

Country Name	Establishment of Rural Electrification Model Using Renewable Energy
Republic of Kenya	

I. Project Outline

Background	Although the Government of Kenya aimed at electrifying 650,000 households in nonelectrified areas from 2008 to 2013, through grid extensions and installation of off-grid power sources, the actual number of households electrified was only 60,000 for the period from 2003 to 2008. Meanwhile, renewable energy had been regarded as important means of electrification in the nonelectrified areas. However, development of models for small-scale off-grid electrification was necessary to promote the use of the renewable energy.		
Objectives of the Project	<p>Through (1) Implementing pilot projects to develop a practical model* for PV (photovoltaic) electrification of health service institutions in nonelectrified areas, (2) Implementing pilot projects to develop a practical model for PV electrification of schools in nonelectrified areas, (3) Conducting technical training for Rural Electrification Authority (REA)/Ministry of Energy–MOEn (formerly Ministry of Energy and Petroleum (MoE&P) staff on Micro Hydro Power (MHP), Biogas and Wind, and (4) making recommendations for necessary policy and institutional frameworks for rural electrification using renewable energy, the project aimed at establishing rural electrification models using renewable energy and thereby disseminating the models in the country.</p> <p>* Practical modes are basically composed of (1) a system design (PV system for lighting, battery charging services and others), (2) sustainable O&M (REA, MOEn, Ministry of Health (MOH)/ Ministry of Education (MOE),(formerly Ministry of Education, Science and Technology (MoEST) and county government), and (3) sustainable financial plans (including income from battery charging services)</p> <ol style="list-style-type: none"> Overall Goal: Rural electrification models using renewable energy are disseminated in the country to improve the quality of Kenyan's life. Project Purpose: Rural electrification models using renewable energy are established. 		
Activities of the project	<ol style="list-style-type: none"> Project site (Pilot projects): 10 sites in Kajiado County, Narok County and Samburu County Main activities: (1) Implementing pilot projects to develop a practical model for PV electrification of health service institutions in nonelectrified areas, (2) Implementing pilot projects to develop a practical model for PV electrification of schools in nonelectrified areas, (3) Conducting technical training for REA/MOEn staff on MHP, Biogas and Wind, and (4) making recommendations for necessary policy and institutional frameworks for rural electrification using renewable energy Inputs (to carry out above activities) <ul style="list-style-type: none"> Japanese Side <ol style="list-style-type: none"> Experts: 11 persons Trainees received (Japan): 3 persons Training in the third country: 4 persons in India, 3 persons in Thailand Equipment: a current meter, satellite phone, computers, photocopiers, etc. Local cost: Salary and allowances, vehicle related expenses, workshop and seminars, etc. Kenyan Side <ol style="list-style-type: none"> Staff allocated: 19 persons Land and facilities: An office space Local cost: per diem for training 		
Project Period	March 2012 – February 2015	Project Cost	(ex-ante) 570 million yen, (actual) 437 million yen
Implementing Agency	Ministry of Energy (MOEn), Rural Electrification Authority (REA)		
Cooperation Agency in Japan	Nippon Koei and KRI International Corporation		

II. Result of the Evaluation**I Relevance**

<Consistency with the Development Policy of Kenya at the Time of Ex-Ante Evaluation and Project Completion>

The project was consistent with the development policies of Kenya both at the time of ex-ante evaluation and project completion. The "Vision 2030" was designed as a vehicle for accelerating transformation of the country into an industrialized middle-income nation. To achieve this goal, electricity was/is identified as one of the drivers where it is expected to achieve 100% electrification rate by 2030. The "Rural Electrification Master Plan (REMP) 2009-2018" aimed at attaining 40% of rural electrification rate by 2020 promoting grid extension and off-grid electrification.

<Consistency with the Development Needs of Kenya at the Time of Ex-Ante Evaluation and Project Completion >

The project was consistent with the development needs of Kenya for PV electrification. At the time of ex-ante evaluation, though the Government of Kenya promoted electrification in nonelectrified areas, rural electrification was 12% in 2010 relative to the target (20% by 2010). In order to promote dissemination of the renewable energy, issues such as utilization and dissemination of appropriate technologies for renewable energy, making models for dissemination, strengthening the capacity of the public and private sectors that were involved with improvement of safety and sustainability of electrified facilities through appropriate maintenance were addressed. At the time of project completion, Kenya had just experienced unprecedented rapid grid extensions under an accelerated government policy for connectivity targeting Public facilities such as schools and dispensaries with the aim to achieve over ambitious 100% electricity access by

2020. Moreover, many Primary school were connected with grid electricity for those located near the grid and with PV system for those in off-grid areas to facilitate digital learning for class one pupils.

Under the new accelerated electricity connectivity programme, schools with installed PV systems became grid connected earlier than envisaged to implement government policy on digital learning.

<Consistency with Japan’s ODA Policy at the Time of Ex-Ante Evaluation>

The project was consistent with Japan’s ODA Policy to Kenya. Under the “Country Assistance Program for the Republic of Kenya (2000), infrastructure development including energy was one of the prioritized areas of assistance.

<Appropriateness of Project Design/Approach>

Although the project was affected by the change of the government policy, the approach was appropriate. The project is considered to have met the development needs of Kenya, , however, some of the pilot sites were being covered by extension plans. At the time of inception, the relevance was high based on the Rural Electrification Master Plan 2008 and the REA Strategic plan 2008-2012. However, the situation changed in 2014/15 following the new government policy for digital learning in primary schools.

<Evaluation Result>

In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Status of Achievement of the Project Purpose at the time of Project Completion>

The Project Purpose was partially achieved. Among the indicators set to measure the achievement of the Project Purpose, “Renewable energy facilities installed by the Project are operated and maintained properly with sustainability.” (Indicator 3), “Implementation structures of national/county governmental agencies and local stakeholders are established.” (Indicator 4), and “Variety of expertise in renewable energy is increased among members of C/P (C/Ps).” (Indicator 5) were achieved, however, “The developed guidelines and manuals are applied to the projects implemented by the REA and MOEn (C/P).” (Indicator 1) was partially achieved and “The Outputs of the Project are incorporated into implementation of REA Annual Renewable Energy Work Programme (Performance Contract).” (Indicator 2) was not achieved.

<Continuation Status of Project Effects at the time of Ex-post Evaluation>

The effects of the project have partially been continued. Many of the facilities installed by the project have been partially or non-functional. Main reason is that the battery life-span of 3-4 years has expired but no replacement. Since Memoranda of Understanding (MOUs) which intended to transfer the Operation & Maintenance (O&M) responsibility to County health office and to Ministry of Education (MOE) have not been signed, no O&M budget has been secured. With battery failure, the systems have been more or less abandoned. Another reason for lack of interest is the grid connection in schools and establishment of hybrid mini-grids by REA with high capacity power through solar and diesel.

<Status of Achievement for Overall Goal at the time of Ex-post Evaluation>

The Overall Goal was partially achieved. In 2014/15 and 2015/16, REA’s focus was on electrification of public primary schools to support the Government’s Digital Learning Programme utilizing grid extension to those schools within grid network and installation of PVs in off-grid public facilities. So far, 4,500 primary schools have been electrified using the 12V, 24V and 48V PV system designs and experiences introduced through this project. However, the dissemination structure of national and county governmental agencies has not been established and neither MOH and MOE has signed MOU with REA/MOEn on O&M.

<Other Impacts at the time of Ex-post Evaluation>

A positive impact has been observed, as safe delivery of babies during the day and at night became possible after the installation of PV systems in dispensaries.

No land acquisition and resettlement occurred under the project. There has been no negative impact on natural environment so far. However, this could change after life spans of some components of the system expire like the batteries, fluorescent tubes, etc where their disposal might have a negative impact on the natural environment. The relevant Kenyan authorities are developing a safe way of disposing waste from the PV system installed in the public primary schools and the ones installed by the project will also be covered.

<Evaluation Result>

Therefore, the effectiveness/impact of the project is fair.

Achievement of Project Purpose and Overall Goal

Aim	Indicators	Results
(Project Purpose) Rural electrification models using renewable energy are established.	Indicator 1: The developed guidelines and manuals are applied to the projects implemented by the REA and MOEn (C/P).	Status of the Achievement: partially achieved (partially continued) (Project Completion) Target was achieved to some extent as the level of utilization of the three out of four Guidelines/Manuals for PV system, MHP, and Biogas was reported to be moderate. However, Wind Guidelines was not utilized as REA and MOEn did not have small wind project. (Ex-post Evaluation) Guidelines and manuals for PV system have been utilized by (i) the institutions where models were installed and still functioning, (ii) 3 public primary schools installed with the 48V systems by REA, and (iii) newly recruited REA engineers and technicians to learn PV systems
	Indicator2: The Outputs of the Project are incorporated into implementation of REA Annual Renewable Energy Work Programme (Performance Contract).	Status of the Achievement: not achieved (not continued) (Project Completion) At the project completion, 2015/2016 Annual Renewable Energy Work Program did not incorporate the implementation of the demonstration project using the developed model due to the completion of guidelines towards the end of project completion. (Ex-post evaluation) Not incorporated, but practiced.
	Indicator 3: Renewable energy facilities installed	Status of the Achievement: achieved (partially continued) (Project Completion)

<p>by the Project are operated and maintained properly with sustainability.</p>		<p>There was a clause on O&M in the handover agreement from JICA to REA. (Ex-post Evaluation) O&M status of the facilities</p> <table border="1" data-bbox="592 143 1513 622"> <thead> <tr> <th>County</th> <th>Community</th> <th>Facility</th> <th>PV size (kW)</th> <th>Functional or unfunctional*</th> </tr> </thead> <tbody> <tr> <td>Kajiado</td> <td>Klkilyeti</td> <td>Dispensary</td> <td>1.4</td> <td>Non-functional</td> </tr> <tr> <td rowspan="3">Narok</td> <td>Illtumtum</td> <td>Primary School</td> <td>4.2</td> <td>Only the charging kiosk is functional. The other systems are non-functional</td> </tr> <tr> <td>Olkinyei</td> <td>Dispensary</td> <td>1.1</td> <td>Non-functional</td> </tr> <tr> <td>Olemoncho</td> <td>Primary School</td> <td>3.0</td> <td>Non-functional</td> </tr> <tr> <td rowspan="5">Samburu</td> <td>Tuum</td> <td>Primary School</td> <td>5.2</td> <td>Functional</td> </tr> <tr> <td>Illaut</td> <td>Primary School</td> <td>5</td> <td>Only the staffroom is functional. The other systems are non-functional</td> </tr> <tr> <td>Marti</td> <td>Primary School</td> <td>6.75</td> <td>Functional</td> </tr> <tr> <td>Latakweny</td> <td>Dispensary</td> <td>2.5</td> <td>Non-functional</td> </tr> <tr> <td>South Horr</td> <td>Dispensary</td> <td>0.5</td> <td>Functional</td> </tr> <tr> <td></td> <td>AngataNanyokei</td> <td>Dispensary</td> <td>0.75</td> <td>Non-functional</td> </tr> </tbody> </table>	County	Community	Facility	PV size (kW)	Functional or unfunctional*	Kajiado	Klkilyeti	Dispensary	1.4	Non-functional	Narok	Illtumtum	Primary School	4.2	Only the charging kiosk is functional. The other systems are non-functional	Olkinyei	Dispensary	1.1	Non-functional	Olemoncho	Primary School	3.0	Non-functional	Samburu	Tuum	Primary School	5.2	Functional	Illaut	Primary School	5	Only the staffroom is functional. The other systems are non-functional	Marti	Primary School	6.75	Functional	Latakweny	Dispensary	2.5	Non-functional	South Horr	Dispensary	0.5	Functional		AngataNanyokei	Dispensary	0.75	Non-functional
County	Community	Facility	PV size (kW)	Functional or unfunctional*																																															
Kajiado	Klkilyeti	Dispensary	1.4	Non-functional																																															
Narok	Illtumtum	Primary School	4.2	Only the charging kiosk is functional. The other systems are non-functional																																															
	Olkinyei	Dispensary	1.1	Non-functional																																															
	Olemoncho	Primary School	3.0	Non-functional																																															
Samburu	Tuum	Primary School	5.2	Functional																																															
	Illaut	Primary School	5	Only the staffroom is functional. The other systems are non-functional																																															
	Marti	Primary School	6.75	Functional																																															
	Latakweny	Dispensary	2.5	Non-functional																																															
	South Horr	Dispensary	0.5	Functional																																															
	AngataNanyokei	Dispensary	0.75	Non-functional																																															
<p>Indicator 4: Implementation structures of national/county governmental agencies and local stakeholders are established.</p>		<p>Status of the Achievement: achieved (Project Completion) Implementation structures of national/county governmental agencies and local stakeholders were established. According to the changes in external conditions, REA will modify the structures. (Ex-post Evaluation) Refer to Indicator 2, Overall Goal.</p>																																																	
<p>Indicator 5: Variety of expertise in renewable energy is increased among members of C/P (C/Ps).</p>		<p>Status of the Achievement: achieved (partially continued) (Project Completion) Technical transfer on MHP, Biogas and Wind were conducted to the counterpart. Expertise is increased among member of C/Ps. (Ex-post Evaluation) - MHP: Knowledge acquired was used in carrying out of feasibility studies for Ndanu Falls in Siaya and Chemosit Hydropower Construction Project in Kericho. - Biogas: The knowledge acquired was used in the re-assessment, quantification and costing of the scope of works required in the rehabilitation of the two pilot biogas projects established by REA in Mangu High School in Thika and Moi Girls High School Isinya in Kajiado. - Wind: Knowledge acquired has not been utilized as there were no wind projects undertaken by REA since the project was completed</p>																																																	
<p>(Overall Goal) Rural electrification models using renewable energy are disseminated in the country to improve the quality of Kenyan's life.</p>	<p>Indicator 1: Number of public facilities who apply and follow the model has increased all over the non-electrified areas in Kenya. Indicator 2: Dissemination structure of national and county governmental agencies is established.</p>	<p>(Ex-post Evaluation) achieved The number of public facilities which apply and follow the model</p> <table border="1" data-bbox="592 1294 1546 1458"> <thead> <tr> <th rowspan="2"></th> <th colspan="2">2014/2015</th> <th colspan="2">2015/2016</th> <th colspan="2">2016/2017</th> <th colspan="2">2017/2018</th> </tr> <tr> <th colspan="2">No. of</th> <th colspan="2">No. of</th> <th colspan="2">No. of</th> <th colspan="2">No. of</th> </tr> <tr> <th></th> <th>counties</th> <th>facilities</th> <th>counties</th> <th>facilities</th> <th>counties</th> <th>facilities</th> <th>counties</th> <th>facilities</th> </tr> </thead> <tbody> <tr> <td>Dispensary</td> <td>03</td> <td>05</td> <td>03</td> <td>05</td> <td>03</td> <td>05</td> <td>03</td> <td>05</td> </tr> <tr> <td>School</td> <td>35</td> <td>2571</td> <td>15</td> <td>327</td> <td>20</td> <td>908</td> <td>6</td> <td>38</td> </tr> </tbody> </table> <p>(Ex-post Evaluation) not achieved - Dispensaries: Draft MOUs are being formulated stating that the assets belong to REA but O&M to be taken care of by MOH at the counties. - Schools: REA intends to transfer the O & M of the PVs systems to MOE through the MOEn. The schools under the project will be included. A letter together with a revised MOU is being prepared on the subject matter.</p>		2014/2015		2015/2016		2016/2017		2017/2018		No. of		No. of		No. of		No. of			counties	facilities	counties	facilities	counties	facilities	counties	facilities	Dispensary	03	05	03	05	03	05	03	05	School	35	2571	15	327	20	908	6	38					
	2014/2015			2015/2016		2016/2017		2017/2018																																											
	No. of		No. of		No. of		No. of																																												
	counties	facilities	counties	facilities	counties	facilities	counties	facilities																																											
Dispensary	03	05	03	05	03	05	03	05																																											
School	35	2571	15	327	20	908	6	38																																											

Source : JICA documents, questionnaire and interview with REA

3 Efficiency

Both project cost and project period were within the plan (the ratio against the plan: 77%, 100%). Therefore, the efficiency of the project is high.

4 Sustainability

<Policy Aspect>

Off-grid electrification has been a policy for increasing access to electricity services in underserved counties in Kenya as stipulated in policy documents such as the "Vision 2030" and "the National Electrification Strategy" (2016-2022). Meanwhile, electrification of the rural areas through grid extension has been moving very fast with REA. Off-grid power source is a stop gap measure in the electrification plan and when the grid arrives it replaces the off-grid power source. However, where appropriate, the grid power runs in hybrid mode with the off-grid power source due to the occasional unreliability of the grid power. As to the direction of MOE and MOH for installation of PV system in schools and dispensaries, plans have been underway to discuss with MOE on the O&M of the PV systems in public primary schools for the Digital Learning Programme. There has been also a window to discuss with the counties in the off-grid areas the electrification of health centres in these areas with PV systems under a REA matching facility program.

<Institutional Aspect>

The Renewable Energy Department under the Directorate of Technical Services of REA is responsible for disseminating the rural

electrification models developed by the project, while the MOEn is responsible for policy formulation and overall energy sector coordination. The number of staff in REA has been insufficient in terms of meeting the devolved functions of Rural Electrification and Renewable Energy Corporation (REREC) in 47 counties. REA was expected to transit into REREC based on the Energy Bill 2015, however, the Bill has not been enacted, and actual experience of working with counties has been still uncertain¹. The Bill is expected to come into force by the end of 2018. Although it was expected that MOE and MOH would be responsible for O&M of the PV facilities, it was not realized. The demarcation among REA and MOE has been unclear with respect to the PV facilities developed under Digital Learning Program.

<Technical Aspect>

The Renewable Energy Department of REA has had sufficient skills to disseminate the rural electrification models developed by the project. Training by the project during the project implementation, further targeted training in the University of Nairobi on solar modules and working with the major solar contractors in the country during the implementation of the public primary schools electrification programme has strengthened the capacity of the Renewable Energy Department. Also, the renewable energy technical personnel of the MOEn are expected to be transferred to REA after the new Energy Bill becomes law.

<Financial Aspect>

REA has been relatively well funded from the Exchequer and especially because of the implementation of the Presidential Laptop project (under the umbrella of Digital Learning Programm), in all primary schools. After transition to the new REREC, REREC will be financed by Exchequer-from rural electrification levy, which is 5% levy on the cost of the units of power consumed by every connected customer. With a plan of electrification of public institutions in the off-grid areas, the budget is secured for the future activities.

Applied and approved O&M budget

(Unit: million Kshs)

	2016/17	2017/18	2018/19
Applied budget	100	680	n.a.
Approved budget	68	30	300

<Evaluation Result>

Therefore, the sustainability of the effects through the project is fair.

5 Summary of the Evaluation

The project partially achieved the Project Purpose at the time of project completion, as the renewable energy facilities under the project were operated and maintained, and implementation structure of dissemination of the models was established, and C/Ps gained various expertise in renewable energy, though some manuals/guidelines developed under the project was not utilized and REA Annual Renewable Energy Work Programme did not incorporate the project outputs, though practiced. As a result of the project, the Overall Goal was partially achieved, as the REA PV systems installed in 4,500 primary schools relied heavily on the design system and skills introduced through the project. As for the sustainability, slight problems have been observed in terms of institutional aspect with respect to O&M, however no problem has been observed in policy, technical and financial aspects.

Considering all of the above points, this project is evaluated to be satisfactory.

III. Recommendations & Lessons Learned

Recommendations for Implementing Agency:

Most of them (est. 90%) of systems are not working mainly because of the “dead” wet-flood type batteries. Adopting the use of “maintenance free” batteries could help to reduce the budgetary burden for buying distilled water. REA could recommend this point to whomever takes over the O&M through MOUs signed between MOH and or MOE with REA/MOEn.

Lessons Learned for JICA:

- The Project Purpose was rather ambitious especially regarding the financing model for O&M. The preparatory missions reports on expected financial viability for O&M was rather overstated noting the economic status of the surrounding communities. It was also rather surprising that most of the project sites came to be covered by the national grid within the life-span of the project due to the Presidential Laptop project and therefore more consultations with MOEn and REA were necessary to identify alternative sites with little chance of being covered by National grid or Mini-grids by REA.
- At the time of ex-post evaluation, it was found that many of the sites were not functional after the project was completed due to the expiration of battery life without replacement. It is normal for batteries to expire after such a period of service irrespective of design. However, under the circumstances, where neither REA nor MOH and MOE are fully responsible for O&M, a change of design to utilize "Maintenance-free batteries" could have minimized the O&M budget and eliminate the purchases of distilled water (not always available in remote areas) and need for a specific person to be assigned for the work to for basic maintenance of the batteries.
- On the grid extensions by REA, it is difficult to avoid site overlapping even if there are close communications with counterpart due to some political reasons. About these small PV systems, to transfer them to other sites is not so difficult. It would be possible to build up a consensus with a partner country in advance, which makes the partner country side responsible to create a plan for transferring the system in case the system becomes unnecessary by grid extension.

¹ REREC will oversee the implementation of the Rural Electrification Programme by providing the necessary technical know-how for the energy reticulation at the counties. However, counties under the constitution have the powers to decide what resources to be developed when and how through the county plans. So, work of REREC will very much depend on close collaboration with the counties.



Students in Tuum Primary school, Samburu



Well maintained PV system in South Horr Dispensary, Samburu County