

Country Name	Le Projet De Promotion De L'Énergie Propre En Utilisant Le Système Solaire Photovoltaïque
Republic of Djibouti	

I. Project Outline

Background	Djibouti depended 100% of energy on import in 2009. Djibouti Government's research into the use of renewable energy began as early as in the 1980s. For solar energy use, it formulated "National Strategy and Action Plans (2008-2012)" with assistance from UNDP, in which it clearly stated the intention to promote the use of solar energy as one of the pillars in the energy policy. The statement also mentioned the necessity of both soft and hard measures, including formulation of development projects, economic measures to nurture related markets, setting up a new agency in charge and institutional provisions. However, to put these measures in place, it would have to rely on technical and financial assistance from various external donors.		
Objectives of the Project	To increase power generation capacity, diversify power sources, and raise awareness of people of Djibouti for utilization of renewable energy by procurement of photovoltaic (PV) system and related equipment in the Project Site as well as technical assistance for capacity building of technical personnel, and thereby contributing to demonstration of Japan's initiatives for promoting collaborative efforts by both developed and developing countries against climate change.		
Contents of the Project	<ol style="list-style-type: none"> 1. Project Site: Centre d'Etudes et de Recherche de Djibouti (CERD) in the suburb of Djibouti ville (original procurement) and Zone de Gabode, Djibouti ville (additional procurement) 2. Japanese side: <ol style="list-style-type: none"> (1) (Original procurement) 300 kW PV generation system (PV modules, watt hour meter, junction box, circuit breaker, collecting box, transformer, cables, data management and monitoring system, display board and others) and PV system spare parts and maintenance tools; (2) (Additional procurement utilizing the remaining fund) 28 sets of Solar Power Street Lighting System for the 580m road section; (3) Technical assistance (soft component): Training on basic knowledge, technical characteristics, preventive inspection, operation and maintenance including the emergency response of grid connected PV system 3. Djibouti side: Clearing and levelling of the site, sending trainees of Ministries and Electricité De Djibouti (EdD) to the Training Programs to be held in CERD, etc. 		
Project Period	E/N Date	December 2, 2009	Completion Date (Original procurement) March 3, 2012 (Completion of Soft Component) (Additional procurement) November 29, 2014 (Handover)
	G/A Date	December 3, 2009	
Project Cost	E/N Grant Limit / G/A Grant Limit: : 610 million yen, Actual Grant Amount: 609 million yen		
Executing Agency	Ministère de l'Énergie et des Ressources Naturelles (MERN) (Presently known as Ministère de l'Énergie chargé des Ressources Naturelles)		
Contracted Agencies	Main Contractor(s): MARUBENI Corporation Main Consultant(s): NEWJEC Inc. / JAPAN TECHNO CO., LTD. (JV) Agent: Japan International Cooperation System		

II. Result of the Evaluation

1 Relevance
<p><Consistency with the Development Policy of Djibouti at the Time of Ex-Ante and Ex-Post Evaluation></p> <p>At the time of ex-ante evaluation, the project was consistent with "National Strategy and Action Plans (2008-2012)," which upheld the use of solar energy as mentioned in "Background" above. At the time of ex-post evaluation, the project is still consistent with development policy because Djibouti aims to become 100% renewable in 2035 under "Vision 2035" and Djibouti developed some PV projects after this project implementation. Also, the country has a law called "loi PIE (Independent Power Producer Law)" from 2015 for the independent power producer.</p> <p><Consistency with the Development Needs of Djibouti at the Time of Ex-Ante and Ex-Post Evaluation ></p> <p>At the time of ex-ante evaluation, there was a need for solar energy development as mentioned in "Background" above. At the time of ex-post evaluation, Djibouti still depends on import energy from the Ethiopian grid although the degree of dependence is lesser than at the time of ex-ante evaluation: according to MERN, about 70% of energy demands are met from Ethiopian grid (generated by hydropower), and the remaining 30% of energy is generated in Djibouti using fossil energy.</p> <p><Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation></p> <p>Energy was one of the three important areas of Japan's assistance for Djibouti confirmed by the economic cooperation mission dispatched from the government of Japan in April 2009.¹ Also, the government of Japan introduced a scheme of "Program Grant Aid for Environment and Climate Change" in 2008 aiming at support for developing countries with lack of implementation capacity and funds for balancing between reduction of CO2 emission and economic growth to effectively promote global efforts against climate change. The project was implemented under this scheme as a mitigation measure through the introduction of clean energy.</p> <p><Evaluation Result></p> <p>In light of the above, the relevance of the project is high.</p>

¹ ODA Country Data Book, 2010.

2 Effectiveness/Impact

<Effectiveness>

The objective of the project has been achieved. Regarding the quantitative effects, the power generation (Indicator 1) and CO2 emission (Indicator 2) targets have been achieved, except the year 2017 as the PV power system has been functioning with the expected capacity. Lower power generation and reduction of CO2 emission for 2017 is due to the breakage of the four air conditioners of the control room. This problem caused consequently the stoppage of the PV power system for more than six months because these type air conditioners did not exist in Djibouti (in six months they were replaced with the new ones purchased in a neighboring country and the power plant resumed operation). The part of generated electricity from the PV system that is not consumed by the buildings of CERD is directly injected into the EdD grid (reverse current occurs) as expected. Sometimes, when the grid faces a shortage, the PV power system is working on the stand-alone mode. The frequency of the stand-alone correspond to the frequency of power shortage and is in a decreasing trend from 202 hours in 2012 to 75 hours in 2016 in accordance with the increasing stability of grid power supply.² Also, we observed that the solar street lighting system (additional procurement) were properly functioning except a few units damaged (see “Current Status of Operation and Maintenance” below). The solar street lights are near a high school and are turned on at 6 PM as the students are leaving the school at night.

Regarding the qualitative effects, CERD confirmed from a recent study on the performance of Djibouti’s solar power generation³ that the PV technicians of CERD trained by the project properly operate and maintain the PV power system and that EdD is capable of handling of reverse current. Also, public awareness activities about the solar power generation by the PV system are conducted - PV power system receives more than ten visits from users, students and investors every year.

<Impact>

The PV power system has become a research and development tool for the Energy Laboratory (LENR) of CERD. It could be an incentive for the future development of grid-connected solar PV plant. The PV facility is currently being analyzed to provide a first estimate of degradation rate for the climate of Djibouti. In parallel, the results of this experimental study are being used to improve the reliability of PV sizing studies for the future power plant. As a contribution to demonstration of Japan’s initiatives for promoting collaborative efforts by both developed and developing countries against climate change, the following case was found. The French Photovoltaic Scientific Institute and LENR use the PV Plant as their main referral research tool for their joint research and the results of this research are presented to international conferences, where the JICA project PV Plant is mentioned. There was no negative impact on the natural environment.

<Evaluation Result>

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

Quantitative Effects

Indicators	Baseline 2007	Target 2015	Actual 2013	Actual 2014	Actual 2015	Actual 2016	Actual 2017
	Baseline Year	3 Years after Completion	1 Year after Completion	2 Years after Completion	3 Years after Completion	4 Years after Completion	5 Years after Completion
Indicator1: Power generation volume at transmission end (MWh/year)	0	460	502	519	492	478	243
Indicator 2: Estimated reduction of CO2 emission (ton/year)	0	330	359	372	352	342	174

Source: Ex-ante Evaluation Report; CERD

Note: Estimated CO2 emission was calculated as follows. Djibouti was 100% dependent on the imported fossil fuel for the primary energy of electricity at the time of ex-ante evaluation. Therefore, it was a diesel generator that should be considered as the alternative to this project. Unit CO2 emission of a diesel generator was calculated as 0.716kgCO2/kWh using "Guideline for Calculation of Greenhouse Gas Emission (March/2007)" published by the Ministry of Environment, Japan. Multiplying this unit to the annual generated energy of the PV system, 460MWh of the reduction of CO2 emission was obtained.

3 Efficiency

While the project cost was as planned, the project period significantly exceeded the plan (ratio against the plan: 100% and 186%, respectively). Out of the actual project period, the period for the original procurement was 127% of the plan for unknown reasons, and the period for the additional procurement was more than 200% of the plan (The plan was made during the project implementation) due to re-design and re-bidding after the first bidding, where the bidding price was higher than the available balance. Therefore, the efficiency of the project is fair.

4 Sustainability

<Institutional Aspect>

The organizational structure for operation and maintenance (O&M) of the project has been established as expected: LENR of CERD is responsible for O&M of the PV power system constructed by the project. LENR consists of one Supervisor, three Electrical technicians, and Four guards/PV array cleaners. The number of staff is sufficient according to CERD based on its experience. Regarding the solar street lighting system, it is part of public street lights under management and maintenance of the City of Djibouti Mayor’s office (MERN was in charge of O&M of the street lights after project completion, but in 2015 a municipal legislation was passed for O&M of projects from donor countries whose facilities are located in public streets to be transferred from the executing agency of the project to the city). No information available on the number of staff allocated for O&M of the street lights.

² Daha Hassan Daher (head of PV Sciences at CERD as well as the PV power plant), thèse de doctorat, “Modélisation et analyse expérimentale d'une centrale solaire en milieu désertique maritime,” INSA Lyon, Nov 2017.

³ Ibid.

<Technical Aspect>

As mentioned in “Effectiveness” above, the technical level of CERD for O&M of the PV power system is sufficient. Four of the six staff trained under this project are working regularly for maintenance and troubleshooting of the PV system. Each technician recruited is trained in the maintenance and operation of the solar PV power system using the manuals provided under this project. In case of replacement of the condensers in 2019 (see below), for which technical know-how of installation is lacking, the installation can be done by the brand maker of the spare part. No information was available on the technical level of the O&M staff for the solar street lighting system.

<Financial Aspect>

The budget for O&M of the PV power system is sourced from CERD, which is financially capable of the O&M. However, since there is no specific recurrent funding or a budget for the PV power system, the LENR makes an ad-hoc budget request to CERD when purchase of spare parts/repair is needed. No information was available on the budget for O&M of the solar street lighting system.

<Current Status of Operation and Maintenance>

At the time of ex-post evaluation, the components of the PV power system are in good condition except for a meteorological observation device.⁴ Several PV panels were broken, but they have been replaced with spare panels. The power conditioner cubicle will need replacement of the condensers and some revision at the end of 2019, as its lifetime is eight years (The condensers are still functioning). CERD technicians conduct regular inspections consisting of Routine inspection (visual inspection of PV arrays, junction box, and the control room) every week and Periodic inspection (electrical inspection) every month. The spare parts, consumables and maintenance tools of the PV system are also properly maintained.

The street lighting system is mostly in good condition except for one street light unit which was damaged from flying debris (crows dropped heavy objects such as animal bones) and one storage box which was damaged by road traffic and then removed. Inspection and maintenance are carried by Djibouti Municipality Mayor’s office.

<Evaluation Result>

Therefore, the sustainability of the project effect is fair.

O&M budget for the PV system installed by the project (unit: DJF)

O&M Cost Items	2015	2016	2017
Personnel (salary*)	2,064,000	2,064,000	2,064,000
Maintenance	0	0	1,700,000**
Repair	0	0	0
Others	356,000***	0	0

Source: CERD

Notes: * Salary for guards & cleaners. ** Replacement of the four defective air conditioners with new ones for the control room of the PV system. *** New instrumentation for wind and module temperature measurement (anemometer, wind vane, thermocouples, data acquisition system)

5 Summary of the Evaluation

The project achieved the objective of increasing power generation capacity with renewable energy with the grid-interconnected PV system (originally planned) and the solar street lighting system (additionally procured). Regarding the sustainability, information on O&M of the street lighting system is not available, while no problem is found in the institutional and technical aspects of the O&M of the PV system. As for the efficiency, the project period significantly exceeded the plan, but the project cost was as planned. Considering all of the above points, this project is evaluated to be satisfactory.

III. Recommendations & Lessons Learned

Recommendations to the Executing Agency:

The Mayor of Djibouti/MERN Director of Energy Dept. are recommended to re-install the storage box and battery that were damaged as soon as possible because the street light is operable only with the installation of new storage box and battery.



Solar panels with the PV plant in the background (white cubic building) located at CERD



Solar street lights located on this segment of the belt road that JICA built in 1997

⁴ The radiation sensor (pyranometer) sometimes has humidity intrusion and needs to be repaired, but no replacement equipment was planned in the project ex-ante. Nevertheless, it affects scientific research data but does not affect power generation.