment, such as inverters.

The guarantee period of solar PV facilities and ancillary equipment covers only one year. On the other hand, the expected life period of batteries to be used for the solar PV system is five years and the owners of the facilities shall cover the costs for battery replacement. If each facility will not allocate funds for battery replacement, such cost shall be covered by the Ministry of Education, Ministry of Health or Constituency Development Fund.

(4) Sustainability of Solar PV System of Public Facilities

Regarding the solar PV system for the electrification of public facilities in Kenya, the design concept was founded as mentioned previously, and the system shall be relatively large with AC converters. However, the cost for each equipment is expensive and the overhead for repair and replacement will be very high. The price of batteries with 12 V 200 Ah is approximately KSh30,000. As for schools, the quantity of battery is relatively more and its total replacement will require even bigger cost.

For such circumstances, the concept of the JICA Program, which focuses on securing daily revenue for operation and maintenance (O&M), seems to be quite effective from the view point of sustainability.

2.2 Rural Electrification Project by Other Donors

Electrification of 380 Schools, Dispensaries, and Health Centers in Arid and Semi-Arid Land Districts

Similar to the rural electrification project in Kenya, there is an electrification project with solar PV system funded by the Kingdom of Spain, which aims at the electrification of 380 schools, dispensaries, and health centers located in the arid and semi-arid areas. The project consists of design, procurement, installation and testing and commissioning of solar PV system. The tender was announced at the beginning of February 2010 and was closed at the end of April 2010.

According to MOE, the guarantee period of solar PV system covers one year. The cost for maintenance, including replacement of battery and other equipment after the guarantee period, shall be covered by each facility.

Rural Electrification Plan by UNIDO

JICA, REA, and UNIDO concluded the LOU aiming to sort out the cooperation framework for rural electrification. In the LOU, it was envisaged that UNIDO would extend its “Energy Kiosk” concept, focusing on industrial development in rural communities, mainly through mini-hydro power and biomass energy based approaches. UNIDO has selected 100 candidate sites for “Energy Kiosk”, and compiled them in the ”National CPC Sites Survey Report, January 2010”. Furthermore, UNIDO has screened the 100 candidate sites and narrowed the selection to ten sites. The detailed investigation for these candidate sites will be carried out in the next stage.

Chapter 3 Selection of Candidate Sites for Pilot Project on CSS

3.1 Procedure of Selection of Candidate Sites for Pilot Project on CSS

At the beginning of the survey, it was expected that 20 candidate sites for the pilot project on CSS be selected and provided by REA. However, 30 candidate sites were actually provided by REA. In this survey, the Survey Team started the study on 30 candidate sites to select three to be included in the first group of pilot projects. The procedure for selecting the candidate sites is shown in Figure 3.1.1.

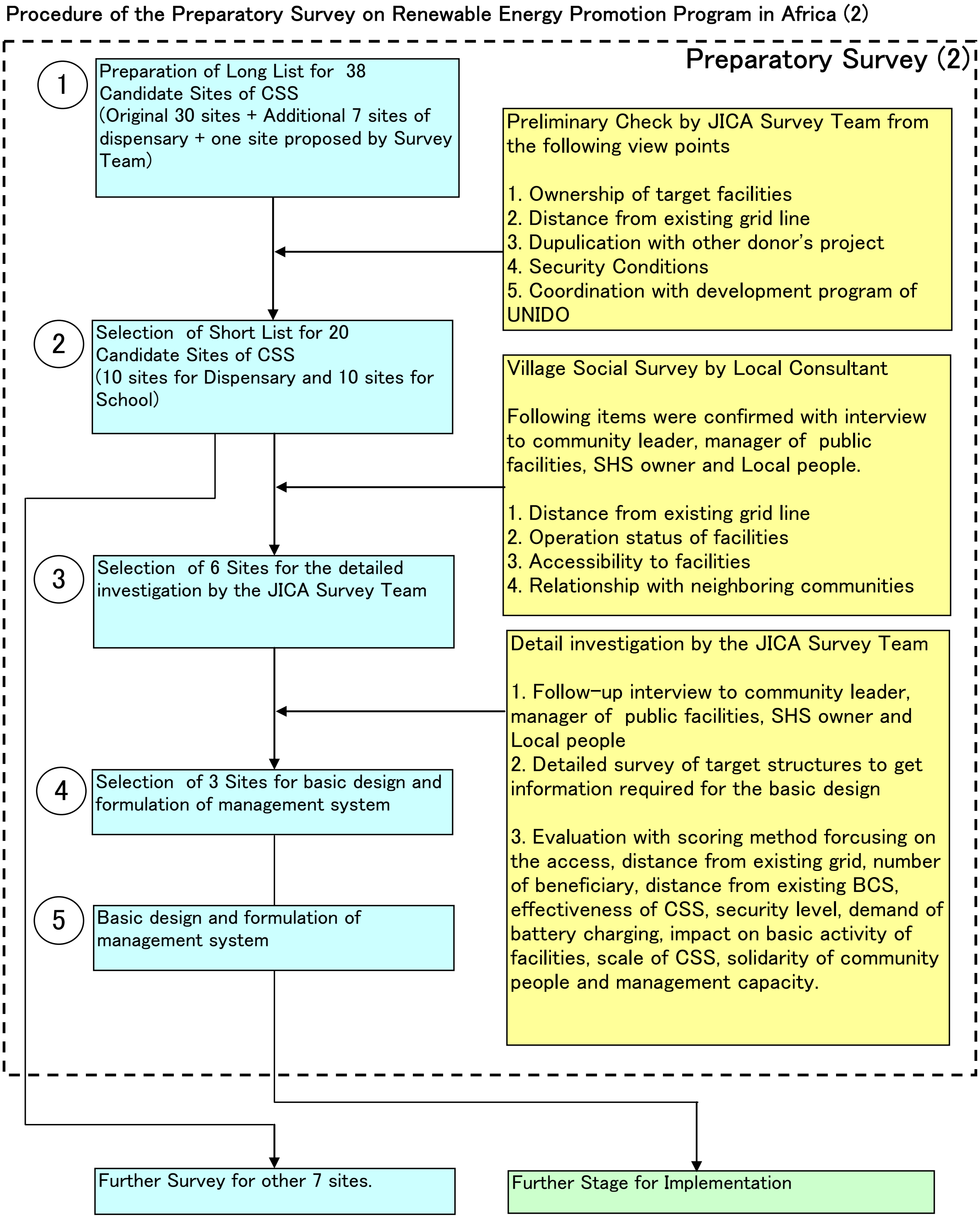

Figure 3.1.1 Procedure of Selection of Candidate Sites

Prepared by JICA Survey Team

3.2 Review of REA List of Candidate Sites (30 sites→20 sites)

The Survey Team obtained the information on the 30 candidate sites from REA, and confirmed their basic conditions focusing on the following items:

(1) Distance from the Existing Grid Line (11kV and 33 kV)

The Survey Team confirmed the distance between the candidate sites and the nearest point of existing grid lines based on the final report of REM, and gridline information from the data in Kenya Power & Lighting Company Ltd (KPLC). In case the distance from the candidate site to the nearest point of grid line is less than 10 km, the site will be connected via grid extension within a few years and will be omitted from the list. According to the criteria of adoption of off-grid rural electrification in MOE and REA, the distance from the target facility to the nearest grid line shall be bigger than 15 km. However, the distance of 10 km was adopted as the criteria considering the uncertainty of the information of distance at this screening.

(2) Ownership of Facilities

Owners of the candidate sites were confirmed with the list of public facilities in Kenya. Meanwhile, facilities belonging to private or mission groups were omitted from the list.

(3) Confirmation of overlapping with candidate sites of other donors

The Survey Team confirmed overlapping of the candidate sites selected in this survey with MOE candidate sites and those of other projects, such as Spanish Program.

(4) Confirmation of Security Conditions

Each candidate site was plotted on a map to confirm if it is located in hazardous zones as stated in the safety information of the Ministry of Foreign Affairs of Japan.

As a results of the confirmation of above items, it was found that the 18 candidate sites in the original list of REA did not qualify for the pilot project. In particular, many of the candidate dispensary sites were omitted. Therefore, the new candidate dispensary sites were added into the list after confirmation with REA. Furthermore, one candidate dispensary site in Kajiado South was added on the basis of investigation results of the Phase I of the JICA Survey. Finally, the short list includes 20 candidate sites consisting of ten schools and ten dispensaries.

All 38 candidate sites and the selected 20 are shown in Table 3.2.1 and Table 3.2.2, respectively. The location map is shown in Figure 3.2.1.

Table 3.2.1 Long List of 38 Candidate Sites of Plop Project

Province	Constituency	Electrification Ratio of Constituency	No.	School/health Facility	Latitude	Longitude	Approx. Distance from existing distribution line	Extension plan of distribution	Candidate sites for Village social Survey	Remarks
Rift Valley	Narok South	5.93%	1	Ilimotiook Secondary School	-0.8630	35.5150	50 km from 33kV	No	Yes	
			2	Meleo Secondary School	-0.9190	35.6190	35 km from 33kV	No	Yes	
			3	Olkoroi Dispensary	-1.6978	35.5571	70 km from 33kV	No	No	Misson
			4	Entasekera Health Center	-1.8322	35.8071	90 km from 33kV	No	No	Misson
			5	Mara Rianta Dispensary	-1.2376	35.1222	100 km from 33kV	No	No	Misson
	Narok North	28.05%	6	Entoltol Dispensary	-0.9408	35.8799	15 km from 33kV	No	No	to be done as Spanish Project
			7	Ngoirienito Dispensary	-0.936	36.241	0 km from 33kV	Yes	No	
			8	Iltumtum School	-1.4000	36.2300	40 km from 33kV	No	Yes	
			113	Olposimoru Disp	-0.5676	35.7250	50 km from 33kV	No	Yes	
			114	Olopironito Disp	-0.9042	35.9070	15 km from 33kV	No	Yes	
	Kilgoris	25.45%	9	Olmelil High School	-0.8980	34.9950	2.8 km from 11kV	Yes	No	
			10	Olaittong Girl's Secondary School	-1.3680	34.8140	5 km from 33kV	Yes	Yes	
			11	Takitech Dispensary	-0.9491	35.0545	1 km from 11kV	No	No	
			118	Kimintet dispensary	-1.1210	35.0741	10 km from 33kV	Yes	Yes	
			120	Emarti Health centre	-0.9977	35.1801	10 km from 33kV	No	Yes	
	Kajiado South	33.87%	12	Oloolaiser Girl's Secondary School	-1.39379	36.73387	0 km from 33kV	No	No	
			13	Meto Dispensary	-2.4090	36.5560	35 km from 33kV	Yes	Yes	Existing PV for lighting and too small. Additional PV system is required for Refresirator, delivery and operation room.
			14	Oloile Secondary School	-2.8080	37.5270	16 km from 11kV	Yes	Yes	200 students, 11 rooms,
			31	Mailwa Dispensary	-2.3289	36.7350	15 km from 33kV	No	Yes	PV system is required for 6 rooms.
	Kajiado Central	27.27%	15	Olmamen Boarding Primary School	-1.7940	37.1270	7 km from 11kV	No	No	
			16	Iloodokilani Secondary School	-1.6260	36.6390	20 km from 11kV	No	Yes	New School
	Baringo East	25.00%	17	Tanyileel Girl's Secondary School	0.6000	35.8800	8 km from 33kV	No	No	
			127	Loiwat Disp	1.048	35.728	35 km from 33kV	No	Yes	
			128	Ptikii Community disp.	1.352	35.726	35 km from 33kV	No	Yes	
	Baringo North	30.84%	18	Katibel Secondary School	0.6240	35.6710	0 km from 33kV	Yes	No	
			19	Moiguitwo Dispensary	0.7790	35.8080	4 km from 11kV	No	No	Small Dispensary with 2 rooms 100hh has PV system.
			133	Issas H/C	0.714	35.861	8 km from 33kV	Yes	Yes	
Coast	Taita Taveta	50.00%	20	Mrabani Bording Primary School	-3.4300	38.3040	0 km from 11kV	Yes	No	
Eastern	Kitui West	23.15%	21	Syomunyu Girl's Secondary School	-1.6730	37.8300	12 km from 11kV	No	Yes	Boading, 153 students, 15 rooms
			22	Kanyangi Boys Secondary School	-1.7530	37.9050	15 km from 11kV	Yes	Yes	Day School, 200 students, 12 rooms
	Kitui South	12.69%	23	Malani Secondary School	-1.2300	38.2120	30 km from 33kV	Yes	Yes	
			24	Kithumuthura Secondary School	-1.2490	37.9430	0 km from 11kV	Yes	No	
			25	Kamutei Dispensary	-1.9300	38.0350	20 km from 33kV	Yes	Yes	
	Mutomo		26	Ikanga Boys	-1.7050	38.0630	0 km from 33kV	Yes	No	Bording, 366 students, 31 rooms
			27	Kiyatune Girls	-1.7810	38.1140	0 km from 33kV	Yes	No	Day/Bording, 250 students, 10 rooms
	Mutito	7.06%	28	Mutito Girl's Secondary School	-1.2270	38.1820	28 km from 33kV	Yes	Yes	Boading, 345 students
			29	Voo Swecondary School	-1.6680	38.3260	27 km from 11kV	Yes	Yes	Day/Boading, 140 students
			30	Kiongwe Dispensary	-1.3850	38.1030	0 km from 11kV	Yes	No	

Candidate sites to be eliminated:
School:
Despensary / Health Center:

Prepared by JICA Survey Team

Table 3.2.2 Shortlisted 20 Candidate Sites for the Pilot Project

Province	Constituency	Electrification Ratio of Constituency	No.	School/health Facility	Latitude	Longitude	Approx. Distance from existing distribution line	Extension plan of distribution	Remarks
Rift Valley	Narok South	5.93%	1	Ilimotiook Secondary School	-0.8630	35.5150	50 km from 33kV	No	
			2	Meleo Secondary School	-0.9190	35.6190	35 km from 33kV	No	
	Narok North	28.05%	3	Iltumtum School	-1.4000	36.2300	40 km from 33kV	No	
			4	Olposimoru Dispensary	-0.5676	35.7250	50 km from 33kV	No	
			5	Olopironito Dispensary	-0.9042	35.9070	15 km from 33kV	No	
	Kilgoris	25.45%	6	Kimintet Dispensary	-1.1210	35.0741	10 km from 33kV	Yes	
			7	Emarti Health centre	-0.9977	35.1801	10 km from 33kV	No	
	Kajiado South	33.87%	8	Meto Dispensary	-2.4090	36.5560	35 km from 33kV	Yes	Existing PV for lighting and too small. Additional PV system is required for Refresirator, delivery and operation room.
			9	Oloile Secondary School	-2.8080	37.5270	16 km from 11kV	Yes	200 students, 11 rooms,
			10	Mailwa Dispensary	-2.3289	36.7350	15 km from 33kV	No	PV system is required for 6 rooms.
	Kajiado Central	27.27%	11	Iloodokilani Secondary School	-1.6260	36.6390	20 km from 11kV	No	New School
	Baringo East	25.00%	12	Loiwat Dispensary	1.0480	35.7280	35 km from 33kV	No	
			13	Ptikii Community disp.	1.3520	35.7260	35 km from 33kV	No	
	Baringo North	30.84%	14	Issas H/C	0.7140	35.8610	8 km from 33kV	Yes	
Eastern	Kitui West	23.15%	15	Syomunyu Girl's Secondary School	-1.6730	37.8300	12 km from 11kV	No	Boading, 153 students, 15 rooms
			16	Kanyangi Boys Secondary School	-1.7530	37.9050	15 km from 11kV	Yes	Day School, 200 students, 12
	Kitui South	12.69%	17	Malani Secondary School	-1.2300	38.2120	30 km from 33kV	Yes	
			18	Kamutei Dispensary	-1.9300	38.0350	20 km from 33kV	Yes	
	Mutito	7.06%	19	Mutito Girl's Secondary School	-1.2270	38.1820	28 km from 33kV	Yes	Boading, 345 students
			20	Voo Swecondary School	-1.6680	38.3260	27 km from 11kV	Yes	Day/Boading, 140 students

School: (blue)
Despensary / Health Center: (pink)

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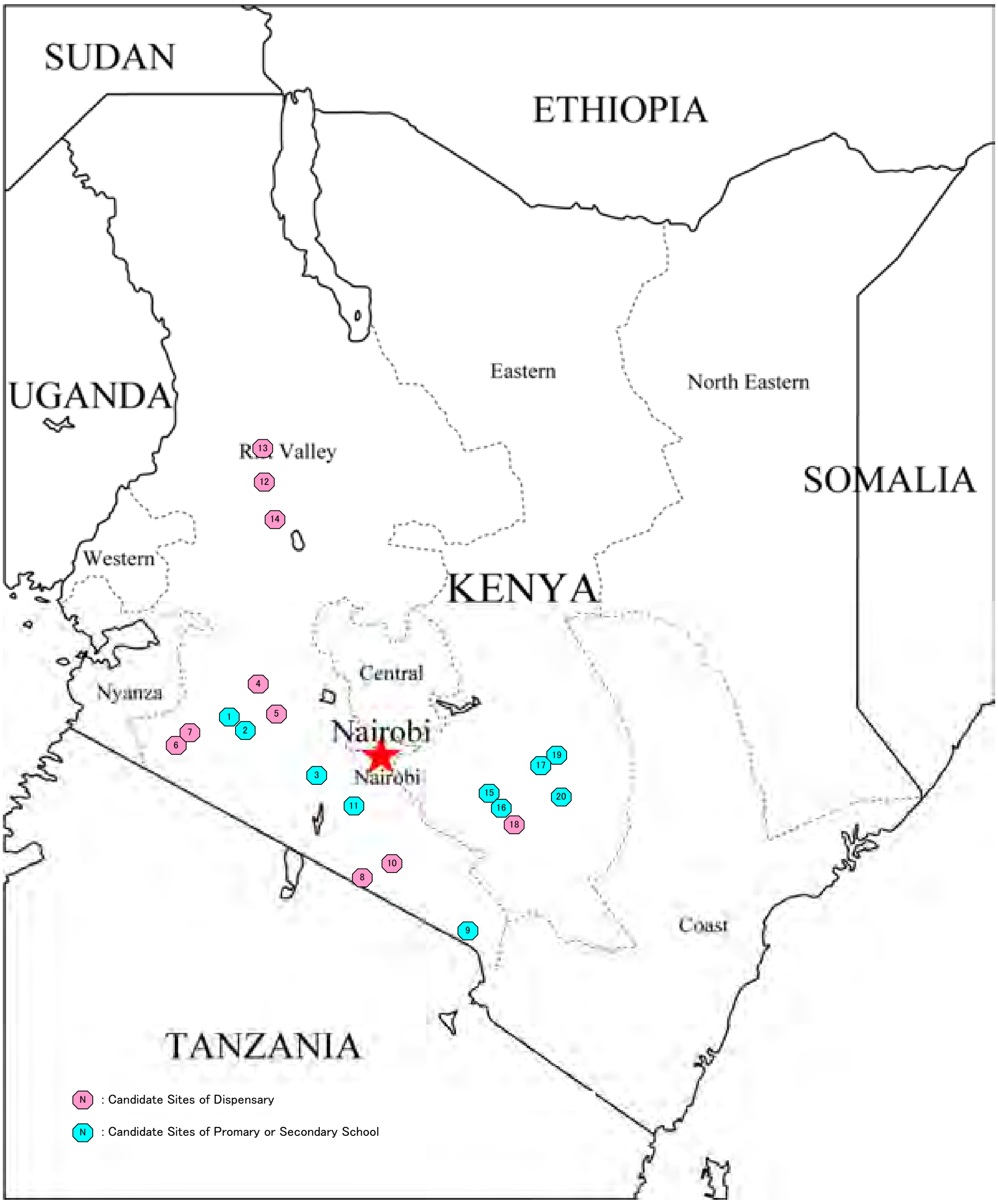

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Figure 3.2.1 Location Map of 20 Candidate Sites for the Pilot Project

(5) Effect to School Activities due to Installation of CSS

At the beginning of the survey, MOE pointed out an inadequacy in installing CSS in schools. The CSS will provide electricity to public facilities through solar PV system and a battery charging station to generate revenue for O&M. MOE commented that the battery charging activities in schools may lower the security level and disturb school activities due to the entry of unknown persons inside the premises.

The Survey Team studied the various layouts of CSS to be installed in the school as shown below, to minimize the effect of its installation to the on-going school activities. However, it is not yet agreed with MOE that to execute pilot project in school by the following solutions. Therefore, JICA shall continuously study and discuss with MOE regarding this matter after this Survey.

Solution 1

Methods on separating the battery charging station from the school area were studied. Various layouts of CSS are shown in Figure 3.2.2. Type-1, the original layout, proposes a battery charging station inside the school premises, where unknown persons will be authorized to access the facility. Type-2 layout shows that the battery charging station will be located just beyond the perimeter of the school to avoid unknown persons from entering the premises. In this case, a power cable only will be connected to the station. Type-3 layout completely separates the battery charging station from the school premises. The operation, management and financial control will be carried out by the same managing organization.

Considering possible property loss, Type-1 is the most preferable since the position of the charging station is highly-guarded.

Solution 2

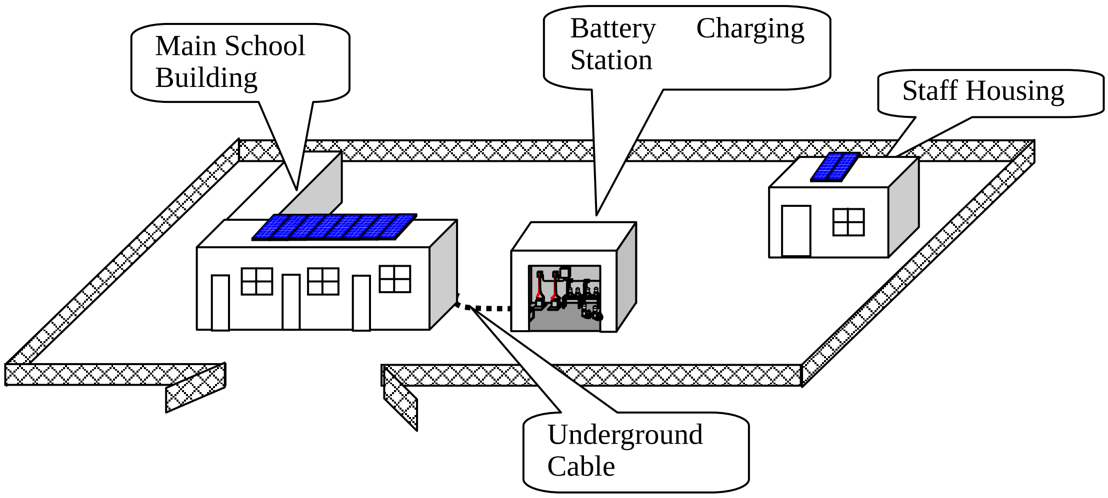
Since Type-1 is to be adopted as discussed in Solution 1, collection and delivery of mobile phones to be charged will be carried out in order to further minimize disturbances to the school activity. The procedure of battery charging is as follows:

① Every morning, the operator collects mobile phones with registration, and collects charging fees at the community center.

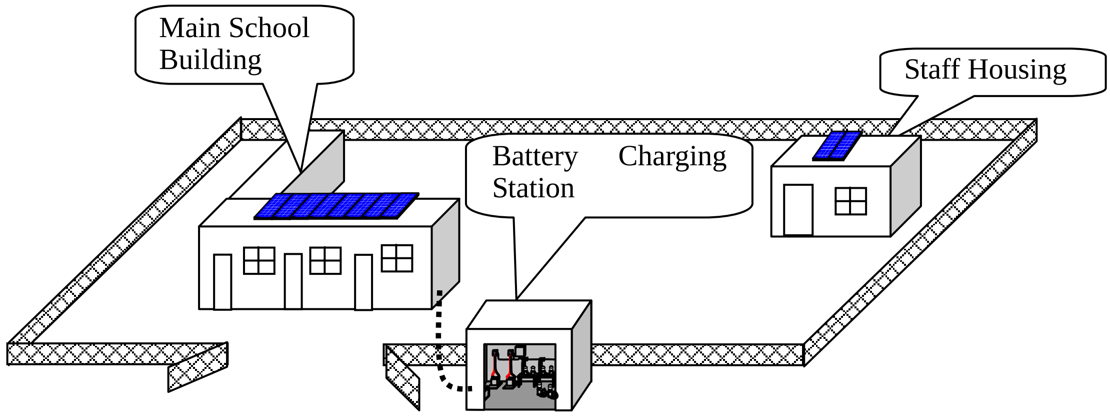
② Then, the operator brings the mobile phones inside the school and charges them with solar PV system.

③ After charging, the operator delivers them back to the customers at the community center. In case of difficulty of delivery, acting branch system is adopted.

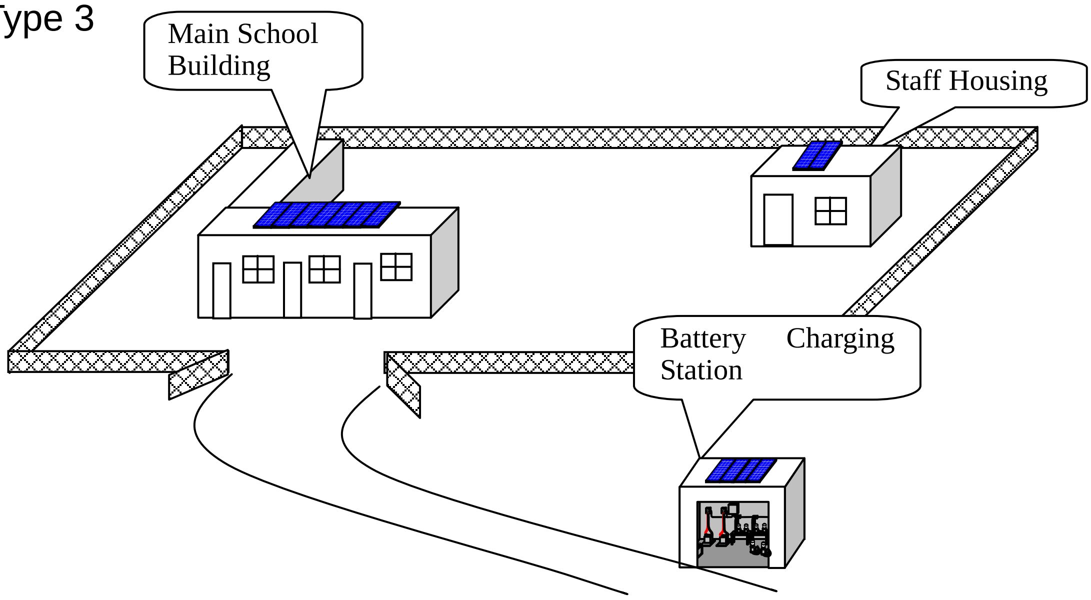
Type 1



Type 2



Type 3



Prepared by JICA Survey Team

Figure 3.2.2 Alternative Locations of Battery Charging Station

Solution 3

The battery charging service of the CSS to be installed in the school shall be limited to the students of the school only, and not for the mobile phones of the community people. Rechargeable lanterns are assumed to be also charged at the station which is provided to all the students for doing their home works. At present, rechargeable lanterns are not often used in remote villages due to limited charging stations and less information on its convenience. Therefore, renting rechargeable lantern will contribute to the dissemination of the system and advancement of lifestyle of the community. The rental fee for rechargeable lanterns is expected to be utilized for the O&M. The further discussion on the practical management system with the management committee of school and teachers is necessary.

3.3 Screening with Village Social Survey (20 Sites→6 Sites)

To comprehend the details of the 20 candidate sites shown in Table 3.2.2, a village social survey was carried out by locally subletting the work from 24 February to 15 March 2010. Based on the results of the social survey, the Survey Team has shortlisted six candidate sites. The results of the village social survey were compiled in Chapter 4.

In the process of shortlisting to six candidate sites, improper factors for the pilot project were itemized and corresponding sites were omitted from the list. The improper factors are summarized below, and the shortlisted candidate sites are shown in Table 3.1.1.

(1) Distance from Existing Grid Line

According to the criteria of adoption of off-grid rural electrification in MOE and REA, the distance from the target facility to the nearest grid line shall be bigger than 15 km. Therefore, the distances from the existing grid line to the candidate sites were re-checked on the basis of the results of the village social survey. Sites located within a distance of 15 km from the nearest existing grid were omitted from the list. As indicated in Table 3.2.2, these are sites 2, 4, 7, 9, 14, 15 and 16.

(2) Access

From the results of the village social survey, it was found that the access to some facilities took longer time as expected by the Survey Team. The Survey Team judged that the candidate sites, which require more than five hours of driving time along single lane unpaved roads, were not preferable for the pilot project. As shown in Table 3.2.3, sites 12, 13, 17, 18, 19, and 20 did not qualify.

(3) Relationship with Neighboring Community

From discussions with community leaders, it was confirmed that sites 6, 7, and 12 have unhealthy relationships with their neighboring communities due to history of ethnic violence, as shown in

Table 3.2.3.

Furthermore, it was confirmed that No.13 Ptikii Community dispensary, is non-operational at the moment.

Table 3.3.1 Selection of 6 Candidate sites on the basis of Village Social Survey

Province	Constituency	Electrification Ratio of Constituency	No.	School/health Facility	Distance from existing distribution line	Operation of facility	Distance from existing BCS	Existing Solar PV (Small capacity)	Distance of Unpaved Road Driving Time	Relationships with neighboring communities	solidarity of community people
Rift Valley	Narok South	5.93%	1	**Ilimotiook Secondary School**	15 km		500 m		15km/ 1hour	Good	High (86%)
			2	Meleo Secondary School	1 km		200 m		20km/1hour	Good	High (86%)
	Narok North	28.05%	3	**Iltumtum School**	20 km		3000 m	Yes	20km/1hour	Good	High (86%)
			4	Olposimoru Dispensary	700 m		-		10km/0.5hour	Good	High (86%)
			5	**Olopironito Dispensary**	46 km		-		35km/2 hours	Good	High (100%)
	Kilgoris	25.45%	6	Kimintet Dispensary	30 km		500 m		40km /2 hours 100km /9 hours	Poor	High (86%)
			7	Emarti Health centre	7 km		-		35km/2hour	Not so Good	High (86%)
	Kajiado South	33.87%	8	**Meto Dispensary**	42 km		1000 m	Yes	38km/2 hours	Good	High (100%)
			9	Oloile Secondary School	1 km		3000 m	Yes	30km/ 1 hour	Good	High (86%)
			10	**Mailwa Dispensary**	21 km		100 m		15km/ 1hour	Good	High (100%)
	Kajiado Central	27.27%	11	**Iloodokilani Secondary School**	32 km		400 m		40km/2.5 hours	Good	High (100%)
	Baringo East	25.00%	12	Loiwat Dispensary	36 km		0 m	Yes	70km/5hours	Poor	High (80%)
			13	Ptikii Community disp.	14 km	No ope.	6000 m		90km/8 hours	Good	Medium (73%)
	Baringo North	30.84%	14	Issas H/C	0 km		-		5km/0.5 hour	Good	High (86%)
Eastern	Kitui West	23.15%	15	Syomunyu Girl's Secondary School	10 km		150 m	Yes	30km/ 1 hour	Good	Medium (53%)
			16	Kanyangi Boys Secondary School	0 km		300 m		50km/3 hours	Good	Medium (66%)
	Kitui South	12.69%	17	Malani Secondary SchoolMutito B	54 km		-	For TV	73km/5 hours	Good	High (80%)
			18	Kamutei Dispensary	36 km		100 m		80km/6 hours	Good	High (86%)
	Mutito	7.06%	19	Mutito Girl's Secondary School	54 km		500 m		73km/5 hours	Good	High (86%)
			20	Voo Swecondary School	36 km		400 m		86km/7 hours	Good	Medium (73%)

School: (blank box)
Dispensary / Health Center: (dotted box)

Name of the facility omitted: (dotted box)

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3.4 Screening with Detail Village Social Survey (6 sites→3 sites)

In order to confirm the suitability of the six candidate sites for the pilot project, the JICA Survey Team carried out the detail village social survey from 30 March to 6 April 2010. On the basis of its results, the scoring evaluation method was adopted to make realistic judgments considering the various issues such as geographical conditions, social impact and management level, etc. The evaluation criteria and evaluation results are shown in the Table 3.4.1 and 3.4.2, respectively. The three candidate sites with higher scores were selected as the first group of the pilot project. The total score and basic information of the six candidate sites are shown in Table 3.4.3.

The Olopironito and Meto dispensaries got relatively high scores and were selected as candidate sites for dispensary. These dispensaries were selected due to their many beneficiary and high demand for mobile phone battery charging. On the other hand, the Ilimotiook Secondary School and the Iltumtum Primary School got same high score. However, MOE and REA have the concept of that the Secondary School has priority of electrification from the view points of requirement of dormitory and night class. Therefore, the Ilimotiook Secondary School was selected as a third candidate site of pilot project of CSS.

Locations of the shortlisted three candidate sites for the pilot project are shown in the Figure 3.4.1.

Table 3.4.1 Scoring Criteria for selection of Three Candidate Sites

No.	Evaluation Item	Index	High Score		Midium Score		Low Score	
1	Accesssibility:	Driving time of un-paved road	less than 30 minutes	3	30 minutes or more but not exceeding 60 minutes: 2	2	more than 60 minutes: 1	1
2	Adequacy of off-grid electrification	Distance from Existing Distribution Line	more than 30 km	3	20 km or more but not exeeding 30 km	2	less than 20 km	1
3	Effectiveness for the community	Population of community	more than 2,000	3	1,000 or more but noe exceeding 1,000	2	less than 1,000	1
4	Suitability of CSS at the community	Distance from existing BCS	more than 5 km:	3	1 km or more but not exceeding 5 km	2	less than 1 km	1
5	Effectiveness for the facilities	Status of electrification	New electrification	3	Replacement of power source	2		
6	Security level of facilities	Numbers of security staff	Two watchman	3	One watchman	2	No watchman	1
7	Degree of contribution to community people	Expected daily demand of battery charging	more than 80 person	3	40 persons or more but not exceeding 80	2	less than 40	1
8	Possibility of disturbance of original activity of facilities	Level of disturbance	Negligible(dispensary): 3	3	Minor (School): 2	2	Serious: 1	1
9	Scale merit of CSS	Scale of Solar PV (kW)	more than 5 kW	3	2 kW or more but not exceeding 5 kW	2	less than 2 kW	1
10	Solidarity of community people	Results of interview to the community leader	High	3	Medium	2	Poor	1
11	Expected management Level	Results of interview to the management committee	High	3	Medium	2	Poor	1
12	Financial stability	Expected yearly balance (Revenue - expenditure)	Yearly balance/O&M cost > 5	3	1<Yearly balance/O&M cost < 5	2	Yearly balance/O&M cost < 1	1
	Total Score			36		24		11

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Table 3.4.2 Results of the Scoring of Six Candidate Sites

No.	Evaluation Item	Index	1 Ilimotiook Secondary School	3 Iltumtum Primary School	5 Olopironito Dispensary	8 Meto Dispensary	10 Mailwa Dispensary	11 Iloodokilani Secondary School
1	Accesssibility:	Driving time of un-paved	2	2	2	1	2	1
2	Adequacy of off-grid electrification	Distance from Existing Distribution Line	1	2	2	3	2	2
3	Effectiveness for the community	Population of community	1	2	3	3	3	3
4	Suitability of CSS at the community	Distance from existing BCS	1	2	3	2	1	1
5	Effectiveness for the facilities	Status of electrification	2	2	3	3	3	3
6	Security level of facilities	Numbers of security staff	3	1	2	2	1	2
7	Degree of contribution to community people	Expected daily demand of battery charging	2	2	3	2	1	2
8	Possibility of disturbance of original activity of facilities	Level of disturbance	2	2	3	3	3	2
9	Scale merit of CSS	Scale of Solar PV (kW)	3	2	2	1	1	1
10	Solidarity of community people	Results of interview to the community leader	3	3	3	3	3	2
11	Expected management Level	Results of interview to the management committee	3	2	2	3	2	2
12	Financial stability	Expected yearly balance (Revenue - expenditure)	1	2	3	2	1	2
	Total Score	(Full score: 36)	24	24	31	28	23	23

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Table 3.4.3 Score and Basic Information on Six Candidate Sites

Province	Constituency	Electrification Ratio of Constituency	No.	School/health Facility	Effectiveness	Scale of Solar PV (kW)	Total Score in evaluation sheet (Full score: 36)	Recommended 1st group of Pilot Project
Rift Valley	Narok South	5.93%	**1**	**Ilimotiook Secondary School**	Replacement of power source	4.78	**24**	Yes
	Narok North	28.05%	3	Iltumtum School	Additional electrification	2.88	24	-
			5	**Olopironito Dispensary**	New electrification	1.78	**31**	Yes
	Kajiado South	33.87%	**8**	**Meto Dispensary**	New electrification (Existing system is not working properly.)	1.38	**28**	Yes
			10	Mailwa Dispensary	New electrification	1.48	23	-
	Kajiado Central	27.27%	11	Iloodokilani Secondary School	New electrification	1.48	23	-

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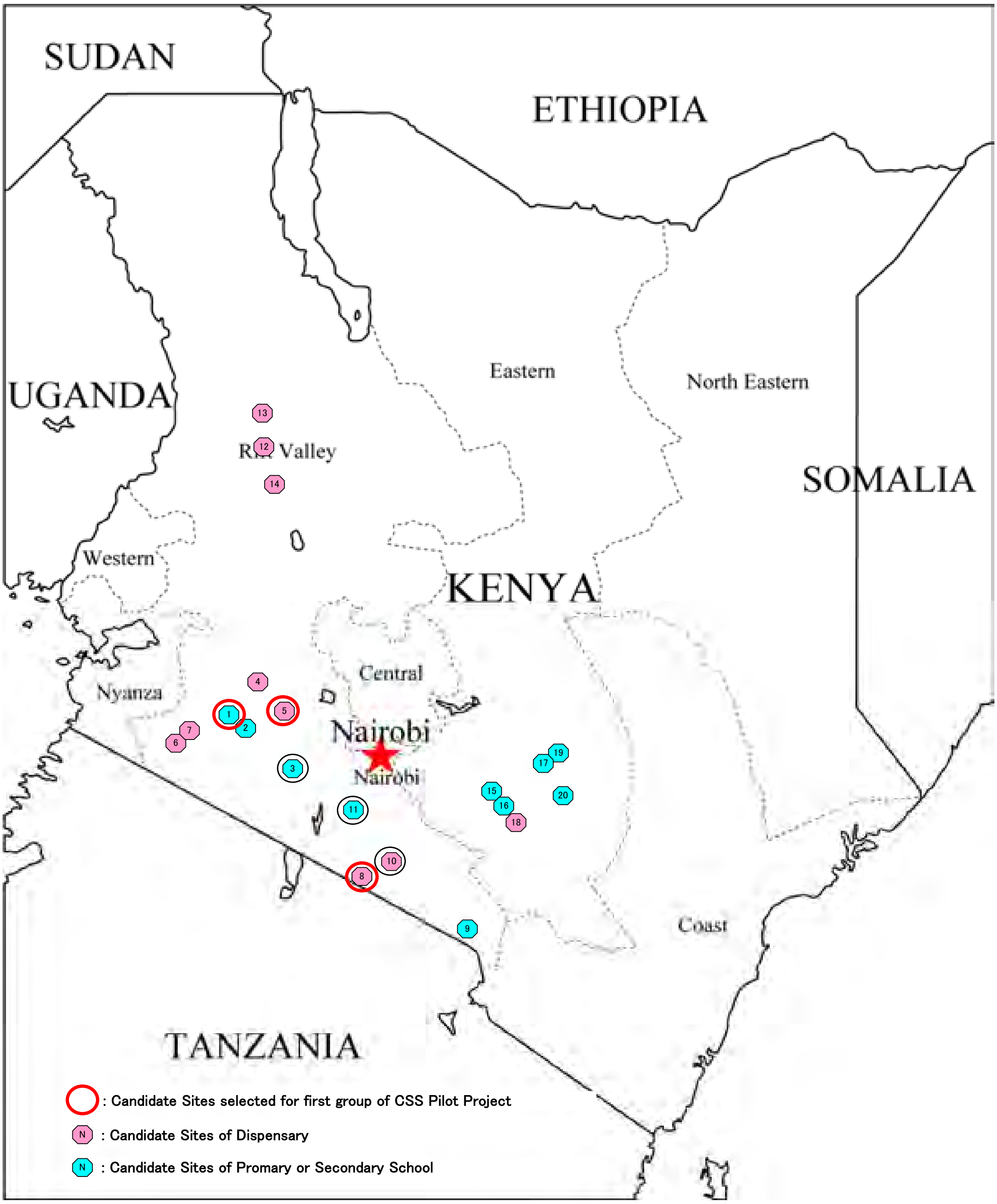


LOCATION MAP

Prepared by JICA Survey Team

Figure 3.4.1 Location Map of the Three Candidate Sites for the Pilot Project

3.5 Financial Revenue and Expenditure of 6 Candidate sites

In the process of selection of the three candidates sites, the financial revenue and expenditure were evaluated as shown in Table 3.4.2, Item 12. The evaluation method is explained below.

The revenue of battery charging service was estimated and compared with the expenditure in the aspects of cost for O&M, salary of operators, etc. The assumptions are as follows:

(1) Financial Revenue

The revenue of CSS will come from battery charging fees of mobile phones to be collected from the villagers. It was estimated based on the expected number of customers and the battery charging fee from the data of the village social survey. The main data used for the analysis is shown below.

- Number of customer of battery charging of mobile phone per day (refer to Chapter 4)
- Battery Charging Fee per phone（based on the fee of BCS）
- Number of operation days of BCS (based no the interview)

Considering the uncertainty in the expected revenue, sensitivity analysis was carried out on the data of expected number of customers and battery charging fee as follows:

- Number of customer of battery charging of mobile phone per day: decrease by 20 %
- Battery Charging Fee per phone: decrease by 25 %

(2) Expenditure

The expenditure of the community solar system consists of salary of operators, cost for replacement of system, and miscellaneous for O&M. The cost for the replacement of the system was assumed with the following:

Cost for Replacement of System

Battery 200 Ah	: Lifetime of 5 years
Controller	: Lifetime of 7.5 years
Inverter	: Lifetime of 7.5 years

The financial revenue and expenditure for each of the six candidate sites were estimated on the basis of assumption mentioned above. Corresponding results are shown in Table 3.5.1. From the results of the evaluation, Olopironito Dispensary was found to be the most financially viable site due to medium scale of CSS and high demand for battery charging services.

In order to take this financial analysis into selection process of candidate sites, the evaluation on the financial viability was made based on the three ranks of ratio of revenue minus expenditure to the yearly cost of operation and maintenance. The criteria are mentioned in Table 3.4.1.

Table 3.5.1 Financial Revenue and Expenditure of Six Candidate Sites of Pilot Project

No.	1			3			5			8			10			11		
School/Health Facility	**Ilimotiook Secondary School**			**Iltumtum Primary School**			**Olonpironito Dispensary**			**Meto Dispensary**			**Mailwa Dispensary**			**Iloodokilani Secondary School**		
Constituency	Narok South			Narok North			Narok North			Kajiado South			Kajiado South			Narok North		
Scale of Solar PV (kW)	4.78			2.88			1.78			1.38			1.48			1.48		
Cases	Basic Case	Sensitivity Analysis		Basic Case	Sensitivity Analysis		Basic Case	Sensitivity Analysis		Basic Case	Sensitivity Analysis		Basic Case	Sensitivity Analysis		Basic Case	Sensitivity Analysis	
		80% of demand	75% of charge fee		80% of demand	75% of charge fee		80% of demand	75% of charge fee		80% of demand	75% of charge fee		80% of demand	75% of charge fee		80% of demand	75% of charge fee
1. Revenue from battery charging																		
Expected demand of battery charging (person/day)	44	35	44	55	44	55	120	96	120	50	40	50	15	12	15	44	35	44
Expected battery charging fee (Ksh/phone)	20	20	15	20	20	15	20	20	15	30	30	22.5	30	30	22.5	20	20	15
Daily revenue (Ksh)	880	704	660	1,100	880	825	2,400	1,920	1,800	1,500	1,200	1,125	450	360	338	880	704	660
Expected number of operating days	30	30	30	30	30	30	30	30	30	21	21	21	30	30	30	26	26	26
Monthly revenue (Ksh)	26,400	21,120	19,800	33,000	26,400	24,750	72,000	57,600	54,000	31,500	25,200	23,625	13,500	10,800	10,125	22,880	18,304	17,160
Yearly revenue (Ksh)	**316,800**	**253,440**	**237,600**	**396,000**	**316,800**	**297,000**	**864,000**	**691,200**	**648,000**	**378,000**	**302,400**	**283,500**	**162,000**	**129,600**	**121,500**	**274,560**	**219,648**	**205,920**
2. Personnel Expenditure																		
Salary of operator (Ksh/month)	5,000			3,000			3,000			3,000			3,000			3,000		
Yearly expense for salary for operator (Ksh)	**60,000**			**36,000**			**36,000**			**36,000**			**36,000**			**36,000**		
3. Expenditure for O&M	**227,293**			**131,671**			**131,907**			**61,724**			**67,709**			**67,709**		
4. Revenue - Expenditure (Yearly)	**29,507**	**-33,853**	**-49,693**	**228,329**	**149,129**	**129,329**	**696,093**	**523,293**	**480,093**	**280,276**	**204,676**	**185,776**	**58,291**	**25,891**	**17,791**	**170,851**	**115,939**	**102,211**
Evaluation	**C**			**B**			**A**			**B**			**C**			**B**		

5. Breakdown of Expenditure for O&M	1	3	5	8	10	11
Battery 200AH						
Unit rate of Battery-200AH (Ksh)	31,100	31,100	31,100	31,100	31,100	31,100
Number of Buttery in CSS	24	12	13	5	5	5
Initial cost for Battery-200AH (Ksh)	746,400	373,200	404,300	155,500	155,500	155,500
Life period of Battery (years)	5	5	5	5	5	5
Annual expenditure for Battery	149,280	74,640	80,860	31,100	31,100	31,100
Battery 100AH						
Unit rate of Battery-100AH (Ksh)	16,900	16,900	16,900	16,900	16,900	16,900
Number of Buttery in CSS	2	2	3	3	2	2
Initial cost for Battery-100AH (Ksh)	33,800	33,800	50,700	50,700	33,800	33,800
Life period of Battery (years)	5	5	5	5	5	5
Annual expenditure for Battery	6,760	6,760	10,140	10,140	6,760	6,760
Controller-20A						
Unit rate of Contloller-30A (Ksh)	8,400	8,400	8,400	8,400	8,400	8,400
Number of Contloller-30A in CSS	3	4	3	3	4	4
Initial cost for Contloller-30A (Ksh)	25,200	33,600	25,200	25,200	33,600	33,600
Life period of Contloller-30A (years)	5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Contloller-30A (Ksh)	5,040	4,480	3,360	3,360	4,480	4,480
Controller-30A						
Unit rate of Contloller-30A (Ksh)	14,720	14,720	14,720	14,720	14,720	14,720
Number of Contloller-30A in CSS	0	0	0	0	0	0
Initial cost for Contloller-30A (Ksh)	0	0	0	0	0	0
Life period of Contloller-30A (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Contloller-30A (Ksh)	0	0	0	0	0	0
Controller-40A						
Unit rate of Contloller-40A (Ksh)	17,000	17,000	17,000	17,000	17,000	17,000
Number of Contloller-40A in CSS	0	0	2	2	0	0
Initial cost for Contloller-40A (Ksh)	0	0	34,000	34,000	0	0
Life period of Contloller-40A (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Contloller-40A (Ksh)	0	0	4,533	4,533	0	0
Controller-60A						
Unit rate of Contloller-60A (Ksh)	19,250	19,250	19,250	19,250	19,250	19,250
Number of Contloller-60A in CSS	6	4	2	0	2	2
Initial cost for Contloller-60A (Ksh)	115,500	77,000	38,500	0	38,500	38,500
Life period of Contloller-60A (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Contloller-60A (Ksh)	15,400	10,267	5,133	0	5,133	5,133
Inverter-300W						
Unit rate of Inverter-300W (Ksh)	8,100	8,100	8,100	8,100	8,100	8,100
Number of Inverter-300W in CSS	0	0	0	0	0	0
Initial cost for Inverter-300W (Ksh)	0	0	0	0	0	0
Life period of Inverter-300W (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Inverter-300W (Ksh)	0	0	0	0	0	0
Inverter-500W						
Unit rate of Inverter-500W (Ksh)	7,300	7,300	7,300	7,300	7,300	7,300
Number of Inverter-500W in CSS	2	2	2	2	2	2
Initial cost for Inverter-500W (Ksh)	14,600	14,600	14,600	14,600	14,600	14,600
Life period of Inverter-500W (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Inverter-500W (Ksh)	1,947	1,947	1,947	1,947	1,947	1,947
Inverter-1000W						
Unit rate of Inverter-1000W (Ksh)	57,333	57,333	57,333	57,333	57,333	57,333
Number of Inverter-1000W in CSS	6	4	3	1	2	2
Initial cost for Inverter-1000W (Ksh)	343,998	229,332	171,999	57,333	114,666	114,666
Life period of Inverter-1000W (years)	7.5	7.5	7.5	7.5	7.5	7.5
Annual expenditure for Inverter-1000W (Ksh)	45,866	30,578	22,933	7,644	15,289	15,289
Others (Distilled water, stationery, remittance)	3,000	3,000	3,000	3,000	3,000	3,000
Total Expenditure for O&M	227,293	131,671	131,907	61,724	67,709	67,709

3.6 Discussion on selected 3 Candidate sites with related Organizations

The selected three candidate sites for the Pilot Project of CSS were explained with the selection process to REA, MOE and UNIDO. Each organization provided their comments on it as mentioned below.

（１） Rural Electrification Authority (REA)

REA accepted the selected three candidate sites as a first group of pilot project of CSS. They recommended the JICA Survey Team to discuss with MOE to get their consent on the implementation of CSS pilot project at school facility.

（２） Ministry of Energy (MOE)

MOE accepted the selected two dispensaries as candidate sites of first group of pilot project of CSS. Though the one of school facility i.e. Ilimotiook Secondary School was selected as a one of candidate site for pilot project, MOE is of the opinion that the pilot project of school facility shall be implemented as the second group after the confirmation of the adequacy of the operation and maintenance in the first group for the dispensaries due to reasons below:

① The dispensary used to manage their daily income. On the other hand, the school facilities had no experience on it.

② MOE has impression of that the CSS to be installed in the school premises will make some disturbance to the school activity.

③ MOE have experience of troubles in the case of that the solar system was installed at school housing such as private use of solar power.

The survey team explained MOE as follows:

① Ilimotiook Secondary School has stable management condition, and the management committee has some idea of management, operation and accounting system to be managed with their school staff.

② The school has practical idea of establishment of BCS at just beside the school entrance facing to the public road, which enable to separate the access of the customer and the school premises.

③ There is no school housing system in the Ilimotiook Secondary School

It is necessary to have careful discussion with the Kenya side on the pilot project of CSS to be implemented in the school facilities. Therefore, JICA should discuss with the Kenya side to determine the basic concept of pilot project before the start of implementation of pilot projects.

（３） United Nations Industrial Development Organization (UNIDO)

UNIDO has no objection to the selected three candidate sites. The important point of screening of the candidate sites is a securement of beneficiary. Furthermore, the use application of solar power should be expanded from the battery charging of mobile phones.

The design of CSS should meet the power demand and the necessity of provision of electric equipment to the target facilities should be considered to minimize the burden to each facilities at the beginning of electrification.

Chapter 4 Village Social Survey

4.1 Results of Village Social Survey conducted by Local Consultant

A village social survey was conducted to determine the required information on the 20 candidate sites for the pilot project of CSS (ten sites for the school facilities and ten sites for the health facilities). The survey was carried out through interviews with questionnaires. Two survey teams were organized with each consisting of one male and female to consider the gender balance. The survey process was conducted as shown in Table 4.1.1, from 23 February to 23 March 2010.

Table 4.1.1 Survey Process

					First Week (21th Feb)							Second Week(28th Feb～)							Third Week(7th Mar～)							Forth Week(14th Mar～)							Fifth Week(21th Mar～)					
Working	The Name of Facility	Day	Start	Finish	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F
Preparation		1day	22th Feb	22th Feb		■																																
Mobilization		1day	23th Feb	23th Feb			■																															
	Team A																																					
Survey	Iltumtum School	2day	24th Feb	25th Feb				■	■																													
	Olopironito Dispensary	1day	26th Feb	26th Feb						■																												
	Meleo Secondary School	1day	1st Mar	1st Mar									■																									
	Ilimokiok Secondary School	1day	2th Mar	2th Mar										■																								
	Emarti Health centre	1day	3th Mar	3th Mar											■																							
	Kimintet Dispensary	1day	4th Mar	4th Mar												■																						
	Olposimoru Dispensary	1day	5th Mar	5th Mar													■																					
	Issas Health Center	1day	8th Mar	8th Mar																■																		
	Loiwat Dispensary	1day	9th Mar	9th Mar																	■																	
	Ptikii Community Dispensary	1day	10th Mar	10th Mar																		■																
	チームB																																					
	Iloodokilani Secondary School	2day	24th Feb	25th Feb				■	■																													
	Meto Dispensary	1day	26th Feb	26th Feb						■																												
	Mailwa Dispensary	1day	1st Mar	1st Mar									■																									
	Oloile Secondary School	1day	2th Mar	2th Mar										■																								
	Syomunyu Girl's Secondary School	1day	3th Mar	3th Mar											■																							
	Kanyangi Boys Secondary Sch	1day	4th Mar	4th Mar												■																						
	Kamutei Dispensary	1day	5th Mar	5th Mar													■																					
	Mutito Girl's Secondary School	1day	8th Mar	8th Mar																■																		
	Malani Secondary Schoo	1day	9th Mar	9th Mar																	■																	
	Voo Swecondary School	1day	10th Mar	10th Mar																		■																
Report	Draft Final	5day	15th Mar	22th Mar																								■	■	■	■	■	■	■	■					
	Final Report	1day	23th Mar	23th Mar																																■			

Source: Local Consultant for Village Social Survey

The respondents of the survey were (1) community leaders, (2) local people, (3) managers of public facilities, and (4) owners of solar PV equipments. The interviews were carried out focusing on the following items:

1. Community Leader
(1) Population, number of villages, and livelihood
(2) Communal organization and social structure
(3) Condition of electrification, energy consumption and distance from national grid

2. Local People
(1) The number of families, responsibility of male and female, and livelihood
(2) Involvement in communal organization and social cohesion in community
(3) Energy consumption, mobile phone recharging and its fee

3. Managers of Public Facilities
(1) The number of users and scale of the public facilities
(2) Organization of management committee of public facilities

(3) Power demand, distance from national grid

4. Owners of Solar PV Equipments
(1) Size and variety of CSS
(2) Management and maintenance method
(3) Business utilizing PV Generation Equipment

Additionally, the social map, facilities outline chart, and photographs were prepared. In the social map, social resources such as water resources, markets, and village location, were described. Furthermore, the facilities outline chart and the facilities photograph were prepared to understand the scale of facilities. The outline of the results of the village social survey is shown in Table 4.1.2.

Table 4.1.2 Results of Village Social Survey

Province	Constituency	Electrification Ratio of Constituency	No.	School/health Facility	Distance from existing distribution line	Operation of facility	Distance from existing BCS	Existing Solar PV (Small capacity)	Distance of Unpaved Road Driving Time
Rift Valley	Narok South	5.93%	1	**llimokiook Secondary School**	15 km		500 m		15km/ 1hour
			2	Meleo Secondary School	1 km		200 m		20km/1hour
	Narok North	28.05%	3	**Iltumtum School**	20 km		3,000 m	Yes	20km/1hour
			4	Olposimoru Dispensary	700 m		-		10km/0.5hour
			5	**Olopironito Dispensary**	46 km		-		35km/2 hours
	Kilgoris	25.45%	6	Kimintet Dispensary	30 km		500 m		40km /2 hours 100km /9 hours
			7	Emarti Health centre	7 km		-		35km/2hour
	Kajiado South	33.87%	8	**Meto Dispensary**	42 km		1,000 m	Yes	38km/2 hours
			9	Oloile Secondary School	1 km		3,000 m	Yes	30km/ 1 hour
			10	**Mailwa Dispensary**	21 km		100 m		15km/ 1hour
	Kajiado Central	27.27%	11	**Iloodokilani Secondary School**	32 km		400 m		40km/2.5 hours
	Baringo East	25.00%	12	Loiwat Dispensary	36 km		0 m	Yes	70km/5hours
			13	Ptikii Community disp.	14 km	No operation.	6,000 m		90km/8 hours
	Baringo North	30.84%	14	Issas H/C	0 km		-		5km/0.5 hour
Eastern	Kitui West	23.15%	15	Syomunyu Girl's Secondary School	10 km		150 m	Yes	30km/ 1 hour
			16	Kanyangi Boys Secondary School	0 km		300 m		50km/3 hours
	Kitui South	12.69%	17	~~Malani Secondary School~~ Mutito Bay's Secondary School	54 km		-	For TV	73km/5 hours
			18	Kamutei Dispensary	36 km		100 m		80km/6 hours
	Mutito	7.06%	19	Mutito Girl's Secondary School	54 km		500 m		73km/5 hours
			20	Voo Secondary School	36 km		400 m		86km/7 hours

School: (blue)
Dispensary / Health Center: (pink)

Prepared by JICA Survey Team

As shown in Table 4.1.2, the JICA Survey Team confirmed the following conditions for the 20 candidate sites:

(1) Distance from Existing Grid Line

Some facilities, such as Melo Secondary School, Kanyangi Boys Secondary School, and Issas Health Center, have already been electrified with the power supply from electric power grid. Furthermore, some other facilities are as close as less than 15 km from the existing power grid. Based on this criterion, said sites were omitted from the list of candidate sites.

(2) Operation of facility

As resulted from the survey, Pitiki Health Center is being closed due to lack of personnel and shortage of medicines. Based on this criterion, the site was omitted from the list of candidate sites.

(3) Distance from existing Battery Charging Station

The following candidate sites have already started operation of their battery charging facilities:

- Ilimotiock Secondary School
- Meleo Secondary School
- Iloodokilani Secondary School
- Syomunyu Girls Secondary School
- Kanyangi Boys Secondary School
- Mutito Girls Secondary School
- Voo Secondary Schoool
- Kimintet Dispensary
- Mailwa Dispensary
- Kamutei Dispensary

Since it was confirmed that the demands for battery charging at each candidate site is higher than the requirement in many cases, the additional capacity for battery charging seems to be acceptable in the communities. Therefore, this criterion is not used as basis for omitting above sites from the list of candidate sites.

(4) Existing Solar PV System

The following candidate sites have been electrified through solar PV system:

- Iltumutum Primary School
- Oloile Secondary School
- Syomunyu Girls Secondary School
- Mutito Boys Secondary School
- Meto Dispensary
- Loiwat Dispensary.

However, some systems are not working properly due to various reasons. Furthermore, the systems are too small for the power demand of the facilities. The detailed investigation of existing solar PV systems were necessary to study the requirement of additional power supply with CSS. Therefore, this criterion is not used as basis for omitting above sites from the list of candidate sites.

(5) Accessibility

Accessibility is a key issue in selecting sites for the pilot project. Through the village social survey, the driving duration on unpaved road were determined by a local consultant. From the results, it was confirmed that it took more than five hours to drive along unpaved roads toward some candidate sites. These sites are as follows:

- Loiwat Dispensary;
- Ptikii Community Dispensary;
- Mutito Boys Secondary School;
- Kamutei Dispensary;
- Mutito Girls Secondary School;
- Voo Secondary School.

Hence, based on this criterion, above sites were omitted from the list of candidate sites.

(6) Relationship with Neighboring Community

When the operation and maintenance (O&M) of facilities is considered, it is indispensable to confirm a character and integral security situation of a community. For example, the tribe conflict between Masai and Kipisigisi is intense based from interviews with community leaders and local people. Cattle rustling have frequently occurred in the territorial border between Masai and Kipisigisi tribeS. According to the community leaders, it was confirmed that a special consideration is required in order to proceed with the CSS program for Kimintet Dispensary, Emarti Health Center and Loiwat Dispensary. Based on this condition, these sites were omitted from the list of candidate sites.

In addition to surveys, a social map was prepared showing village distribution, market, and water resource. The map also shows the target facilities and the surrounding conditions. A sample is shown in Figure 4.1.1. Meto dispensary is located in the vicinity of the community center. Information such as boreholes and river alignment are also shown in the map. The social map was used to obtain basic information during the detailed village social survey conducted by the JICA Survey Team.

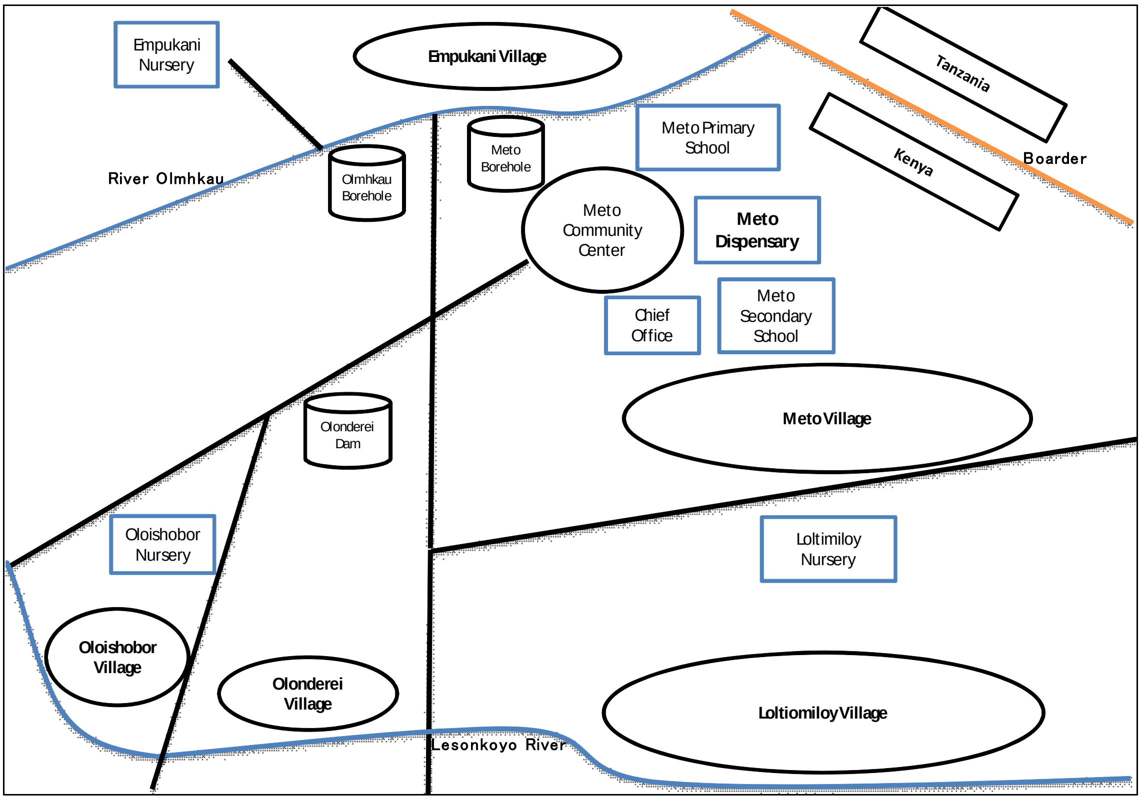


Figure 4.1.1 Sample of Social Map (Meto Dispensary)

Prepared by JICA Survey Team

4.2 Results of Detailed Village Social Survey by the JICA Survey Team

The Survey Team selected six promising candidate sites based on the results of the village social survey on the 20 candidate sites. The process of selecting the six candidate sites is as explained in Chapter 3. Furthermore, the Survey Team conducted the detailed social survey on the six candidate site to shortlist three sites as first group for the pilot project. In the detailed village social survey, the following items were confirmed:

- Location and accessibility
- Outline of the target facilities
- Necessity of electrification through CSS
- Adequateness of CSS

Each survey result for the six candidate sites regarding the aforementioned items were compiled and are shown at end of this chapter.

In order to estimate the demand of battery charging, which is the basic function of CSS, the following information were also collected:

(1) Number of villages, where people will use the charging service

(2) Population of corresponding villages

(3) Number of mobile phone users in the corresponding villages

(4) Dissemination ratio of mobile phone, method of charging, and fees

(5) Frequency of mobile phone charging

Based on the information above, the expected numbers of customer of battery charging station was estimated and shown in Table 4.2.1.

Table 4.2.1 Expected Numbers of Customer of Battery Charging

Name of Facility	Number of Village	Population	Adult Population	Mobile Phone possession Population	Rate of Mobile Phone Possession	Number of Mobile Phone recharging /Month	Mobile phone charge demand forecast value per day	Recital
Olopironito Dispensary	2	2,000	1,200	1,000	83%	12times	**120**	It is presumed that 30 % of the Mobile phone possession population uses the facility
llimokiook Secondary School	5	685	380	240	63%	11times	**44**	It can be confirmed 88 customers per day. However, it is assumed that 44 customers use competing battery charging station.
Iltumtum Primary School	7	1,008	480	166	35%	10times	**55**	Because present charge facilities are located on Narok Town on foot 3-4 hour, rival charge facilities are presumed not to be.
Lloodokilani Secondary School	4	2,001	1,302	366	28%	6times	**44**	It can be confirmed 73 customers per day. However, it is assumed that 29 customers use competing battery charging station.
Mailwa Dispensary	5	6,380	3,590	1,975	55%	4times	**15**	It presumes that most of resident use competitive charge shop in the facilities neighborhood though the charge demand during 282 people/day can be confirmed.
Meto Dispensary	5	3,125	1,845	460	25%	6times	**50**	There is Home Solar owner, too and demand is presumed to reduce by half though the charge demand during 102 people/day can be confirmed.

Prepared by JICA Survey Team

From the results of the detailed village social survey, usage of mobile phones and rechargeable lanterns were confirmed.

<u>Usage of Mobile Phone</u>

Dissemination ratio of mobile phone ranges vary for each candidate site, ranging from 25% to 83%. The expected charging fee of mobile phone in CSS to be installed ranges from KSh10 to KSh30, which is equal or less than the present charging fee.

Uses of mobile phone in the area of target facilities were confirmed and summarized as follows:

(1) Information exchange concerning the market price of agricultural products and livestock.

(2) Information exchange concerning pasturing.

(3) Communication with children living in school dormitories.

Mobile phones are used to acquire indispensable information to improve lives, and there are some villages where people normally walk for three to four hours to reach battery charging station for mobile phones. The frequency of charging of mobile phone is once in every 2.5 to 7.5 days.

Usage of Rechargeable Lantern

The dissemination of rechargeable lantern and demand in the village were investigated. The number of rechargeable lantern users is not much, as related information is limited even in local cities as well as in un-electrified villages. Furthermore, un-electrified villages do not have charging station. On the other hand, it was confirmed that some villagers have been using rechargeable lamps for their children while doing their homeworks. The reasons for the delay of dissemination of rechargeable lanterns in un-electrified areas are (1) delayed supply of rechargeable lantern and advertisements; and (2) lack of charging stations. In case the price of rechargeable lantern will range from KSh1000 to KSh3000, the village people intend to purchase it in the same manner as the mobile phones. The opening of battery charging stations in un-electrified areas will increase the demand for rechargeable lantern accordingly.

Result of Detailed Village Social Survey (Six Candidate Sites)

(1) Olopironito Dispensary (Narok North)

1. Location and Access

Olopironito Dispensary is located in an un-electrified area in Narok North. The route to Olopironito Dispensary is through Route 147 from Narok towards 15 km to the east. Then, turn left along the un-paved road and travel 20 km towards north-north-east direction (40 minutes drive). The community is formed with five other villages, where Ildamat Village is located at the center. Olopironito Dispensary is located about 5 km from Ildamat Village, while the distance from the other four villages are 2 to 3 km. Moreover, the distance from the existing electrification power grid is about 20 km. Other main facilities, such as secondary schools, are also located in Ildamat Village. Accessibility to Olopironito Dispensary from Ildamat is poor due to muddy road, especially during rainy season.

2. Outline of Health Facility

The total population of the community is 2,000. About 44% of these,accounts for the population of Ildamat Village. The targeted number of patients is 4,981 although there is only one nurse in Olopironito Dispensary.

3. Necessity of Electrification with the Community Solar System

The diagnosis and treatment facilities including staff houses have not been electrified, thus, the vaccine refrigerators are gas operated. At present medical diagnosis and treatment is done during daytime. Lighting equipment is necessary during emergency cases at night time. Furthermore, it is necessary to provide electricity for vaccine storage refrigerators to improve reliability. It was confirmed that the villagers are in favor of providing solar PV system at the dispensary, and then expanding such system to the schools by turning over the revenue from CSS.

4. Adequateness of the Community Solar System

The health facility has not been electrified yet. Hence, the electrification with CSS is expected to be quite effective. Furthermore, guards will be consistently deployed at the clinic, and no problem is seen in terms of security in the area.

No battery charging stations have been established in four villages located near the target facility. At present, the villagers are charging their mobile phone at IIdamat, which is 2 to 3 km travel by foot. Therefore, installation of CSS will be beneficial for the villagers.

5. Photos

Facility layout

Facility layout

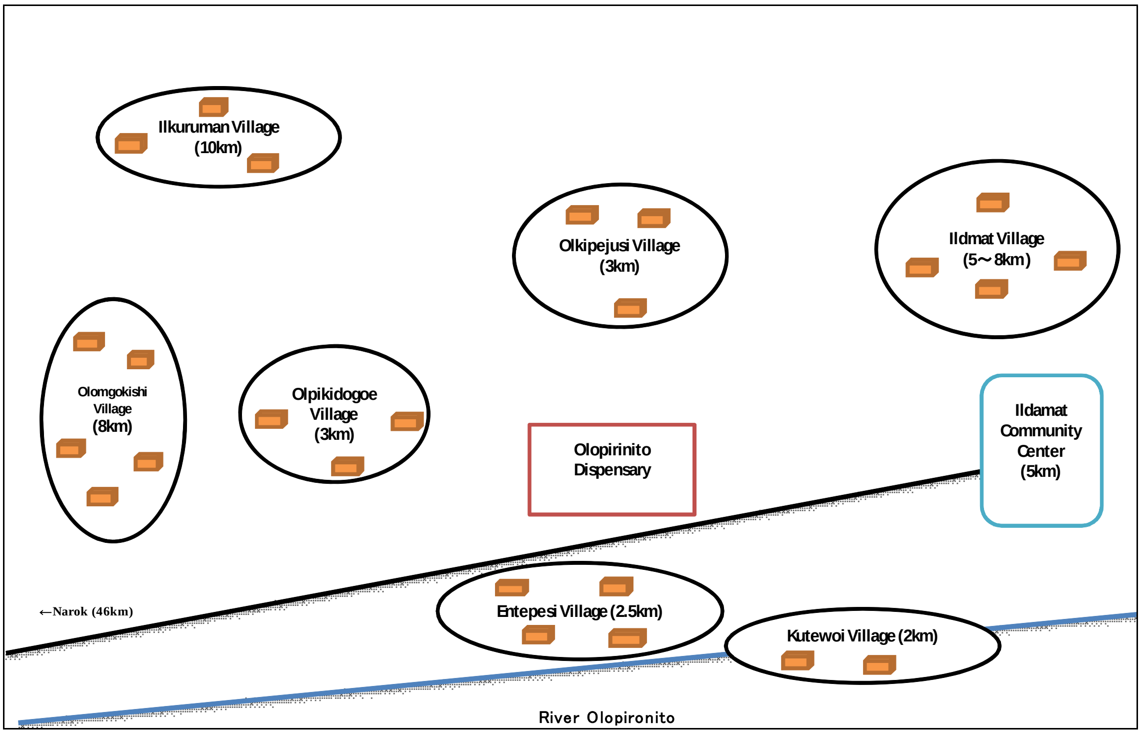
Meeting with school management committee

Road to Olopironito Dispensary

From Olopironito Dispensary to Ildamat Village

Secondary School

6. Social Map



Prepared by JICA Survey Team

(2) Ilimotiock Secondary School (Narok South)

1. Location and Access

Ilimotiock Secondary School is located in an un-electrified area in Narok South. The route to Ilimotiock Secondary School is through Route 147 and B 3 from Narok, 50 km towards the west direction. Then, turn right along the un-paved road and travel 15 km towards the north-east direction by (35 minutes drive). The community is formed with eight villages, where Ilimotiook Village is located at the center. Ilimotiock Secondary School, the community center, and market are adjacent to Ilimotiock Village. The distance from the school to the existing national power grid is about 15 km.

2. Outline of School Facility

The total population of the community is 685, where 20% accounts Ilimotiock villagers. There 34 staff members and 360 students (192 boys and 168 girls). Diesel generator is used to provide electricity for the school.

3. Necessity of Electrification with the Community Solar System

The management cost per year which include expenses for diesel for the generator and its repairs is KSh162,000. This is basically covered from the tuition of students. If CSS will be installed, the cost for the fuel will be saved, and there will be funds for upgrading school facilities.

4. Adequateness of the Community Solar System

Replacing diesel generator with solar PV system is effective in reducing costs for fuel and maintenance. There are two guards in the school area, and the security level is relatively high. Although there is a battery charging station in Ilimotiook Village, the other villages adjacent to the school have no such facilities, forcing several villagers to walk 2 to 3 km to have their mobile phones charged. Therefore, the new charging station to be installed in the school area will be effective in improving the lifestyle of villagers. To avoid disruption to school activities and the entering of unauthorized people inside the school premises, they intend to build the battery charging station at the entrance of the school facing the road.

5. Photos

Facility Layout

Facility Layouy

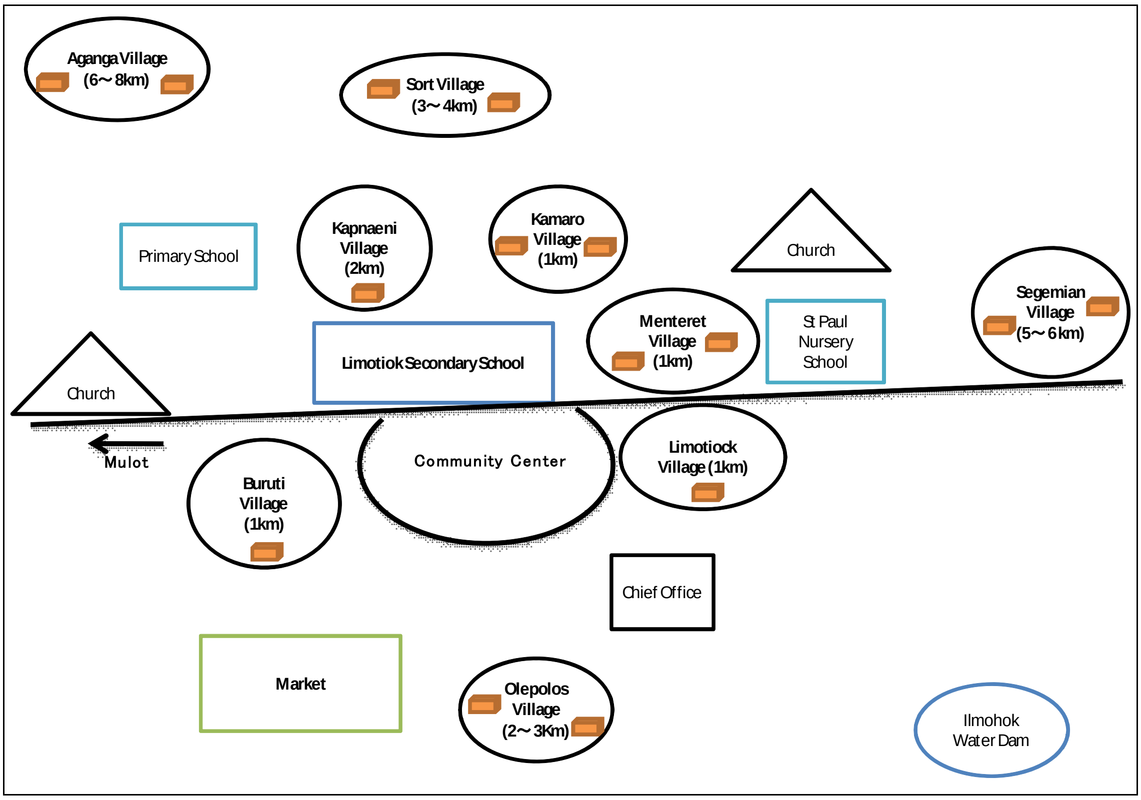
Security guards' room located next to entrance gate

Meeting with school management committee

Battery charging shop
in community center

Battery charging devices

6. Social Map



Prepared by JICA Survey Team

(3) Iltumutum Primary School (Narok North)

1. Location and Access

Iltumtum Primary School is located in an un-electrified area in Narok North. Going to Iltumtum Primary School, it will require 20 km (45 minutes drive) travel through the un-paved road from the center of Narok towards south. The community is formed with other six villages where Iltumtum Village is located at the center. The school is 1 km away from Ilimotiock Village, while 1 to 5 km away from other villages. Moreover, the distance from the existing national power grid is about 20 km. The nearest trading center, such as market, is in Narok Town. The condition of road to Narok is relatively good even during rainy season.

2. Outline of School Facility

The total population of the community is 1,008, where 19% accounts for the Iltumutum villagers. There are ten teachers and 235 students registered in Iltumutumu Primary School.

3. Necessity of Electrification with the Community Solar System

Iltumtum Primary School has been partially electrified with a small scale solar PV system. However, the power supply capacity is still insufficient for its buildings such as for class rooms and dormitory. The area is under populated, and the long distance travel to the school is one of the hindrances for continuing education. Therefore, the electrification with solar PV system for the dormitory is an effective means of improving education.

4. Adequateness of the Community Solar System

Battery charging facilities are located in Narok Town, where the villagers have to walk 20 km to charge their mobile phones. Therefore, installation of the battery charging station in this school is extremely beneficial. Moreover, disturbance to school activities is not a serious problem considering the typical society of the Masai Tribe.

5. Photos

Facility layout (Dining Building)

Facility layout (Classroom Building)

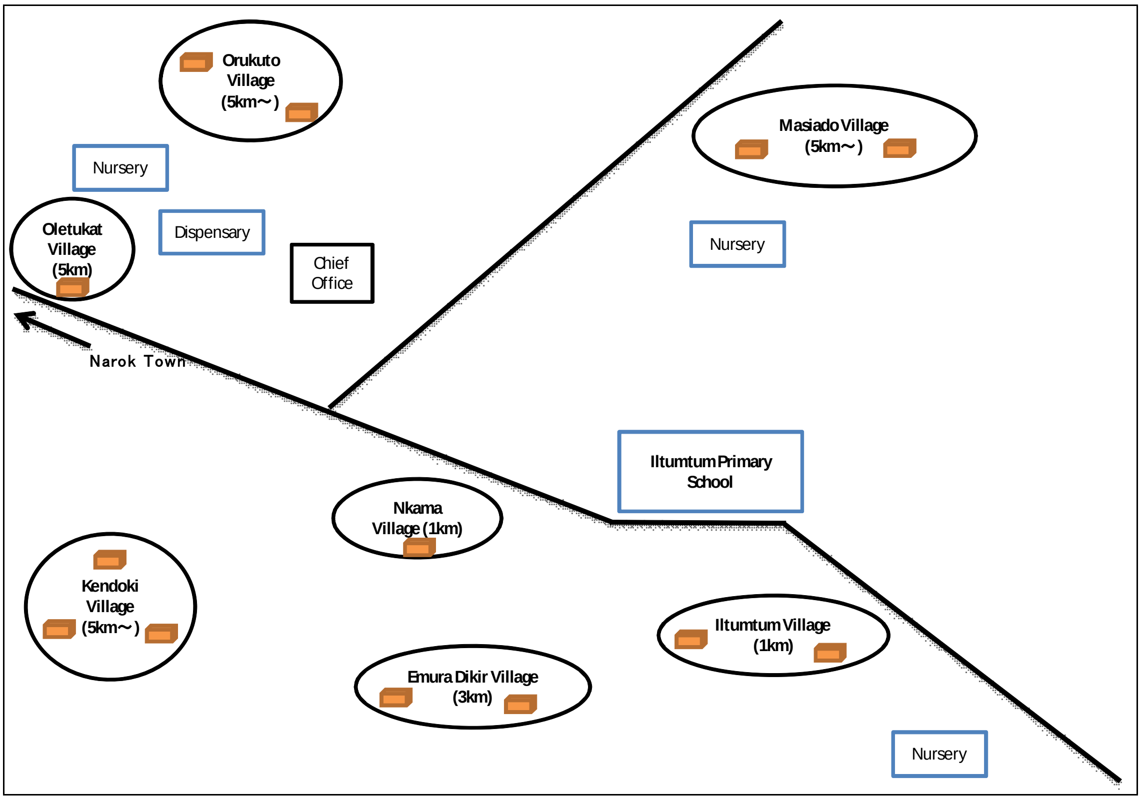
Photovoltaic generation controller

Meeting with
school management committee

Local people using mobile phone

Local people using mobile phone

6. Social Map



Prepared by JICA Survey Team

(4) lloodokilani Secondary School (Kajiado Central)

1. Location and Access

Iloodokilani Secondary School is located in an un-electrified area in Kajiado Central. Going to Iloodokilani Secondary School would require 2 km rive on Route 104 from Kajiado toward south direction. Then, turn right along the un-paved road and drive 40 km (60 minutes) toward west direction . The un-paved road crosses small tributaries, and is difficult to access during rainy season. The community consists of five villages, where the Holy Ground Village is at the center. Iloodokilani Secondary School is adjacent to the Holy Ground Village within a distance of 1 km. The other villages are 2 to 8 km from the school. Moreover, the distance from the existing national electricity power grid is about 32 km.

2. Outline of School Facility

The total population of the community is 2001, where 18% accounts for the villagers of Holy Ground. The school has 11 teachers and 49 students, and was opened at beginning of this year. The school has plans for future expansion.

3. Necessity of Electrification with the Community Solar System

The school facility is not electrified. Dormitories are planned to be constructed, while the school gathers for funds. Electrification with solar PV system will be effective for the dormitories. According to the management committee of the school, they want to start a photocopy service in the community to avoid long trips to Kajiado Town for printing their school documents.

4. Adequateness of the Community Solar System

The school facility has not yet been electrified, and the effect of electrification by CSS will be beneficial. Although the security system is operational, the fence surrounding the school is not durable enough. The battery charging station operated using diesel generator and a small scale solar PV system is located at the center of community. These facilities only operate every Saturdays. Therefore, the installation of battery charging system at the school will be very beneficial for the villagers.

5. Photos

Facility layout

Facility layout (Entrance)

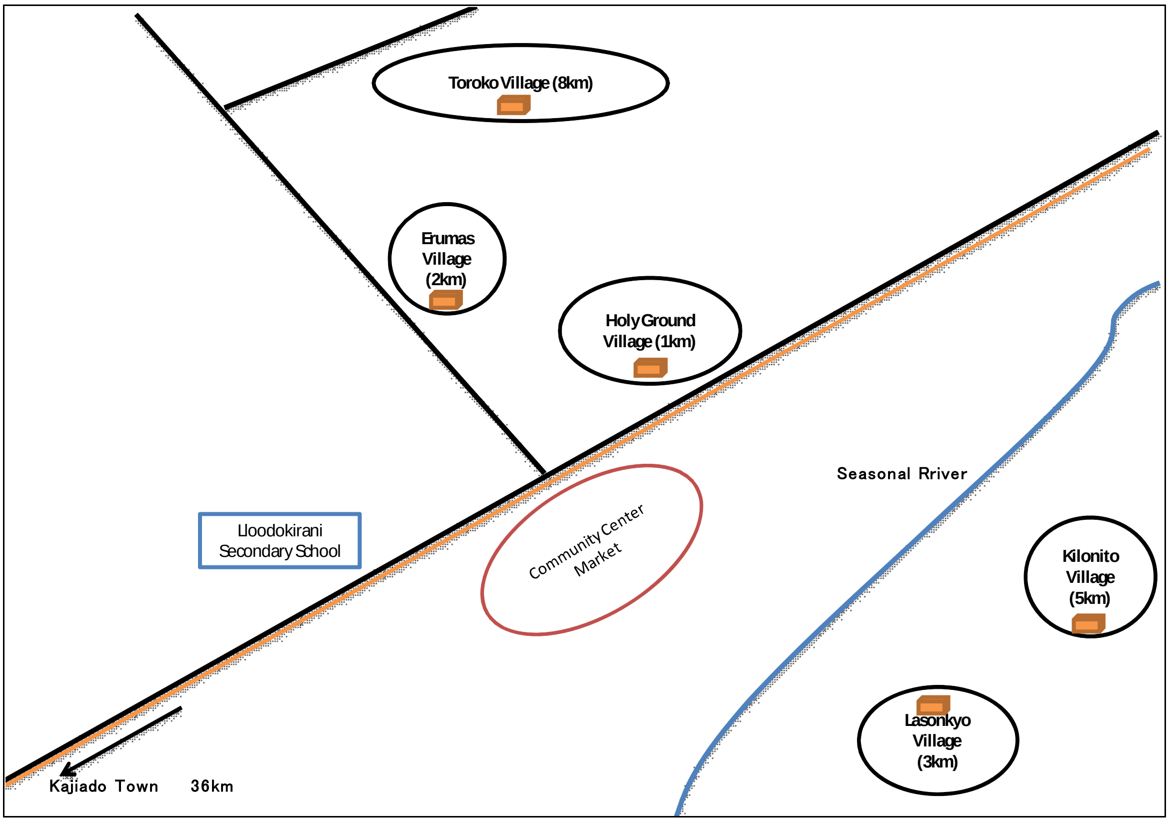
Classroom

Meeting with
School Management Committee

Battery charging shop in community center

Local people using mobile phone

6. Social Map



Prepared by JICA Survey Team

(5) Meto Dispensary (Kajiado South)

1. Location and Access

Meto Dispensary is located in an un-electrified area in Kajiado South. The route to Meto Dispensary is by driving 57 km along Route 104 from Kajiado toward south direction; turning right along the un-paved road and driving 38 km (70 minutes) towards the south-west direction. The un-paved road crosses many tributaries, and is difficult to access during rainy season. The community consists of five villages, where Meto Village is at the center. Meto Dispensary is located at the perimeter of the community and is close to the boundary of Tanzania. Therefore, the Masai people living in the Tanzanian territory also has access to the dispensary. The distance from the existing national electricity power grid is about 38 km. There is a primary school near Meto Dispensary, while a secondary school is under construction.

2. Outline of Health Facility

The total population of the community is 3125, where 10% accounts for Meto villagers. There is one male and one female nurse in the dispensary. The number of patients is considerable, causing long queuing time at the dispensary everyday.

3. Necessity of Electrification with the Community Solar System

The dispensary has been electrified with a small scale solar PV system in cooperation with NGO. From the detailed investigation, when the battery depletes due to overload, the solar panel is directly connected to the electrical current. Therefore, the people only have electricity during day time. Gas system runs the vaccine refrigerator, and medical care is carried out only during daytime. However, the proper lighting system is required especially during emergency. The refrigerator also should be electrified to function steadily.

4. Adequateness of the Community Solar System

The present solar PV system is not working properly, and a new battery charging system is necessary. There is a guard watching over the medicine at present. The existing battery charging station is located at the center of Meto Village which is a bit far from the dispensary. The demand for battery charging is expected to expand also to the villagers in the Tanzanian territory. For this dispensary, the installation of CSS will not cause any disturbance.

5. Photos

Facility Layout

Facility Layout

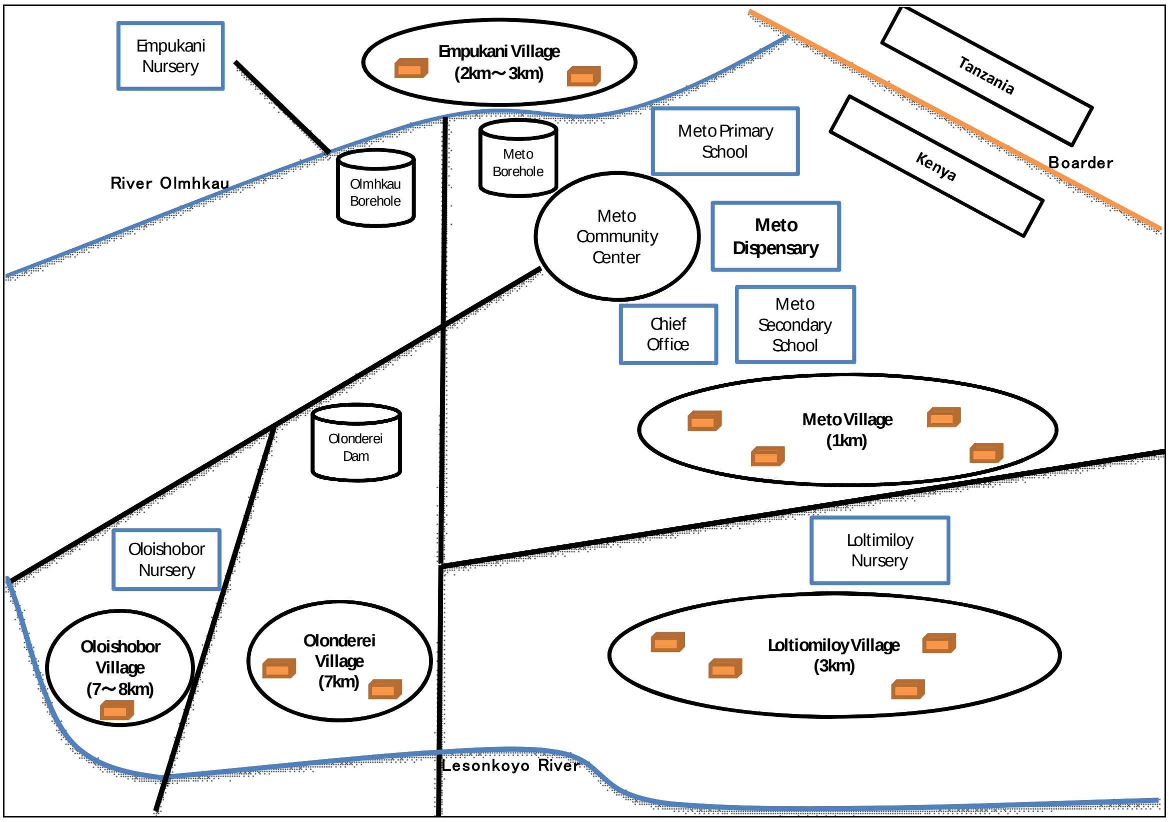
Possible site for CSS

Refrigerator for vaccines operated by gas

Meeting with committee Member

Existing system without controller

6. Social Map



Prepared by JICA Survey Team

(6) Mailwa Dispensary (Kajiado South)

1. Location and Access

Milwa Dispensary is located in an un-electrified area in Kajiado South. The route to Milwa Dispensary is through Route 104, 70 km from Kajiado toward south direction. Then, take a left turn to the un-paved road; and drive 22 km (30 minutes) toward north-east direction . The community is formed with five villages, where Milwa Village is at the center. The distance from the existing national power grid is about 22 km. There is a primary school near Milawa Dispensary.

2. Outline of Health Facility

The total population of the community are 6,380, and community people are concentrated at each village where a market exist. There is one male nurse and one support staff tasked to clean the dispensary. The dispensary is small and has no security fence. One person watches over the area, including the secondary school.

3. Necessity of Electrification with the Community Solar System

The dispensary has not yet been electrified and the medical service is carried out during day time. Electricity is necessary during emergencies at night time. The refrigerator also should be electrified to keep it functioning steadily. There is a battery charging station near the dispensary and many customers are using this service. According to the shop owner, there are normally 20 customers per day. Therefore, if the CSS will be installed and battery charging station will operate near the dispensary, two shops may compete against each other.

4. Adequateness of the Community Solar System

The dispensary has not been electrified and the electrification with CSS will be very beneficial. However, the security level is low and property loss is likely. Furthermore, there is an existing battery charging shop near the dispensary which is a potential competitor, and thus, the revenue of the charging services may be smaller than expected.

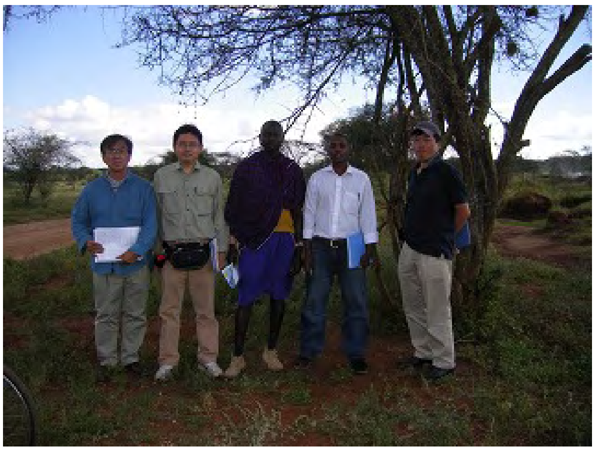
5. Photos

Main building

Main building

Main building

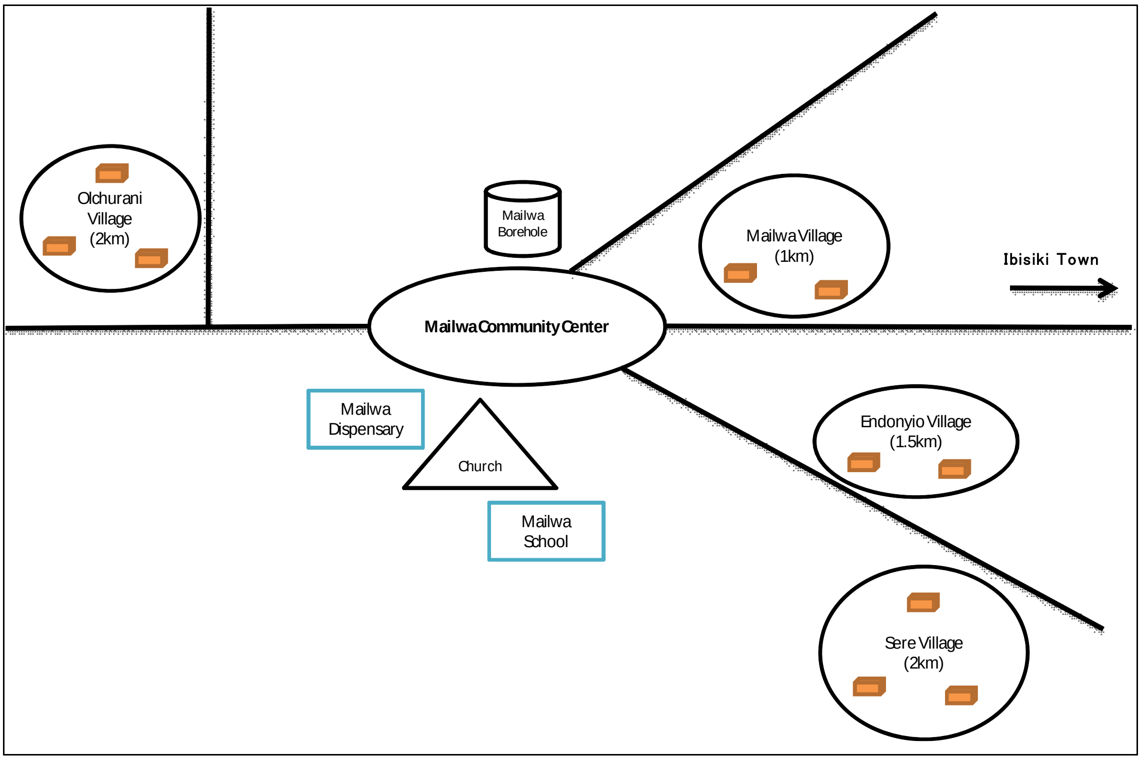
Possible place of battery charging



Meeting with committee members

Battery charging service located near the dispensary

6. Social Map



Prepared by JICA Survey Team

Chapter 5 Market Survey Concerning Local Procurement of Related Materials and Equipment

5.1 Trends in Materials and Equipment Related to PV System in Kenya

JICA Survey Team studied the trends in materials and equipment related to PV system in Kenya during the field work to collect necessary information for the basic design and cost estimates of the pilot projects to be implemented in the future.

In Nairobi, there are several companies that specialize in PV system, and some of them have openly provided their work details and related information to the public through the internet. Major companies offer series of services from design and quotation to implementation and maintenance after fully handing over the project through turn-key contracts. They also offer these services to local cities through their local offices and authorized agents in Kenya.

The recent trends in the price of materials and equipment related to PV system have been relatively stabilized. Besides, the Kenyan government does not impose 16% value added tax (VAT) on specialized items, except for items used for general purposes, such as ordinary fluorescent tubes.

In Kenya, items made in China and India are widely distributed. Items made in developed countries including Japan are also distributed, but are approximately 1.2 to 1.5 times more expensive than others.

5.2 Survey on Unit Prices of Materials and Equipment Related to PV System in Kenya

During the field work period, the Survey Team also studied the unit prices of main materials and equipment, such as PV panels, batteries, and inverters, related to PV system in Kenya for purposes of carrying out cost estimates.

The following companies provided their unit prices to the Survey Team:

(In alphabetical order)

Company	Contact Person	Telephone Number
Chloride Exide Kenya Ltd.	Mr. Sammy Waite Technical Manager	020 532 211
Davis & Shirtliff Ltd.	Mr. Norman Chege Solar Manager	020 696 8000

Company	Contact Person	Telephone Number
Kenital Solar Ltd.	Ms. Connie Nyamboki Sales Executive	020 271 4551
Solagen Power Ltd.	Mr. John Kiama Technical Manager	020 444 1160
Telesales Ltd.	Mr. Nashir N. Abdulla Director	020 387 3179

Table 5.2.1 reveals the unit prices of main materials and equipment related to PV system, which were provided by the five companies above.

Since all unit prices provided by the five companies are within appropriate range, the Survey Team estimates the PV system costs using the averages of the given unit prices.

These companies have basic knowledge on Community Solar System (CSS), and can carry out series of services from design and quotation to implementation and maintenance after handing over of the project through full turn-key contracts.

Table 5.2.1 Unit Prices of Main Materials and Equipment Related to PV System (5 Companies)

Item	Major Available Size		Average Price (Ksh)	(1) Chloride Exide Kenya Ltd.			(2) Davis & Shirtliff Ltd.			(3) Kenital Solar Ltd.			(4) Solagen Power Ltd.			(5) Telesales Ltd.		
				Size		Price (Ksh)	Size		Price (Ksh)	Size		Price (Ksh)	Size		Price (Ksh)	Size		Price (Ksh)
PV Module	50 W	12 V	22,000	50 W	12 V	25,000	50 W	12 V	18,000				50 W	12 V	23,000	50 W	12 V	22,000
	60 W	12 V	35,000							60 W	12 V	35,000						
	80 W	12 V	36,950	80 W	12 V	40,000	80 W	12 V	28,800	80 W	12 V	44,000				80 W	12 V	35,000
	85 W	12 V	35,500										85 W	12 V	35,500			
	100 W	12 V	40,250	100 W	12 V	41,000										100 W	12 V	39,500
	120 W	12 V	49,733				120 W	12 V	43,200	120 W	12 V	58,000	120 W	12 V	48,000			
	130 W	12 V	55,000										130 W	12 V	55,000			
	150 W	24 V	63,475				150 W	24 V	54,000	150 W	12/24 V	85,900	150 W	12 V	58,000	150 W	12 V	56,000
	160 W	24 V	70,000	160 W	24 V	70,000												
Charge Controller	10 A	12/24 V	3,900	10 A	12 V	2,600	10 A	12 V	2,900				10 A	12/24 V	3,000	10 A	12/24 V	7,100
	12 A	12/24 V	4,000							12 A	12/24 V	4,000						
	15 A	12 V	3,800				15 A	12 V	3,800									
	20 A	12/24 V	8,400	20 A	12/24 V	5,000				20 A	12/24	12,000	20 A	12/24 V	7,000	20 A	12/24 V	9,600
	30 A	12/24 V	14,720	30 A	12/24 V	16,300	30 A	12 V	18,000	30 A	12/24	16,000	30 A	12/24 V	12,000	30 A	12/24 V	11,300
	40 A	12/24 V	17,000	40 A	12/24 V	13,000				40 A	12/24	25,000	40 A	12/24 V	13,000			
	45 A	12/24 V	22,250				45 A	24 V	25,000							45 A	12/24 V	19,500
	60 A	12/24 V	19,250	60 A	12/24 V	19,000							60 A	12/24 V	19,500			
Inverter	150 W	12 V	3,500	150 W	12 V	3,500												
	300 W	12 V	8,100	300 W	12 V	4,800				300 W	12 V	7,500	300 W	12 V	12,000			
	375 W	12 V	7,500				375 W	12 V	7,500									
	500 W	12 V	7,300	500 W	12 V	7,300												
	600 W	12 V	22,000										600 W	12 V	22,000			
	700 W	12 V	18,000				700 W	12 V	18,000									
	720 W	12 V	20,000							720 W	12 V	20,000						
	750 W	12 V	39,000				750 W	12 V	39,000									
	1000 W	12/24 V	57,333	1000 W	12 V	70,000							1000 W	12 V	62,000	1000 W	12/24 V	40,000
	1250 W	12 V	46,000				1250 W	12 V	46,000									
	1500 W	12/24 V	75,000							1500 W	12/24 V	75,000						
	2000 W	12 V	117,000	2000 W	12 V	160,000	2000 W	12 V	74,000									
	2400 W	12/24 V	91,333				2400 W	24 V	94,000	2400 W	12/24 V	85,000	2400 W	12/24 V	95,000			
	3000 W	12/24 V	212,500	3000 W	24 V	210,000							3000 W	12/24 V	215,000			
	3500 W	12/24 V	140,000							3500 W	12/24 V	140,000						
Deep Cycle Battery	45 Ah	12 V	5,600							45 Ah	12 V	5,600						
	50 Ah	12 V	8,550	50 Ah	12 V	5,100	50 Ah	12 V	12,000									
	70 Ah	12 V	9,500							70 Ah	12 V	9,500						
	75 Ah	12 V	11,550	75 Ah	12 V	7,100	75 Ah	12 V	16,000									
	100 Ah	12 V	16,900	100 Ah	12 V	11,000	100 Ah	12 V	18,000	100 Ah	12 V	22,000	100 Ah	12 V	16,000	100 Ah	12 V	17,500
	150 Ah	12 V	27,000				150 Ah	12 V	29,000				150 Ah	12 V	25,000			
	200 Ah	12 V	31,100	200 Ah	12 V	27,000	200 Ah	12 V	34,000	200 Ah	12 V	39,000	200 Ah	12 V	28,000	200 Ah	12 V	27,500
	1000 Ah	2 V	68,000	1000 Ah	2 V	68,000												
	1320 Ah	2 V	64,000										1320 Ah	2 V	64,000			
Lamp	FL straight 10 W	12V	1,060				10 W	FL straight	1,200							10 W	FL straight	920
	CFL 11 W	12V	410	11 W	CFL	390				11 W	CFL	550	11 W	CFL	350	11 W	CFL	350

Prepared by JICA Survey Team (VAT 16% not included)