

Country Name	The Project for Introduction of Clean Energy by Solar Home System			
Kingdom of Tonga				
I. Project Outline				
Background	Tonga had promoted the installation of solar home system (SHS) under support from Australia and the EU, etc. on remote islands since the 1990s. However, most of the 169 remote islands including those in Vava'u and Tongatapu islands had remained unelectrified or with deteriorated and unusable SHS that had been installed in the 1990s. In tandem with support for a sustainable energy supply setup on remote islands, there was also a need to utilize the know-how accumulated in these projects with a view to developing a mechanism for realizing clean energy utilization appropriate for supporting measures to address climate change.			
Objectives of the Project	To improve the electrification rate, diversify power sources, and raise awareness of people of Tonga for utilization of renewable energy by procurement of photovoltaic (PV) system and related equipment in part of the Tongatapu and Vava'u islands 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: Three islands in Tongatapu Group and 12 islands in Vava'u Group¹ 2. Japanese side <ol style="list-style-type: none"> (1) 552 sets of SHS (PV module, panel mounting structure, charge controller, storage battery, box for battery and controller, terminal box, lighting fixture (indoor), lighting fixture (outdoor), DC/DC converter, wiring/interconnects) installed at households or institutional buildings; PV system spare parts and maintenance tools. *The number of SHS was increased from the originally planned 512. (2) Technical assistance (soft component): Training on basic knowledge, technical characteristics, preventive inspection, operation and maintenance of SHS-type PV system. 3. Tonga side: <p>Securing of the equipment installation site, ground leveling and removal of obstructions on the site, fences and gates, parking area works, road works, etc.</p> 			
Project Period	E/N Date	March 12, 2010	Completion Date	October 2013 (Completion of Soft Component)
	G/A Date	March 22, 2010		
Project Cost	E/N Grant Limit / G/A Grant Limit : 590 million yen, Actual Grant Amount: 590 million yen			
Executing Agency	Ministry of Metrology, Energy, Information, Disaster, Environment and Climate Change (MEIDECC) (Ministry of Lands, Environment, Climate Change and Natural Resources in October 2012-May 2014; Ministry of Land Survey and Natural Resources (MLSNR) before October 2012)			
Contracted Agencies	Main Contractor(s): ITOCHU Corporation Main Consultant(s): YACHIYO Engineering Co. Ltd. / ICONS International Cooperation Inc. / SHIKOKU Electric Power, Co., Inc. (JV) Agent: Japan International Cooperation System			

II. Result of the Evaluation

< Special Perspectives Considered in the Ex-Post Evaluation >

According to the Ex-ante Evaluation Sheet, the target year for the indicators is set at "2013 (3 years after project completion)." However, this seems to be a mistake considering that this project was planned to complete in around March 2012. Since "3 years after project completion" seems to be correct according to similar Grant Aid projects in other countries, this evaluation interprets that the Ex-ante Evaluation Sheet meant to set the target year of 2015. In addition, since the actual project completion date was 2013, the target values are accordingly compared to the actual values of 2016.

1 Relevance
<p><Consistency with the Development Policy of Tonga at the Time of Ex-Ante and Ex-Post Evaluation></p> <p>At the time of ex-ante evaluation, the Government of Tonga was aiming to develop renewable energy as stipulated in Renewable Energy Act (enacted in 2008 as the first such legislation in the Pacific region) under support from the Pacific Islands Energy Policy and Strategic Action Plan (PIEPSAP) and the Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP), etc. At the time of ex-post evaluation, the plans/policies such as Tonga Strategic Development Framework 2015-2025, Tonga Energy Roadmap 2010-2020, Nationally Determined Contribution 2015-2030, and MEIDECC Corporate Plan 2018-2019 aim to derive 50% of electricity generation from renewable sources by 2020 and 70% by 2030.</p> <p><Consistency with the Development Needs of Tonga at the Time of Ex-Ante and Ex-Post Evaluation ></p> <p>At the time of ex-ante evaluation, there was a need for sustainable energy supply setup on remote islands as mentioned in "Background" above. At the time of ex-post evaluation, obviously Tonga is still pursuing its renewable energy agenda. According to MEIDECC, Tonga at this stage is generating renewable electricity averaging to 10% of national electricity supply, and shift from the traditional reliance on fossil fuels to climate-resilient renewable energy systems coupled with battery energy storage system and reduced greenhouse gas emissions is ongoing with development partners.</p> <p><Consistency with Japan's ODA Policy at the Time of Ex-Ante Evaluation></p> <p>Based on the Islanders' Hokkaido Declaration made at the fifth Pacific Islands' Leaders Meeting (PALM 5) in May 2009 for Pacific</p>

¹ Tongatapu Group: Tongatapu (office of the executing agency), Atatta, and Eueiki; Vava'u Group: Neiafu (office of the executing agency), Hunga, Ovaka, Lape, Nuapapu, Matamaka, Otea, Falevai, Kapa, Taunga, Olo'ua, and Ofu.

Islands Forum members, the Japanese government set out the cooperation policy for Tonga mainly in the following areas: (a) education, (b) sustainable economic development, (c) health, (d) measures against climate change, and (e) disaster prevention.² Also, the Japanese government 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.

<Evaluation Result>

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

2 Effectiveness/Impact

<Effectiveness>

The objective of the project has been achieved. All quantitative indicators, i.e., power generation volume and hypothetical saving of CO2 emission, fossil fuel consumption and electricity cost (that could not have been saved if the target area had been electrified with fossil fuel generation)³ as well as household electrification rate of the target area, achieved the target. At the time of ex-post evaluation, MEIDECC confirmed through its annual monitoring that all the 552 sets of SHS are still in use. Regarding qualitative effects, the soft component of this project enhanced the technical sustainability of the project effects (see below). Also, public awareness about solar power generation has been raised. For example, Department of Energy (DoE) of MEIDECC (formerly known as Energy Planning Unit of MLSNR) showcases its SHS electrification schemes in the outer islands, including the ones installed under this project, at Annual Agricultural and Industrial show, Environment Week and other public exhibitions.

<Impact>

Contribution to demonstration of Japan’s initiatives for promoting collaborative efforts by both developed and developing countries against climate change was observed as expected. SHS in Vava’u and Tongatapu provided by this micro-grid project as well as Japan’s Pacific Environment Community (PEC) Fund Project in Ha’apai are cases in point of demonstration of Japan’s initiative.

There was not negative impact on the natural environment. Proper disposal of batteries has now been planned and is expected to be executed when most of batteries are failed around 2025 year.

Huge positive impacts on women and persons with disabilities have been witnessed from the field visits as the number of mats (handicraft) being woven were increased compared with the years prior to the commissioning of the systems. Hours for handicraft making have in fact extended to night time as electricity supply is now on 24 hours/7 days. Women tend to be more productive in terms of income generation activities. On the other hand, some negative impacts have realized in families as men, as head of the family, spend more hours in drinking kava (traditional drink) and other social activities in night time as better quality lights are available in the village.

<Evaluation Result>

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

Quantitative Effects

Indicators	Baseline 2010 Baseline Year	Target 2015 3 Years after Completion	Actual 2014 1 Year after Completion	Actual 2015 2 Years after Completion	Actual 2016 Target year 3 Years after Completion	Actual 2017 4 Years after Completion
Indicator 1: Power generation volume at transmission end (MWh/year)	-	108.3	109	109	109	109
Indicator 2: Estimated reduction of CO2 emission (ton/year)	-	117.3	118.156	118.156	118.156	118.156
Indicator 3: Estimated reduction of fossil fuel consumption (ton/year)	-	37.9	43.6	43.6	43.6	43.6
Indicator 4: Estimated reduction of electricity cost (thousand yen/year)	-	4,100	4,709	4,709	4,709	4,709
Indicator 5: Household electrification rate of the target area	-	100	100	100	100	100

Source : Annual Monitoring Survey (2018), conducted by Department of Energy under MEIDECC

3 Efficiency

While the project cost was as planned, the project period significantly exceeded the plan (ratio against the plan: 100% and 191%, respectively). The delay was caused by bidding failures. The Outputs of the project were slightly increased from the plan (the number of SHS was increased from 512 to 552 using the balance of the funds). 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: Tongatapu Outer Islands Solar Electricity Incorporated (TOISEI), chaired by CEO of MEIDECC, and Vava’u Outer Islands Solar Electricity Incorporated (VOISEI),⁴ chaired by the Governor of Vava’u, are responsible for O&M of SHS (including fee collection) in Tongatapu Group and Vava’u Group, respectively, under the supervision and management by DoE. Users of SHS are responsible for replacing faulty components inside the houses (switches, light holder and bulbs, wires) and paying monthly fees. According to MEIDECC, the number of staff of each

² Ministry of Foreign Affairs, ODA Country Data Book 2009.

³ As the target area had not been electrified even with household-size diesel generators before this project, the mentioned ‘saving’ does not really mean actual cost saved by the beneficiaries.

⁴ TOISEI and VOISEI were formerly known as Tongatapu Outer Islands Solar Electricity Society (TOISES) and Vava’u Outer Islands Solar Electricity Society (VOISES), respectively.

organization (7 at DoE, 4 at TOISEI and 22 at VOISEI) is sufficient for the O&M activities.

<Technical Aspect>

There were two technicians from each island, trained by the project. They currently do O&M of the SHS and assist users on their respective island. Regular trainings for local technicians have been conducted each year by DoE and hands-on training provided during DoE's annual monitoring trip. Annual Meeting of TOISEI and VOISEI, respectively, is usually hosted together with a training. Such efforts mitigate impacts of migration of technicians and engagement on other attractive wages jobs, which has been an issue. The manuals prepared by the project are kept in the main office of Neiafu and used for O&M training of new replacement of local technicians. The technical level of the O&M staff is considered sufficient based on these training practice and the good conditions of all SHS.

<Financial Aspect>

The budget mentioned in the tables below sufficiently cover O&M of SHS. Besides, DoE's annual monitoring trip to each island, for which inter-island transportation cost is high, is funded by the Government every year.

O&M budget for the SHS (unit: Tongan Pa'anga)

	Tongatapu Group				Vava'u Group			
	2014	2015	2016	2017	2014	2015	2016	2017
Income								
Initial installation cost collected from users	11,300	0	0	0	89,400	0	0	0
Monthly payment from users	5,130 (6 months)	10,440	10,440	10,440	100,370	60,751	52,574	41,568
Expenditure								
Personnel	3,051	3,051	3,051	3,051	22,978.8	22,978.8	22,978.8	22,978.8
Parts	0	0	0	0	0	0	0	0
Others	1,200	2,400	2,400	2,400	7,675.2	7,675.2	7,675.2	7,675.2
Balance	12,179	4,989	4,989	4,989	159,116	30,097	21,920	10,914

Source: DoE

<Current Status of Operation and Maintenance>

All the technical components of SHS are still in good conditions after five years from the commissioned date, while some houses were abandoned as dwellers migrated (Town Officers are yet to decide the second owner of the SHS). Two system operators (above-mentioned local technicians) employed by TOISEI or VOISEI in each island conduct regular maintenance, and DoE monitors all SHS every year. All the spare tools and spare parts at the DoE's equipment storage in Nuku'alofa (Tongatapu) and Neiafu (Vava'u) are properly stored and used. However, tools distributed to the islands were not properly managed as some tools were gone missing. System operators in every island reported all failure components to MEIDECC office and must be replaced with the spare parts stored at TOISEI or VOISEI. Recent renewable energy project of DoE on the same villages (as those targeted by this JICA project) also provided additional tools to the island technicians. A new storage container box was also procured for all DoE equipment storage in Tongatapu and Vava'u.

Although they are not the issues of this project itself, there are some issues reported from the islands visited: increasing loads to 6-7 (1.5 watts) bulbs (the system was designed for 5 bulbs of 1.1 watts or higher), community consultation concerning with the slacking payments, and some cases including invertors connected to the systems, which show people's increasing demand for more electricity.

<Evaluation Result>

Therefore, the sustainability of the project effect is fair.

5 Summary of the Evaluation

The project achieved the objective of increasing power generation capacity with renewable energy by installing 552 SHS in unelectrified villages in 12 islands. A problem was found in the technical aspect of the sustainability, i.e., drain of skills due to the migration of technicians, while no problem was found in the institutional and financial aspects of the O&M of the SHS. As for the 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 the Executing Agency:

Since there are no major problems found, no need to improve except below:

- 1) Keep securing the cost of transportation i.e. hiring the boat is very expensive.
- 2) Increase the capacity/power of electricity. People want to use more electricity like city dwellers.
- 3) Decide the second owners of the houses that were abandoned due to migration (but the SHS are still well functioning).



SHS next house 1



SHS next house 2



SHS box clean and well kept