Internal Ex-Post Evaluation for Grant Aid Project

conducted by Ghana Office: March, 2019

Country Name	The Project for Introduction of Clean Energy by Solar Electricity Generation System
Republic of Ghana	

I. Project Outline

Background	Until the mid-1990s, Ghana obtained its domestic electricity supply and even exported electricity by hydroelectric power generation utilizing abundant water resources from Lake Volta to the neighboring countries of Cote d'Ivoire and Togo. However, since Ghana had become unable to satisfy the growing domestic power demand through domestic hydroelectric power alone, it had recently responded by promoting construction of thermal power plants and electric power interchange with Cote d'Ivoire via an international interconnected grid. Furthermore, climate change had triggered frequent droughts in recent years and the generation capacity of the Akosombo Hydropower Plant, which was a main power source in Ghana, had been declining. In response, the Government of Ghana had adopted diversification of energy sources and promotion of renewable energy as policy targets and was striving to strike a balance between improving the energy supply situation and mitigating environmental loads.			
Objectives of the Project	To increase power generation capacity, diversify power sources, and raise awareness of people of Ghana for utilization of renewable energy by procurement of photovoltaic (PV) generation system and related equipment in the Noguchi Memorial Institute for Medical Research (NMIMR) 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	1. Project Site: Accra (NMIMR) 2. Japanese side (1) 315kWp PV generation system (PV module, PV module frame, Junction box, Collecting box, Power conditioner, Step-up transformer, Display unit, Data management system, Wiring materials, Grounding works materials) and PV generation system replacement parts, maintenance parts and test apparatus. (2) 400 kWp additional PV generation system (The output was added by using the residual amount of the E/N limit amount) (3) Technical assistance (soft component): Training on basic knowledge, technical characteristics, preventive inspection, operation and maintenance (O&M) including emergency response of PV system 3. Ghana side: (1) To secure a disposal site for excavated earth, sewage, waste oil and recovered equipment and materials during the works period (if necessary), (2) To secure the safety and provide guidance and education to local residents and related officials of the University of Ghana and NMIMR during the works period, and others			
Project Period	E/N Date	March 12, 2010	Completion Date	- Original component: April 22, 2013 (Completion of soft component) - Additional procurement: August 13, 2014 (Handover of the equipment)
	G/A Date	March 12, 2010		
Project Cost	E/N Grant Limit / G/A Grant Limit: 610 million yen			Actual Grant Amount: 610 million yen
Executing Agency	The Noguchi Memorial Institute for Medical Research (NMIMR), University of Ghana			
Contracted Agencies	Main Contractor(s): Marubeni Corporation Main Consultant(s): Yachiyo Engineering Co., Ltd Agent: Crown Agents			

II. Result of the Evaluation

1 Relevance

<Consistency with the Development Policy of Ghana at the Time of Ex-Ante and Ex-Post Evaluation>

The project has been consistent with the development Policy of Ghana to raise the share of renewable energy such as "the Strategic National Energy Plan 2006-2020 (SNEP)" "the Coordinated Programme of Economic and Social Development Policies (2017–2024)" and "The Ghana Energy Policy 2017" (Draft)

<Consistency with the Development Needs of Ghana at the Time of Ex-Ante and Ex-Post Evaluation >

The project has been consistent with the development needs of Ghana for the renewable energy. At the time of ex-ante evaluation, Ghana had previously advanced the introduction of small-scale independent PV generation systems not connected to the grid in order to supply electricity in non-electrified areas, however, it had not introduced any large-scale grid-connected PV generation systems. At the time of ex-post evaluation, the Government has tried to increase the installation of grid connected PV, though Ghana has been still dependent on hydro and thermal power generation.

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

The project was also consistent with the Japan's ODA policy at the time o ex-ante evaluation. Under "the Country Assistance Program for Ghana (2006)", support for infrastructure including energy was one of the strategies for the prioritized support area of "Promoting Industrial Development". 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 CO_2 emission and economic growth in order to effectively promote global efforts against climate change.

<Evaluation Result>
In light of the above, the relevance of the project is high.

2 Effectiveness/Impact

<Effectiveness>

The project has mostly achieved its objectives. Quantitative effects such as “power generation volume” (indicator 1) and “reduction of CO_2 emission” (indicator 2) have almost been meeting the targets set at the time of ex-ante evaluation. Power generation volume increased significantly and almost achieving the target with the average ratio against the target of approximately 85%. The target was not met due to a national power rationing. The PV is a grid connected system and it is designed that when the power grid goes off, the PV generation also stops. There have been frequent power outages (national power rationing) over the past years and the target power generation volume did not consider the power outages. It was confirmed during the site visit that operation of the PV generation system in accordance with manual and training material was generally good.

There has been increased public awareness about the PV generation system installed among users and visitors for the project site. Many organizations and individuals including students of the School of Engineering Sciences of the University of Ghana and Japanese visitors visited the PV generation facilities since the installation was done. School of Engineering Sciences, the University of Ghana sent approximately 80 students in the past and there are plans to send 100 more students in 2018. In addition, the Vice Chancellor of the University of Ghana and the Director of the Institute referred to the PV generation systems during symposiums held at the Institute. One of which is the ninetieth (90th) anniversary celebration of arrival of Dr. Hideyo Noguchi to Ghana.

It was expected that the experience of the personnel who acquired knowledge and experience on PV generation equipment under the project was going to contribute to dissemination of the PV generation system in Ghana, as they were to be involved in the planning, installation and maintenance of grid-connected PV generation system equipment. After the project was completed, the Government of Ghana has been facilitating installation of grid-connected PV generation systems including the installation of 200,000 rooftop solar PV generation systems in residential facilities (homes) under the Capital Subsidy Scheme. The primary objective of the program is to provide 200MW peak load relief on the national grid through solar PV generation technology in the medium term. According to the Ministry of Energy, data from the project were analysed as part of preparation towards this program.

<Impact>

This project was expected to contribute to demonstrating Japan's initiative on climate change measures. However, cases led by the Government of Japan have not been confirmed at the time of Ex-Post Evaluation. Similarly, there has not been a dedicated symposium due to budget constraint on the part of Ministry of Energy. That said, this project has been helpful to the government of Ghana on the promotion of renewable energy and climate change mitigation, as described above. The project is highly acknowledged by the Ministry of Energy.

No negative impact on natural environment was observed. No land acquisition and resettlement occurred under this project.

<Evaluation Result>

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

Quantitative Effects

(1) Original 315kWp PV generation system

	Baseline 2010 Baseline Year	Target 2015 3 Years after Completion	Actual 2014 1 Year after Completion	Actual 2015 2 Years after Completion	Actual 2016 3 Years after Completion	Actual 2017 4 Years after Completion
Indicator 1: Power generation volume at transmission end (MWh/year)	0	382	325	282*2	333	365
Indicator 2: Estimated reduction of CO_2 emission (ton/year) *1	0	220	187	162	191	210

Source: NMIMR

*1 Estimated CO_2 emission is calculated as follows

According to statistics from the Ghana Energy Commission, the base unit of CO_2 emissions in power generation in 2007 was 0.575 t CO_2/MWh. As a result of the PV power generation in the Project, it is estimated to reduce CO_2 emissions by 219.8 tons per year.

[Formula] 0.575 t CO_2/MWh x 382,227 kWh/year ÷ 1,000 = 219.8 t CO_2/year

*2 National power rationing was at its peak in 2015.

(2) Additional 400kWp PV generation system

	Baseline	Target*1	Actual 2015 1 Year after Completion	Actual 2016 2 Years after Completion	Actual 2017 3 Years after Completion
Power generation volume at transmission end (MWh/year)	0	n.a.	258*2	376	109*3

Source: NMIMR

*1 No target was set. *2 January and February data not available *3 Data covers January to April. Data management system broke down in April 2017 (generation system itself continued working).

3 Efficiency

Although the project cost was within the plan (ratio against the plan: 100%), the project period significantly exceeded the plan (the ratio against the plan: 295%), as the project installed additional PV generation system. Even taking consideration of the added output (the ratio against the plan: 227%), the project period is deemed slightly exceeded the plan. Therefore, the efficiency of the project is fair.

4 Sustainability

<Institutional Aspect>

The Maintenance Unit of NMIMR has been responsible for the O&M of the PV generation systems installed under the project and has three (3) staff members responsible for the PV generation system. They have collaborated with the cleaning section of NMIMR to conduct O&M activities. The Maintenance Unit reports to the administrator and the Director of the NMIMR. Some technical issues have been discussed with the Dean of School of Engineering Sciences, University of Ghana. Collaboration between the Maintenance Unit and the IT Unit has been weak, as minor problem of the display unit of the 400kWp PV generation system had not been repaired until JICA intervened, which could have been resolved by the IT Unit if these two units would had coordinated well. Also, issues such as insufficiency of personnel were observed. No activity has been constrained due to the insufficiency, but usually staff have been over tasked.

<Technical Aspect>

The technical staff trained by the project have been continuously engaged in O&M. The manuals prepared by the project has been properly used for O&M. However, the configuration of the systems, the original 315kWp and the additional 400kWp, are different, and therefore understanding of the O&M of 400 kWp system is somewhat limited, it has caused additional burden to the Maintenance Unit of NMIMR as the staff members have to understand two different systems. With the O&M training given to staff during the project, the same kind of training and knowledge can be imparted to newly assign technical staff to disseminate the skills.

<Financial Aspect>

NMIMR secured budget for their personnel responsible for O&M as well as budget for infrastructure maintenance. NMIMR is able to incur cost for replacement/repair of the equipment when necessary. The air conditioner installed in the power conditioner room of the 315 kWp system installed by the project broke down. However, two new air conditioners were installed to replace the old one on February 2018 with the budget from NMIMR. Total cost was 8,000 cedis.

Budget of NMIMR

(Unit: cedis)

O&M Cost Items	2015	2016	2017
Personnel*	18,000	18,000	30,000
Maintenance	n.a.	n.a.	n.a.

*Personnel amount is the estimated cost for NMIMR internal personnel.

<Current Status of Operation and Maintenance>

Inspection and regular maintenance activities have been carried out properly. Routine maintenance has been done almost every working day, while periodic maintenance has been done annually by the Maintenance Unit of NMIMR. O&M status of equipment/facilities are generally in good condition and actions have been taken for problems including the above-mentioned air conditioner. Spare parts, consumables and maintenance tools procured by the project are properly maintained and utilized for the facility. So far, there have not been any management and procurement problems. Three power conditioners of the 400kW system were faulty. All the faulty power conditioners had the same problem of cooling fan. The faulty cooling fans have been replaced and the system is working normally. It has taken a time to solve some problems with the data management system of the additional 400kWp system, though it doesn't affect power generation itself. The operating system has been corrupt and needed to be repaired but the corrupt might have been caused by the capability of PC, therefore, it is better to consider if the current system unit ought to be replaced with a more stable system unit to and avoid regular break down.

<Evaluation Result>

Some problems have been observed in the institutional and technical aspects of the implementing agency. Therefore, the sustainability of the project effect is fair.

5 Summary of the Evaluation

The project has mostly achieved its objectives, "To increase power generation capacity, diversify power sources, and raise awareness of people of Ghana". Quantitative effects such as "power generation volume" and "reduction of CO2 emission" have almost been meeting the targets set at the time of ex-ante evaluation. Public awareness has been increased, as many organizations and individuals have visited the PV generation systems. As for the sustainability, some problems have been observed in the institutional and technical aspects, however, no problems have been observed in the financial aspects. As for the efficiency, although the project period exceeded the plan, the project cost was within the plan.

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

III. Recommendations & Lessons Learned

Recommendations to Executing Agency:

- The display unit of the 400kWp PV generation system was faulty since September 2017 and was recently repaired with JICA's intervention. The problem was found to be a minor IT problem. If the IT Unit of NMIMR had been involved, the problem could have been resolved much earlier. Therefore, the Management Unit of NMIMR is recommended to report all IT related issues to IT Unit as soon as they are discovered. In general, collaboration between the Maintenance unit and IT Unit of NMIMR needs to be strengthened to resolve promptly all IT related issues.
- The Maintenance Unit's understanding of the 400kWp system is relying on their understanding of the 315kWp system to operate and maintain the entire facility. Since the configuration of the systems are different, it will be appropriate to check the O&M manual particularly for the 400kWp PV generation system, that was not well organized, for both maintenance and IT units of NMIMR.
- It has taken a time to fix the broken-down Data Management System of the 400kWp system. The operating system is plausibly corrupt (Some boot files are faulty) according to IT technician. With communicate with Japanese contractor and find the cause of the problem, then in the long term, the operating system should therefore be considered to be replaced with a higher capacity system.

Lessened Learned

- When the new system is different from existing system or Phase 1, development of O&M manual and training should be more detailed and focused on the differences of each system.

315kWp Original PV System

400 kWp Additional PV System