

Country Name	<b>The Project for Introduction of Clean Energy by Solar Electricity Generation System</b>
Republic of the Marshall Islands	

**I. Project Outline**

Background	Diesel fuel drove the majority of power generation in the Marshall Islands. However, heavy dependence on imported fuel made the energy supply setup extremely vulnerable to fuel price fluctuations. Thus, one of the issues facing the sector concerned strengthening of the energy supply setup. Against such a background, the Ministry of Resource Development compiled a plan for the introduction of clean energy utilizing solar power geared to the promotion of photovoltaic and other renewable energies, and it requested the Government of Japan to provide grant aid for its implementation.				
Objectives of the Project	To increase power generation capacity, diversify power sources, and raise awareness of people of the Marshall Islands for renewable energy by providing Photovoltaic (PV) system and related equipment in Majuro and by providing technical assistance for capacity development of technical personnel, and thereby contributing to publicity of Japan's initiative for promoting measures for climate change both by developed and developing countries.				
Contents of the Project	<ol style="list-style-type: none"> <li>1. Project Site: Majuro Hospital, Majuro</li> <li>2. Japanese side: <ol style="list-style-type: none"> <li>(1) 205kW PV generation system (PV modules, PV module installation frame, Junction box, Collecting box, Transformer, Cables, Data management and monitoring system, display board and others) and PV system spare parts and maintenance tools</li> <li>(2) Technical assistance (soft component): Training on basic knowledge, operation and maintenance (O&amp;M), and troubleshooting of grid connected PV system, and making a proposal</li> </ol> </li> <li>3. Marshall Islands side: the final connection works to the grid on the high voltage side</li> </ol>				
Ex-Ante Evaluation	2009	E/N Date	December 16, 2009	Completion Date	September 19, 2012
		G/A Date	December 16, 2009		
Project Cost	E/N Grant Limit/ G/N Grant Limit: 530 million yen, Actual Grant Amount 530 million yen				
Implementing Agency	Marshalls Energy Company (MEC)				
Contracted Agencies	Yachiyo Engineering Co., Ltd, Icons, Inc. Shikoku Electric Power Co., Inc., Marubeni Corporation, Japan International Cooperation System (Procurement Agent)				

**II. Result of the Evaluation**

<b>1 Relevance</b>
<p>&lt;Consistency with the Development Policy of the Marshall Islands at the time of ex-ante and ex-post evaluation&gt;</p> <p>This project has been highly consistent with development policy of the Marshall Islands. At the time of ex-ante evaluation, National Energy Policy was established in 2003 in line with the Vision 2018 (the economic development plan targeting the next 15 years up to 2018) (2003-2018). Under the National Energy Policy, the vision for the energy sector in the next 15 years was defined as the attainment of "Available, affordable, reliable and sustainable energy for social and economic development for all the people of the Marshall Islands." One of the goals was to supply 20% of all energy as renewable energy by 2020. At the time of ex-post evaluation, National Energy Policy and Energy Action Plan was updated in July 2016. The vision was defined as, "an improved quality of life for the people of the Marshall Islands through clean, reliable, affordable, accessible, environmentally appropriate and sustainable energy services." One of the goals is "to provide 20% of power generation through indigenous renewable resources by 2020."</p> <p>&lt;Consistency with the Development Needs of the Marshall Islands at the time of ex-ante and ex-post evaluation&gt;</p> <p>The project has been relevant with development needs of the Marshall Islands for clean energy. At the time of ex-ante evaluation, the Marshall Islands heavily depended on imported diesel fuel energy. At the time of ex-post evaluation, the Marshall Islands is still dependent upon diesel generation. Energy source is slowly shifting to renewable energy as funding permits. On Majuro Atoll, renewable energy accounts for 0.5% and Diesel 99.5% of energy demand. Nationally renewable energy accounts for approximately 7% and diesel 93% of energy demand.</p> <p>&lt;Consistency with Japan's ODA Policy at the time of ex-ante evaluation&gt;</p> <p>The project was also consistent with Japan's ODA policy at the time of ex-ante evaluation as based on the presentation at the 5th Pacific Islands Leaders Meeting (PALM) in 2009, prioritized areas of ODA to the Marshall Islands were clarified. Renewable energy was one of those areas.</p> <p>&lt;Evaluation Result&gt;</p> <p>In light of the above, the relevance of the project is high.</p>
<b>2 Effectiveness/Impact</b>
<p>&lt;Effectiveness&gt;</p> <p>The project has mostly achieved its objectives, "to increase power generation capacity, diversify power sources, and raise awareness of people of the Marshall Islands for renewable energy" as indicators of quantitative effects such as "Net power generation", "CO2 Emission", and "Fossil fuel consumption" have achieved the targets set at the time of ex-ante evaluation. MEC said that the system is excellent so that it rarely has a trouble.</p> <p>It was expected that installing the PV system in the project site (Majuro Hospital) means the use of PV power can be publicly advertised to citizens who use the hospital, as Majuro Hospital is situated in the center of Majuro and is the tertiary medical care institute of the Marshall Islands. However, the demonstration effect has been limited since 2014 because the display function (monitor) of the information display</p>

board in the waiting lounge of the Hospital has not been working (see the “Current Status of Operation and Maintenance” under the “Sustainability” below).

As a result of soft-component, staff’s capacity to operate and maintain the PV system has been enhanced, though further improvement is necessary to tackle some O&M problems including the display board mentioned above. Although the soft-component proposed the decision of the electricity price, it has been suspended due to political reason but overall financial situation of MEC has been improving. A review is underway at the time of ex-post evaluation with anticipated changes in Fiscal Year 2017.

<Impact>

Japan has taken some initiative for promoting measures for climate change, as policy dialogue between the Government of Republic of the Marshall Islands and the Government of Japan on the area is ongoing, while other development partners also have supported enhancing PV generation including new 600kW PV system supported by the United Arab Emirates (UAE) and the International Renewable Energy Agency (IRENA). And technical assistance from Japan, the Project on the Formulation of a Self-Sufficient Energy Supply System (Technical Cooperation for Development Planning 2013-2015), was implemented, which led to PV generation system construction project in Ebeye (Preparation Study stage).

No negative impacts on natural environment were observed and no land acquisition occurred under this project.

<Evaluation Result>

In light of the above, the effect of the project has been observed mostly as planned. Therefore, the effectiveness/impact of the project is high.

### Quantitative Effects

	Before the project (2009)	Target figure at target year (2014)	Actual result at completion (2012)	Actual Figure at target year (2014)	Most recent actual result(2015)
Indicator1: Net power generation (MWh/year)	0	228	170	259	303
Indicator 2: CO2 Emission (tons/year) <sup>(1)</sup>	0	167	109	165	194
Indicator 3: Fossil fuel consumption (litters/year)	0	63,84 <sup>(2)</sup>	41,778 (April-December)	63,650	78,477

Note: (1) CO2 Emission = 2.62 kg-CO<sub>2</sub>/litter x diesel fuel consumption (See \*2 below). (2) 228MWh x 0.28 litters/kWh =63,84 litters. Fossil fuel consumption (0.28 litters/kWh) is calculated based on the specification of the existing 6.4 MW diesel power plant. Source : JICA internal documents, questionnaire and interviews with MEC.

### 3 Efficiency

The project cost was as planned (ratio against the plan: 100%). Regarding the project period, reasons of the extension are that it took more than five months from the agency agreement to consultant agreement, and the detailed design bidding work exceeded from four months planned to seven months (ratio against the plan: 118%). Therefore, the efficiency of the project is fair.

### 4 Sustainability

<Institutional Aspect>

O&M of the PV system procured and installed under the project is carried out by MEC. There is no particular change in organizational structure of MEC and the organization structure is appropriate to carry out O&M of the PV system in Majuro. There is no problem in the number of staff for implementing routine maintenance of PV system as it has increased from the number at the ex-ante evaluation which was deemed appropriately. However, MEC may need a few more staff because the 600kW PV system has been newly installed near airport.

<Technical Aspect>

The staff members at MEC have basic skills to operate and maintain the PV system. However, there are some technical limitations as failure of display monitor in the information display board and delay in taking countermeasure for rust of junction boxes were observed.

<Financial Aspect>

Though the equipment procured under the project is basically maintenance-free, it is necessary to replace some spare parts in case of mechanical failure. Maintenance costs have been relatively low in these early years. MEC needs to forecast future years’ expense such as instruments. Financial status of MEC as a whole has improved as MEC has generated surplus for past three years. Electricity price is still not a full recovery tariff but it is close, and the tariff structure is under review and is expected to be approved for full cost recovery in Fiscal Year 2017.

<Current Status of Operation and Maintenance>

The generation system itself has functioned well, however some problems were observed. Physically, part of PV module frame became rusty, however, MEC touched it up by rust-proof paint. Most of junction boxes are found to be corroded, for which MEC conducted tip and paint work in September 2016. MEC may need to replace boxes, otherwise, water seeped in could cause trouble in the near future. As to data management and monitoring system, data was not recorded from August 2015 to August 2016. However, the system was recovered in September 2016 and the data log was recovered by obtaining the program from the supplier and reinstalling it. MEC could not have contact with the supplier for a while after the change of the person in charge of the project, mistakenly update from Windows7 to Windows10 could be a cause of trouble apart from restructure of intranet in the Majuro Hospital. Although information display board itself does not fail, “display (monitor)” function has not been working since 2014. MEC staff tried to sort out, but unsuccessful. Upgrading to Windows 10 might solve the problem, however, the system is not upgraded as it requires license fee.

MEC conducts inspection weekly following the inspection worksheet in O&M manual. Most consumables are available locally, and no spare parts have been required to date.

<Evaluation Result>

In light of the above, some problems have been observed in terms of the technical and current status of operation and maintenance 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 the Marshall Islands for renewable energy” as indicators of quantitative effects such as “Net power generation”, “CO2 Emission”, and “Fossil fuel consumption” have achieved the targets have achieved the targets set at the time of ex-ante evaluation. For sustainability, some problems have been observed in terms of the technical and current status of operation and maintenance aspects of the implementing agency. As for efficiency, 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 implementing agency:

- The number of staff for maintenance should be reinforced since new PV system installed (600kW by UAE and IRENA around water reservoirs near airport) and other donor are planning to bring more renewable energy source to the Republic of Marshall Islands.
- Replacement of rusty junction boxes are strongly recommended before seeped water may cause trouble to the system.
- The monitoring system to be fixed and utilized fully.

Lessons learned for JICA:

Selection of material in the environment with extremely high salinity: Considering status of PV panel frame, selection of material resilient to the salinity seemed to be considered but some parts were not paid much attention and missed out from standardized specification considering extremely high salinity environment. Most of system is working properly but rust developed on the junction boxes. The project’s choice of frame of PV panel looks fine but other material resilient to salinity could have been selected for junction box material.



PV modules



A junction box