

Country Name	Project for Introduction of Clean Energy by Solar Electricity Generation System
Belize	

I. Project Outline

Background	In Belize, more than 50% of power supply heavily depended on import of electric power from Mexico. However, there was an accident in major power-generation facilities in Mexico in 2009, which caused a temporary suspension of power supply to Belize. The Government of Belize was seeking for alternative energy sources such as hydro, biomass, photovoltaic (PV) and wind which do not to depend on import electric power and the fossil fuel.				
Objectives of the Project	To increase power generation capacity, diversify power sources and raise Belizean citizen's awareness for renewable energy, by providing PV system and related equipment and technical assistance at the University of Belize in Belmopan, thereby contributing to publicity of Japan's initiative for promoting measures for climate change by both developed and developing countries.				
Contents of the Project	<ol style="list-style-type: none"> 1. Project Site: University of Belize (UB) 2. Japanese side: <ol style="list-style-type: none"> (1) Procurement and installation of PV system mounting structure, PV system (350kW), outdoor transformer (500kVA), switchgear for grid connection, load distribution board, monitoring B, data management and monitoring system, control house, etc. (2) Technical assistance (soft component for trainings on basic knowledge and maintenance on grid interconnected PV system, development of the educational pamphlets, etc.). 3. Belizean Side: Acquisition of land necessary for PV system, site clearance and leveling, construction of the access road to the site, extension of 11 kV distribution line and installation of the load break switch, etc. 				
Ex-Ante Evaluation	2009	E/N Date	December 14, 2009	Completion Date	August 24, 2012
		G/A Date	December 14, 2009		
Project Cost	E/N Grant Limit: 510 million yen, Actual Grant Amount: 510 million yen				
Executing Agency	Ministry of Works (MOW)				
Contracted Agencies	Nippon Koei Co., Ltd., Marubeni Corporation, (Procurement Agent) Japan International Cooperation System				

II. Result of the Evaluation

< Special perspectives considered in the ex-post evaluation >

- Indicator 1 of the quantitative effects set at the ex-ante evaluation was the "power generation volume at transmission end". However, the data recording equipment was out of order at the time of the ex-post evaluation; the amount of received power was used, which can be slightly smaller than power generation volume at transmission end.
- Indicator 2 of the quantitative effects set at the ex-ante evaluation was "CO₂ emission reduction." However, in Belize, there was no registered unit of CO₂ emission reduction, therefore, the indicator of "estimated CO₂ emission reduction" was used at the ex-post evaluation.
- One of the indicators on qualitative effects had been set as "publicity of Japan's initiative for promoting measures for climate change" at the ex-ante evaluation. However, since this is a change to be brought by the project effects, it was used for verification of the impact.

1 Relevance

<Consistency with the Development Policy of Belize at the time of ex-ante and ex-post evaluation>

There was no effective energy policy at the time of the ex-ante evaluation, but renewable energy projects have been implemented since 1991. At the time of the ex-post evaluation, renewable energies are prioritized in the National Energy Policy Framework (2011-2040) and National Sustainable Energy Strategy and Action Plan (2013-2033). Thus, the project has been consistent with the development policy of Belize.

<Consistency with the Development Needs of Belize at the time of ex-ante and ex-post evaluation>

More than 50% of the power supply depended on the import from Mexico, and the Government of Belize sought for alternative energy sources including PV. The project has met Belizean development needs for energy sources which do not depend on the import electric power and fossil fuel.

<Consistency with Japan's ODA Policy at the time of ex-ante evaluation>

Based on the "New Framework for Japan-CARICOM Cooperation in the 21st Century" developed in Japan-CARICOM Ministerial Meeting (2000), the priority areas were set as "poverty reduction" and "environment and disaster reduction." The project was consistent with Japan's ODA policy at the time of ex-ante evaluation. In addition, the project was implemented under a scheme of "Program Grant Aid for Environment and Climate Change", which the Government of Japan newly introduced in 2008 in order to support developing countries for mitigation of climate change.

<Evaluation Result>

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

2 Effectiveness/Impact

<Effectiveness>

The project has partially achieved its objectives. Through the installed PV system at UB, both power output and CO₂ emission increased more than planned. As the data recording equipment was out of order at the time of the ex-post evaluation, the data of generated power at transmission end were not available. However, it can be judged that the power generation volume increased more than planned, considering that the amount of power received (Indicator 1) by the Belize Electricity Limited (BEL) increased from 255 MWh in 2012 to 628 MWh in 2015. Annual CO₂ emission reduction (Indicator 2) in 2015 is calculated as 262 tons, increasing from 79 tons in 2012 and almost doubling the target figure (142 tons). These achievements were attributed to the abundant amount of solar radiation.

As qualitative effects, it was expected that public awareness on the use of the renewable power would be increased. The technical training on environmental education and awareness raising was provided mainly for the personnel of UB. However, no public relations

(PR) activities have been conducted because UB personnel is not given access to PV system facility by MOW. In the project, another technical training on operation and maintenance (O&M) of PV system and data analysis/management was conducted, and through the training the personnel of the private company (HDC & Sons Professional Services & Solutions) acquired sufficient skills and knowledge to perform inspection and repair of PV power generation system, according to the chief engineer of MOW.

<Impact>

Based on the project experience, Japan's initiative for promoting measures against the climate change has been demonstrated. Among the efforts related to the climate change, Japan's cooperation has been appreciated as being differentiated from other donors as it has good technical training programs, according to the Energy Unit of the Ministry of Public Service. As another impact, as the government conducted an auction for new photovoltaic electricity generation because it realized the significance of renewable energies. One was selected among 11 bidders and the facility construction is being planned. There was no negative impact on the natural environment and no land acquisition and no resettlement caused by the project.

<Evaluation Result>

In light of the above, project effects such as the increase of the power output and CO₂ emission have been observed, but no PR activities have been conducted for the public awareness raising. Japan's initiative for promoting measures against the climate change has been demonstrated. Therefore, the effectiveness/impact of the project is fair.

Quantitative Effects

Indicators	Baseline 2012 Planned year	Target 2015 3 years after completion	Actual 2013 1 year after completion	Actual 2014 2 years after completion	Actual 2015 3 years after completion
1. Power generation volume at transmission end by PV system installed by the project (MWh/year)	255	460	581	622	628
2. Estimated reduction volume of CO ₂ emission through power generation by PV system installed by the project (t/year)	79	142	242	259	262

Source: Ministry of Public Service.

Note: Considering the percentage of power generation and adopting the reduction unit in accordance with "CO₂ Emissions from Fuel Combustion -Highlights", which was published by IEA (unit in Central and South America area in 2007), the annual CO₂ emission reduction is estimated as follows:
Annual CO₂ emission reduction = emission reduction unit x annual power output = Import Power x CO₂ emission reduction unit + Diesel Power x CO₂ emission reduction unit

3 Efficiency

The project cost was as planned, but the project period exceeded the plan (ratio against the plan: 100% and 129%, respectively). This is because it took 2 additional months for the contract modification of the additional procurement of PV module and power conditioner. However, this contributed to the increase of outcomes. In other words, quantitative effects were produced. Therefore, the efficiency of the project is high.

4 Sustainability

<Institutional Aspect>

MOW exchanges the contract with HDC & Sons Professional Services & Solutions for daily O&M and regular check-up and repair. From this company, the necessary number of the personnel has been assigned (1 engineers for management, 1 engineers for regular service and repair and 2 technicians for daily O&M). The five year contract expires in 2017, and the information on the plan after the expiration was not available. The procured equipment had been expected to be delegated to the Ministry of Energy but it has not yet at the time of the ex-post evaluation. Instead, there is possibility of the hand-over of the equipment to the Energy Unit of the Ministry of Public Service, according to this unit which is in charge of coordination with donors including Japan in the energy sector. For PR activities of PV solar system, UB was expected to be responsible. However, as mentioned earlier, it has not conducted any activity and they have no plan. At the ex-post evaluation survey, it was not confirmed who manages the educational pamphlets developed by the project and how many copies are left. It has not decided yet when the hand-over of the procured equipment will be realized, but if after it is, UB will take responsibility in PR activities in collaboration with the Energy Unit, according to the unit.

<Technical Aspect>

The engineers of the contracted company have sufficient skills and knowledge for O&M of the procured equipment including trouble-shooting of PV system, as they were training in the project, according to the Chief Engineer of MOW. On the other hand, MOW does not have a training system to transfer technical skills and knowledge of O&M of PV power generation system. MOW has not utilized the training materials and O&M manuals developed by the project. With regard to PR activities of PV solar system, UB has had no opportunity to exercised skills and knowledge acquired from the project.

<Financial Aspect>

For O&M of PV solar system, MOW has allocated 67,000 BZD¹ each year since the project completion, and there will be no change to be expected in the future revenue and expenditure. This is more than the planned at the preparatory survey and is sufficient, according to the Chief Engineer of MOW. It had been expected that the government would accumulate funds by selling electricity to BEL for procurement of spare parts and emergency accident, but it has not. According to MOW, there is no sale contract with BEL because it is also a government control company.

<Current Status of Operation and Maintenance>

As planned, the contracted O&M company has conducted daily inspection (cleaning of the site and array of PV system, visual checking of operating conditions), bi-monthly inspection and repair upon necessity. The procured equipment has been functioning except the data management system for one year and an air conditioner for six months. The data recording and analysis on PV system operation have not been conducted because of the breakup of the data system, and the amount of generated power has not been monitored. The

¹ 1 BZD = 56.32687 Japanese Yen (August 2017), according to JICA Exchange rate.

O&M company has not been able to fix it as they have no IT technician. It was not confirmed whether it has a plan to hire an IT technician. Several PV panels had been broken but they were renewed. The O&M company can purchase spare parts in most cases at the national market, except a few exceptions such as some part of the broken air conditioner made in Japan, and the air conditioner has been unrepaired. This has not directly affected operation of PV system, but if it is left un-functioning for a long time, the raised temperature in the operation room may cause other equipment broken.

<Evaluation Result>

In light of the above, several problems have been partially observed in terms of the institutional and technical aspects of the executing agency and also in the current status of operation and maintenance. Therefore, the sustainability of the project effect is fair.

5 Summary of the Evaluation

The project objectives have been partially achieved. Though strict data verification was not possible, the power output and CO₂ emission have been increased. Whereas it is presumed that the project has not contributed to the public awareness raising on the use of the renewable power, since no PR activities have been implemented, it can be said that Japan's initiative for promoting measures against the climate change has been demonstrated to a certain degree. Regarding the sustainability, the engineers of the contracted company have sufficient skills and knowledge for O&M of the procured equipment, and they have conducted inspection works as planned. On the other hand, as UB has not been given access to PV solar facility, expected responsibilities have not been exercised, and has not exercised acquired skills and knowledge on PR activities. Among the procured equipment, due to the unrepaired data management system, data recording and analysis have not been conducted. Regarding the efficiency, the balance was used for additional procurement which resulted in the increase of outcomes, but the project period exceeded the plan.

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

III. Recommendations & Lessons Learned

Recommendations to executing agency:

- It is strongly recommended to MOW to take an immediate action to assign IT personnel or contract IT firm to help the currently contracted O&M company to repair the solar generation data recording system, so that the power generation volume at transmission end can be monitored properly.
- It is recommended that the Government of Belize start procedures for the transfer the administrative jurisdiction of PV solar facility from MOW to the Ministry of Public Service or UB. The Ministry of Public Services has more know-how on energy matters and can provide more effective support for O&M company.
- It is recommended to the Government of Belize to give UB access to PV solar facility for conducting PR activities. In connection with this, it is suggested that the Power Purchase Agreement would be concluded between UB and BEL, so that UB would get fund from the sale for conducting PR activities.

Lessons learned for JICA:

- In the project, one of the quantitative indicators was set as a "power generation volume at transmission end by PV system," but the necessary data were not available. The data recording equipment has remained out of order, since the O&M company has no IT technician to repair it. In the project, technical training on data analysis and management was conducted for the management but not working-level personnel. The training dealt with how to interpret recorded data, how to download data, how to compile data, etc., but it did not cover whom to request for repair when the system becomes out of order. In the country which has no experience in operation of PV power system, the specification of the system for data analysis and management should be selected according to the technical level of IT technicians and availability of spare parts in the target country. Also, the technical training should include not only data analysis and management but also repair of the system.



Solar radiation sensor and panel array



Monitor showing zero due to the broken data system