Evaluation Report

2017-

Impact Evaluation of Construction of Photovoltaic Power Plants Project in Mozambique

The Export-Import Bank of Korea

Government Agency for EDCF

Evaluated by

Sangmyung University, Cheonan Council for Industry Academic Cooperation

Table of Contents

I. Introduction

1. Background and Purpose of Impact Evaluation

☐ As part of the efforts for contributing to stable electrical supplies for regional development and poverty reduction in Niassa Province in north of Mozambique, the Export-Import Bank of Korea has implemented an independent solar power plant construction project.

☐ This is the first attempt to evaluate the mid- to long-term effects of the infrastructure sector, one of EDCF's major aid provision areas. The purpose is to diversify ex-post evaluation methods and to offer further expert insights.

☐ Other motivating factors for evaluating such mid- to long-term effects are conducting an objective analysis of the project's performance factors as well as strengthening evaluation indicators in renewable energy.

2. Direction of Evaluation

☐ The purpose of this impact evaluation is to assess the applicability of the techniques used in ODA evaluations and to apply such techniques on a trial basis. This impact evaluation measures the performance of the target project through a scientific, systematic analysis. Furthermore, it offers suggestions for advanced performance management of future energy projects.

3. Scope of Evaluation

- ☐ As this impact evaluation was designed after the completion of the project, the logic model at the planning stage was ambiguous. Accordingly, the evaluation team started designing the logic model for the project.
- ☐ The research method was established by taking as a basis the indicators used by KOICA in renewable energy and electrical installation projects and applying such indicators to the project. The final conclusion is drawn based on the analysis of the data collected by literature review, survey and interview.

II. Theoretical Background

1. Impact Evaluation

- ☐ The importance of impact evaluations has become greater in recent years. As a consequence, more impact evaluations have been conducted on diverse subjects, from an independent evaluation by a single donor country to a joint evaluation by multiple donor countries or international organizations. For example, the Norwegian Agency for Development Cooperation (NORAD) carried out an impact evaluation of the 2013 electrification project in Northern Mozambique.

2. Target Project

Table 1. Target Project

Project Name	Construction of Photovoltaic Power Plants Project in Mozambique	
Loan Amount / Total Amount	USD 35,000 thousand / USD 41,157 thousand	
Name of Borrower / Project Executing Agency	Ministry of Finance in Mozambique / Fundo de Energia (FUNAE)	
Purpose of Project	The "Construction of Photovoltaic Power Plants Project" aimed to develop three regions with a lack of electricity (i.e. Mavago, Mecula and Muembe in Niassa) by constructing sustainable 400-500kW photovoltaic power plants.	
Scope of Project	- Construction of 400-500kW photovoltaic power plants in Mavago, Mecula and Muembe - Establishment of electric power distribution systems between plants and consumers as well as electrical installation - Maintenance service for a year, education and training, consulting, etc.	
Time Frame	Loan approval: Loan agreement: Contract of procurement: Submission of PCR:	September 16, 2010 October 13, 2011 December 11, 2012 July 18, 2016.

Figure 1. Niassa Province

III. Evaluation Methodology

1. Analysis of Performance Model of Target Project

☐ Modified Project Design Matrix (PDM)

Table 2. Modified PDM

Narrative Summary	Objectively Verifiable Indicator	Means of Verification	Important Assumption
Impact Improvement of local people's life quality	- Attracted population - Increase in the number of businesses as well as communication systems - More equipment in health centers - Diversification of local broadcasts' contents - Increased NGO activity	Statistical data of each district in Niassa Province	Electricity costs will not increase rapidly.
Outcome Expansion of access to electricity supply	- Increased electricity consumption hours in beneficiary groups - Increased electricity use in the project area	Survey	Local demand will remain on a steady level.
Output Photovoltaic power plants in three districts	- Operation of the plants - Increase in the number of beneficiary groups for power facilities	- Current status of FUNAE - Survey - On-site visit	Operation staff will be employed sustainably.
Activity 1. Construction of photovoltaic power plants 2. Establishment of electric power distribution systems 3. Establishment of electric power facilities in households 4. Provision of equipment for households 5. Capacity-building for operation staff	**Input** USD 35,000 in loan USD 6,157 from the Mozambique government		**Pre-condition** - Administrative support - Securing the project site

2. Evaluation Methodology Design

- □ Direction of Design

- ○ The following methodology was selected for the evaluation of the project.

Table 3. Impact Evaluation Techniques

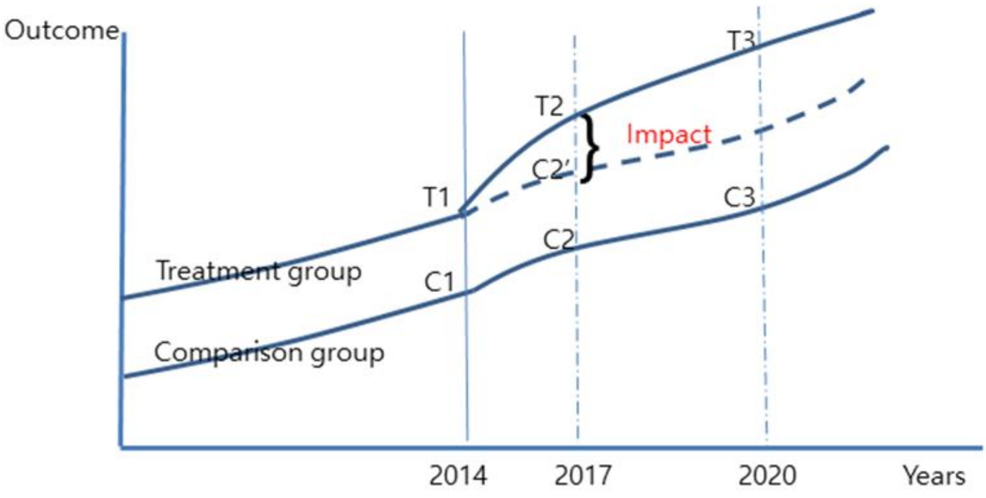
Evaluation Design	Before the Project	Executio n Stage	During the Project	After the Project	Explanation
After the midway point of the project, pre- and post-survey of the experimental group and the comparison group		X	P1 C1	P2 C2	- Useful when evaluation starts in the course of the project. - Delays in execution may make this design much weaker than Design 1, but this design can save costs due to its shorter evaluation contract period.

*P: experimental group / C: comparison group

- ○ The key issue to this technique is to designate two independent groups (i.e. P and C), the members of which should bear similar characteristics, before the implementation of the project. Factors taken into consideration for the designation of the groups in the project include electricity penetration rate and industrial structure. The primary analysis of the project's effectiveness is carried out by designating Group P, who did not have access to electricity before the project but as a result of the project gained access to electricity, and then comparing Group P with Group C, who did not have access to electricity before or after the project. After a couple of years, Group P and Group C are once more subject to surveys, i.e. P2 and C2 and then the difference in the experimental group (P2-P1) and the difference in the comparison group (C2-C1) are calculated. This is the method used in the DiD (Difference in Differences) approach.

- ☐ Selection of Evaluation Technique
- ○ In order to use the DiD technique, the experimental group and the comparison group are selected before the implementation of the project. This requires a baseline survey of the two groups before the implementation stage. But as no baseline survey was conducted for this project, the baseline survey in this impact evaluation is in fact a midway survey. Due to the absence of a baseline survey (i.e. T1 and C1), a reliable calculation of T2-C2' (= (T2-T1) – (C2-C1)) is impossible and thus T2-C2 should be computed at our disposal. After the midway survey, the impact evaluation enables us to see the difference in the impact of the project on the experimental group and the comparison group by estimating T3 and calculating (T3-T2) - (C3- C2).

Figure 2. Evaluation Methodology Design



- Comparison Group Design
  - (Outcome/Unit: Household) The evaluation team decided to designate the villages in the same district with similar environments as the comparison group. However, while the households in the experimental group are all located in a sede, i.e. the administrative central area in a district, the comparison groups without access to photovoltaic electricity are on the outskirts of a sede. As such, experimental and comparative households could be different in terms of economic power. In order to mitigate such difference, the comparison groups were finally chosen as recommended by the governor of each district who was acquainted with the situation of local villages..
  - (Impact/Unit: District) Other districts within Niassa Province that bear similarities to Muembe, Mavago and Mecula were selected. Due to the difficulty of selecting the comparison groups that exactly match the social, economic and geographic circumstances of the three districts in question, the Instituto Nacional de Estatística (INE), i.e. the Statistical Office in Niassa, assisted in the selection of 3 comparison districts that are the most appropriate for the evaluation.

3. Design of Survey Methodology

- Survey Questionnaires
  - Ultimately, six districts as well as their sedes and a number of comparison villages were selected for the survey: 110 households in the sedes of Muembe, Mavago and Mecula using FUNAE electricity and 35 households using electricity of Electricidade de Moçambique (EDM); and 35 households not using the grid installed in their sede and 50 households in villages that do not have access to electricity.

○ In the districts of Sanga, Chimbunila and Marrupa without FUNAE electricity supply and only with an EDM electricity network, 35 households with access to the network and 35 households without access were surveyed, as well as 35 households in villages that are not connected to electricity supply.

Table 4. Comparison Group

	Total (i.e. Six Districts)				
	A (Sede with FUNAE or EDM electricity supplies)	**B (Villages without access to electricity)**	**Subtotal**	**Result**	**Difference**
Household	810	255	1,065	1,078	13
Institution (School)	12	12	24	21	-3
Institution (Health Center)	12	12	24	6	-18
Shop	210	30	240	242	2
Village Leader	6	6	12	12	0
Total	1,050	315	1,365	1,359	-6

The questionnaires for evaluation were compiled based on the pre-existing questionnaires prepared by Gesellschaft für Internationale Zusammenarbeit (GIZ) and used by NORAD in similar projects in Mozambique.

□ Focus Group Interview (FGI)

○ Focus group interviews were conducted after an initial screening of the survey results to allow for further examination of individual cases.

□ Literature Review

- The evaluation team analyzed the statistical data provided by the Statistical Office of Niassa in order to measure changes on the district level annually.

□ Joint Workshop

- A joint workshop was held with the relevant organizations of Mozambique to analyze the results of surveys, interviews and literature reviews. During the workshop, a number of final conclusions were agreed in conjunction with the relevant stakeholders.

4. Limitation of Methodology

- For each question, there was an option for participants to answer assuming the conditions four years ago. However, when the responses obtained in such manner are likely inaccurate, the questions are limited to the present situation of respondents, thereby preventing an excessive amount of questions. Also, selecting an adequate comparison group was difficult.

IV. Impact Analysis

1. Outcome

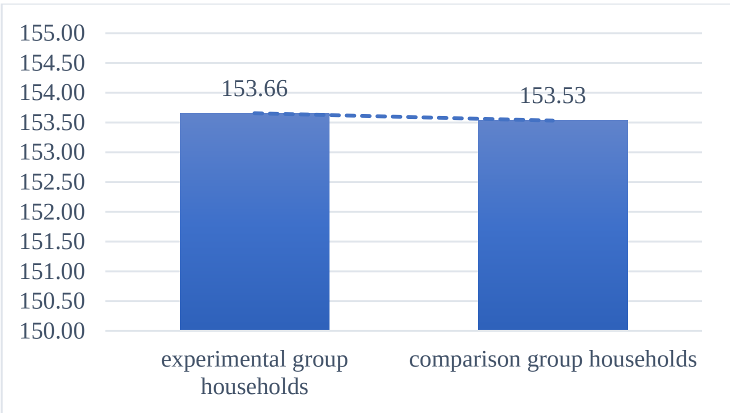
☐ Basic Analysis

	Experimental Group	Comparison Group	Total
Household	419	251	670
Business	55	56	111
School and Health Center	10	14	24
Total	484	321	805

☐ Result of Household Analysis

○ The average weekly fuel expense of households in the experimental group and the comparison group are MZN 153.66 and MZN 153.53, respectively. However, the two groups show a difference in the overall fuel consumption ratio out of total consumption.

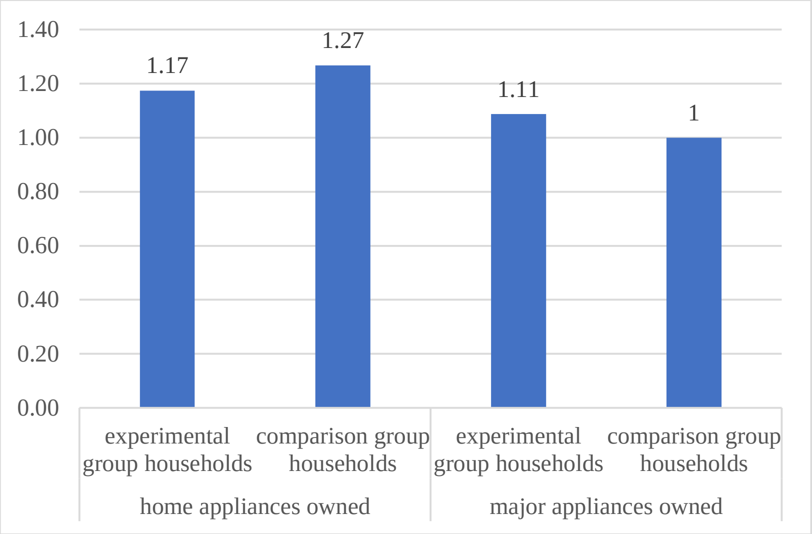
Figure 3. Average Weekly Fuel Expense (Unit: MZN)



○ According to the survey responses from the experimental group households, the use of wood, coal and domestic photovoltaic systems as well as access to the electricity network increased, while the use of dry batteries and candles as energy sources dropped sharply. On the other hand, an increase was seen in the use of wood, dry batteries and any other energy sources among the comparison group households.

- In comparing experimental and comparison groups by district, it can be seen that in all three districts, i.e. Muemba, Mecula and Mavago, the experimental group was spending more money on fuel than the comparison group on a weekly basis. In Mavago, where such difference is the largest, the experimental group was spending on average MZN 71.14 (USD 1.18) more on fuel than the comparison group.
- In Mavago, the responses show that the number of experimental group households using wood, domestic photovoltaic systems and the electricity network as energy sources increased, while the use of dry batteries and candles decreased. In Muembe District, despite the supply of electricity via the electricity network, the use of domestic photovoltaic systems became more frequent. Dry batteries, candles and similar energy sources became less widely used. Among comparison group households, again, fuel and other energy sources were up. In Mecula District, however, while energy uses from the electricity network and domestic photovoltaic systems increased, there was no corresponding decrease in other electricity sources. Among comparison group households, the use of fuel increased in most cases, but the use of domestic photovoltaic systems became less frequent.
- The home appliances owned by the experimental group differ from those owned by the comparison group in quantity. Experimental group households owned on average 1.17 home appliances, while comparison group households owned 1.27.
- In terms of major appliances (e.g. TVs, glaciers, freezers and computers), however, experimental group households owned 1.11, while comparison group households owned only 1.

Figure 4. Home Appliances Owned by Experimental and Comparison Groups



○ The evaluation team analyzed the use of home appliances before and after the project by conducting FGIs. By gaining access to electricity, people in villages can watch TV and use phones. As such, now, they are able to acquire information via different devices as opposed to the past when radio was the only option for gaining information. Thus, access to electricity is closely connected to people's information accessibility.

□ Result of Business Analysis

○ Similar to the differences observed between the household groups, experimental group businesses and comparison group businesses made use of different types of fuel. With access to the electricity supply system, experimental group businesses used more electricity but still used other types of fuels as well.

○ As to communications systems used by experimental group businesses, all replied that they used mobile phones, telephones and radio transmitters for communications at least three times a day. Many businesses replied that they used mobile phones and telephones more than 100 times a day.

Table 5. Businesses Using Communications Devices Five Times a Day or More

	Mobile Phone	Telephone	Radio Transmitter
Experimental Group Business	2	28	1
Comparison Group Business	0	20	5

2. Medium-term Impact

□ Result of Household Analysis

○ As to income, on the 5-point Likert scale, the experimental group scored 3.3 while the comparison group scored a slightly lower 3.09.

Figure 5. Perceived Income

	Average	Standard Deviation
Experimental Group	3.30	1.025
Comparison Group	3.09	1.001

t=0.001

□ Result of Business Analysis

○ Compared with the 2014 experimental group, businesses now open on average 22.44 minutes earlier, while closing time is on average 81.27 minutes later than before. Therefore, people living in villages with access to the electricity network will benefit from longer opening hours as well as more convenience to their daily lives.

Table 6. Change in Operating Hours of Businesses before and after the Project (Unit: Minute)

		Difference of Opening Time	Difference of Closing Time
Village with Access to Electricity	Average	22.44	81.27
	Frequency	41	37
	Standard Deviation	38.489	51.766

□ Result of Institution Analysis

○ The operating hours of both schools and health centers did not change after the installation of the electricity network. Schools typically open until about 5 pm, and no change in this practice was seen after the electricity network was available. As to health centers, 2 out of 3 centers operated 24 hours a day in 2014 and continue doing so today. One center opened from 7:30 am until 15:30 pm and this has not undergone any change to this day.

Table 7. Opening and Closing Time of Schools

Opening Time			Closing Time		
2014	2017	Difference	2014	2017	Difference
7:20	7:20	0:00	17:30	17:30	0:00
7:30	7:30	0:00	12:30		
7:30			17:30		
7:15	7:15	0:00	17:30	17:30	0:00
6:00			17:45		
6:45	7:00	0:25	17:10	17:30	0:20
7:00	7:00	0:00	17:40	17:00	-0:40
7:00	7:00	0:00	17:00	17:35	0:35
6:30	7:00	0:30	17:30	17:00	-0:30
7:00	7:00	0:00	17:35		
7:00			17:40		
6:45			17:30		

The FGIs revealed that flexible operating hours have led to additional school classes. In the past, when there was no electricity, classes ended at 5 pm regardless of how many students wanted night classes. As yet, schools do not have any evening classes, but if there is a demand for classes after 5 pm, they are willing to extend their existing opening hours.

3. Baseline for Long-term Impact Analysis

- ☐ Basic Frequency Analysis
- ○ The table below shows the experimental and comparison groups' access to the electricity network according to the responses from the village leaders.

Table 8. Basic Frequency Analysis of Village Leader Survey Results

Region			Frequency	Total
A	Experimental Group Village (Muembe)	FUNAE	1	4
		No Electricity	1	
	Comparison Group Village (Sanga)	EDM	1	
		No Electricity	1	
B	Experimental Group Village (Mecula)	FUNAE	2	4
		No Electricity	0	
	Comparison Group Village (Marupa)	EDM	2	
		No Electricity	0	
C	Experimental Group Village (Mavago)	FUNAE	1	4
		No Electricity	1	
	Comparison Group Village	EDM	1	

	(Chimbonila)	No Electricity	1	
Total				**12**

- ☐ Comparison between Villages
  - ○ 95 businesses have been registered in Muembe and 59 among them are located in the sede. 36 out of 59 businesses were open after 2014.
  - ○ 81.7% of teachers of experimental group schools have mobile phones or tablet PCs, while 93.9% of teachers of comparison group schools have such devices.

Figure 6. Teachers with Mobile Phone or Tablet PC

	Average	**Per Cent (%)**
Experimental Group Schools	20.64	81.7
Comparison Group Schools	12.4	93.9

- ○ The assumption, to begin with, was that a stable electricity supply would lead to more NGO activities within the village, but this has not proved to be the case yet. In villages with electricity supply, there is at least one more development project (such as bridge construction and health center support) than in comparison group villages.

- ☐ Comparison between Districts
  - ○ According to the data of the Statistical Office, a rapid increase of businesses was seen in Sanga and Marrupa in 2010 and 2011, i.e. at the time of the establishment of the electricity network.
  - ○ In terms of supplying medical services via health centers in each region, no marked difference was shown between experimental and comparison groups. Therefore,

electricity supply will contribute to the diversification of health and medical services in the near future.

Table 9. Medical Services in Health Centers by Region

	Muembe	Sanga	Mavago	Total
Day Care	2	2	1	5
Night Attendance	2	2	1	5
Minor Surgery		2	1	3
Vaccination	2	2	1	5
Laboratory Test	2	2	1	5
Stomatology	2	2	1	5
PARTO	2	2	1	5
Prenatal Consultation	2	2	1	5
Others	2	2	1	5

○ In one village in Muembe District, drinking water supply facilities are located in the village and electric pumps that help bring water to the surface are being used. In another village in Sanga, where the electricity network has not been in use for long, neither wells nor pumps used for drinking water procurement exist as yet.

Table 10. Current State of Muembe Drinking Water Facilities

<table>
<tr><th colspan="2"></th><th>Well</th><th>Pump</th></tr>
<tr><td rowspan="2">Muembe</td><td>Experimental Group Village</td><td>O</td><td>O</td></tr>
<tr><td>Comparison Group Village</td><td>O</td><td>X</td></tr>
<tr><td rowspan="2">Sanga</td><td>Experimental Group Village</td><td>X</td><td>X</td></tr>
<tr><td>Comparison Group Village</td><td>X</td><td>X</td></tr>
</table>

- In Mavago District, villages in the sede area as well as comparison group villages do have drinking water facilities, but no electric pumps. In the comparison group district, Chimbonilla, on the other hand, villages located within the sede are using electric pumps.

Table 11. Current State of Mavago Drinking Water Facilities

		Well	**Pump**
Mavago	**Experimental Group Village**	O	X
	Comparison Group Village	O	X
Chimbonilla	**Experimental Group Village**	O	O
	Comparison Group Village	O	X

- In Mecula District and in the comparison group district, Marupa, there do exist drinking water supply facilities, but no electric pumps are being used as yet

Table 12. Current State of Mecula Drinking Water Facilities

		Well	**Pump**
Mecula	**Experimental Group Village**	O	X
	Comparison Group Village	O	X

Marrupa	**Experimental Group Village**	O	X
	Comparison Group Village	O	X

V. Conclusion and Recommendations

- ☐ The stable electricity supply resulting from the project led to marked improvements in people's everyday lives. The ensuing change starting at the household level and then expanding to the village as a whole is leading to urbanization and is expected to have positive long-term effects on businesses in the area.
- ☐ To maximize positive outcomes in future projects, it is recommended to prioritize public services in the provision of electricity in order to reach households, schools, and health service providers in a more effective manner.