Republic of Palau

FY2017 Ex-Post Evaluation of Japanese Grant Aid Project

"The Project for Enhancing Power Generation Capacity in the Urban Area in the Republic of Palau"

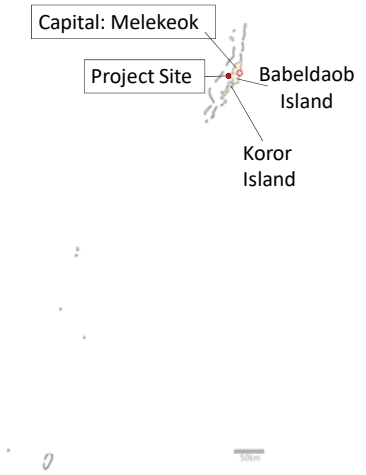
External Evaluator: Keisuke Nishikawa, Japan Economic Research Institute Inc.

0. Summary

In this project, diesel-operated generation facilities and equipment were developed to alleviate power shortages in the urban areas of Palau. The relevance of this project is high as it was both consistent with the development plan and development needs of Palau at the time of both planning and ex-post evaluation and was also consistent with Japan's ODA policy at the time of planning. As for implementation of the project, the project outputs were largely as planned, and the project costs and periods were within the plan. Therefore, the efficiency is high. With regard to project effects, reserve power supply capacities were sufficiently secured, and the occurrences of power supply restrictions caused by power generation equipment were eliminated, leading to stable power supply in the urban areas of Palau. It was also heard that the reduction of business costs and the expansion of businesses were realized because of stable power supply, confirming that economic activities, including tourism, had been underpinned. Furthermore, there were no issues in terms of negative impacts on the natural environment as well as resettlement and land acquisition. As a whole, the effectiveness and impact of this project are high. Regarding operation and maintenance, there were no major problems in terms of all institutional, technical, financial aspects as well as the operation and maintenance status. Therefore, sustainability is judged to be high.

In light of the above, this project is evaluated to be highly satisfactory.

1. Project Description



Project Location

Generator Installed in this Project

1.1 Background

The power demand in Palau recorded an average annual growth rate of 7.3% in the nine-year period from 1997 to 2005 because of the development of tourism as the main industry, population growth of 2% a year, increased power consumption per capita, and so forth. Also, it was estimated in the 'Strategic Action Plan for the Energy Sector', established in October 2009, that power demand would increase at around 5% per annum till 2019. However, while electric power was being supplied by Aimeliik and Malakal Power Plants as the power supply system for Palau's urban areas (Babeldaob Island, where the capital of Melekeok is located, and Koror Island, which is the economic center), power generators could not be stopped because of the shortage of reserve supply capacities, and a stable power supply was difficult because of deterioration and insufficient maintenance of the equipment.

The supply capacity of generation facilities in Palau was 14.4MW at that time and the peak power demand was already in a tight condition at 12.5MW. However, a fire occurred at Aimeliik Power Plant in November 2011, reducing the outputs to 6.6MW temporarily. Because of this fire, the president issued a state of emergency, and planned outages were implemented by alternating blackout areas every four hours in Koror and Babeldaob islands. Subsequently, the planned outages and the state of emergency were lifted by resuming operation of the power generators that had not been in use at the time of the fire and by operating the urgently-procured 2MW diesel generator. However, even by adding another 0.5MW/generator x 4 generators procured by the Japanese government as an emergency grant after the fire, stabilization of the power supply remained an immediate challenge as the existing equipment had deteriorated and a shortage of reserve supply for maintenance had not been eliminated.

1.2 Project Outline

The objective of the project was to alleviate power supply shortages in the urban areas of Palau by providing diesel power generators at Aimeliik Power Plant in Babeldaob Island thereby contributing to economic development, industrial promotion, and improvements of the lives of residents.

Grant Limit/ Actual Grant Amount	1,729 million yen / 1,578 million yen
Exchange of Notes Date / Grant Agreement Date	June, 2012 / June, 2012
Executing Agency	Palau Public Utilities Corporation: PPUC
Project Completion	May, 2014
Main Contractors	(Construction) Toshiba Plant Systems & Services Corporation

	(Equipment) Marubeni Corporation
Main Consultant	Yachiyo Engineering Co., Ltd.
Basic Design	October, 2011 ~ April 2012
Related Projects	[Grant Aid] Babelthuap Electrical Transmission and Distribution Lines Project in the Republic of Palau (1985) The Project for Improvement and Development of Power System (1993) The Project for Upgrading of Electric Power Supply (1996) The Project for Introduction of Clean Energy by Solar Electricity Generation System (2009) Emergency Grant Aid for Power Crisis (2011) [Technical Cooperation for Development Planning] The Project for Study on Upgrading and Maintenance Improvement of National Power Grid (2017-2018) [Other International and Aid Organizations] EU: Installation of Solar Power Generating Equipment with Grid Connection for the Capitol of Palau (2008) Taiwan: Installation of Solar Power Generating Equipment with Grid Connection for Belau National Hospital (2008), Installation of Solar Power Generating Equipment with Grid Connection for Ministry of Education (2010)

2. Outline of the Evaluation Study

2.1 External Evaluator

Keisuke Nishikawa, Japan Economic Research Institute Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: October, 2017 – December, 2018

Duration of the Field Study: February 12, 2018 – February 24, 2018, and April 27, 2018 – May 4, 2018

3. Results of the Evaluation (Overall Rating: A[1])

3.1 Relevance (Rating: ③[2])

3.1.1 Consistency with the Development Plan of Palau

In Palau, which became independent in 1994, a long-term national development plan called *Palau 2020 National Master Development Plan* (hereinafter referred to as 'PNMDP') was formulated in 1996 and economic development measures were promoted. Successively, the *Medium-term Development Plan* (2009-2014) was formulated, which had a focus on profits for Palau Public Utilities Corporation (hereinafter referred to as 'PPUC') as well as on the capacities of its power generation, transmission and distribution to be sufficiently secured. Also, the *Strategic Action Plan for the Energy Sector*, formulated in 2009, had a target of abandoning PPUC's dilapidated base-load generators and to newly install 5MW/generator x 4 generators. Furthermore, in the *Palau National Energy Policy* (hereinafter referred to as 'PNEP') formulated in 2010, it was indicated that the introduction of renewable energy would be promoted. However, power generation based on fossil fuel remained positioned as the base source.

The above gives the details of national development plans and sector plans at the time of project planning. With regard to the national development plans, the PNMDP remained in effect at the time of ex-post evaluation, setting out (1) 'economic growth leading to income increases through sustainable methods' and (2) 'equal spreading of the benefits of economic growth to each field of the private sector' as its vision to improve the quality of life of Palauan people toward the future. As a sector-level plan, the PNEP has remained in effect, even at the time of ex-post evaluation. In August 2017, a policy goal was set where the power generation ratio through renewable energy sources would be raised to 45% by 2025. At the time of ex-post evaluation, a policy called the *Palau Energy Roadmap* was being drafted with assistance from the International Renewable Energy Agency.

Based on the above, the long-term national development plan has remained unchanged, with the version drafted at the time of planning being in effect also at the time of ex-post evaluation. At the sector level, while the introduction of renewable energy was promoted, fossil fuel-based power generation was positioned as the base-load source, showing the validity of the plan at the time of both planning and ex-post evaluation. Therefore, this project was consistent with the national plan and the energy sector plan of Palau at the time of both planning and ex-post evaluation.

[1] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[2] ③: High, ②: Fair, ①: Low

3.1.2 Consistency with the Development Needs of Palau

At the time of project planning, it was projected that the electricity demand would increase at a rate of approximately 5% a year from 2009 to 2019, but it had become difficult to supply electricity stably as the electricity supply capacity had been reduced because of dilapidation and a lack of maintenance of equipment. Palau also suffered a substantial reduction of power outputs temporarily due to the fire at Aimeliik Power Plant that occurred in November, 2011. While generators with a combined 2.0MW capacity (0.5MW/unit x 4 units) were provided through Japan's Emergency Grant Aid immediately after the fire, the supply capacity of the power plant remained at one-fourth operating capacity of the pre-fire period, making the stabilization of the power supply an urgent issue.

By implementing this project, Aimeliik Power Plant generates the amount of electricity in recent years as shown in Table 1. Aimeliik Power Plant only houses and operates two diesel generators, which were procured in this project, and has been an important facility catering for 44% - 51% of the power for the urban areas of Palau since this project was completed.

Table 1: Power Generated for the Urban Area of Palau and at Aimeliik Power Plant

FY	2014/15	2015/16	2016/17
Power generated for the urban area of Palau (MWh)	82,909	85,508	85,829
Power generated at Aimeliik Power Plant (MWh)	42,573	37,749	41,546
Proportion of power generated at Aimeliik Power Plant of the entire amount (%)	51%	44%	48%

Source: Data provided by the executing agency

Note: The Financial Year (FY) is from October to September of the following year

Also, according to the executing agency, it is set out as a policy to raise the share of renewable energy; nevertheless, diesel generation will play a vital role as a base load power source (the proportion of diesel generation in 2017 was 98.67%). While this project secured the generating capacity without supply restrictions caused by generation-related troubles, it is a crucial challenge to develop transmission and distribution networks to stably supply it to various locations.

Therefore, this project can be said to be in line with Palau's development needs in terms of securing the sufficient amount of electricity needed for economic and social activities at the time of both planning and ex-post evaluation.

3.1.3 Consistency with Japan's ODA Policy

Japan's Rolling Plan for Palau placed 'Vitalization of Island Economy' as a focused development challenge at the time of planning of this project, which was positioned in the

'Program for economic and social infrastructure development and maintenance capacity development'. Also, in the Annex 2 *Action Plan* of the *Islanders' Hokkaido Declaration*, adopted at the 5th Pacific Islands Leaders Meeting[3] in 2009, Japan adopted a stance that was to extend support for an increase in the energy supply in each of the Pacific island countries.

Therefore, this project can be said to have been consistent with Japan's ODA directions for the Pacific and Palau on power infrastructure development at the time of planning.

It was confirmed that this project was consistent with the development and sector plans as well as the development needs of Palau at the time of both planning and ex-post evaluation and with Japan's ODA policy at the time of planning.

Therefore, the relevance of this project is high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

In this project, it was planned at Aimeliik Power Plant, one of the two power plants supplying electricity to Palau's urban areas, to develop two diesel generators and related equipment and construct buildings to house the generating equipment.

Details of the planned outputs are shown in Table 2.

Table 2: Planned Outputs of This Project

Japan Side	Procurement and Installation of Equipment	・ Diesel engine generator (5MW/unit x 2 units) ・ A set of mechanical equipment for generating equipment (fuel supply system, lube oil system, cooling water system, etc.) ・ A set of electrical equipment for generating equipment (control panel, transformer, power board, etc.) ・ 13.8kV high-voltage switchboard ・ A set of maintenance tools, replacement parts, and emergency spare items for power generation
	Construction of Facilities	・ Power house (approximately 1,190m^2) ・ Switchboard house (approximately 90m^2)

[3] A summit-level meeting held every three years since 1997 to establish closer cooperative relationships and to enhance ties between Japan and Pacific island nations through exchanging opinions at the leadership level regarding various issues that both the Pacific island countries and the region have been facing

Palau Side	・ Securing of land for the project and clearing of existing buildings and facilities within the project site ・ Installation of permanent fences and a gate ・ Construction of an access road to the project site ・ Water supply works (leading and connecting works) ・ Drainage works (outside the project site) ・ Securing of land (temporarily used for materials and equipment, and car parking) ・ Provision of disposal site for surplus soil and discharged water from construction works ・ Final connection to the existing equipment (such as the power system)

Source: Preparatory survey report of this project

These components to be borne by both Japan and Palau were implemented mostly as planned. According to the document provided by JICA, there were only three minor changes; it was confirmed that they were not the changes that had negative influences on generating the effects of this project. They included:

- Changing specifications of the floor in the engine room
- Changing specifications of cable installation between the switchboard house and the existing substation
- Changing the pipe connecting with existing fuel tanks.

Panoramic View of the Power House

Control Panel

3.2.2 Project Inputs

3.2.2.1 Project Cost

This project was planned at a total cost of 1,775 million yen composed of Japan's project cost of 1,729 million yen and Palau's project cost of 46 million yen.

The actual project cost borne by Japan was 1,578 million yen, as shown in Table 3, while the amount of input by Palau was unknown.

Table 3: Breakdown of Actual Project Cost by Japan

(Unit: million yen)

Breakdown		Project Cost
Construction		324.5
	Direct construction	282.9
	Other construction	41.6
Equipment		1,171.5
Design and supervision		82.5
Total		1,578.5

Source: Information provided by JICA

As the cost borne by Palau could not be captured, only those by Japan were compared. The actual cost was 91% of the plan, showing that it was within the plan.

3.2.2.2 Project Period

The planned implementation period[4] of this project was 25 months, including the detailed design period. The actual project period was 23 months from July 2012 till May 2014. All the construction and equipment procurement were completed within the planned period, showing that the actual period was within the plan (92% of the plan).

The outputs of this project were implemented largely as planned and minor changes were made based on the necessity for more efficient operation of the power plant. The project costs and periods were also within the plan. Therefore, the efficiency is high.

3.3 Effectiveness and Impacts[5] (Rating: ③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operational Effects)

At the time of planning of this project, the reserve supply capacity and the days of restricted power supply were set as an operation indicator and effect indicator respectively. In addition to these indicators, the number of outages and the hours of outages in Palau's urban areas were captured in the ex-post evaluation.

[4] As the ex-ante project evaluation summary did not have a specific commencement date for the planned period, the work schedule indicated in the preparatory survey report was adopted. In the work schedule, the Exchange of Notes date and the Grant Agreement date were not included as the planned period of this project. The commencement of the project period was considered to have started from the detailed design phase (contract signing date for consultants). Therefore, the start of the detailed design phase was regarded as the commencement of the project in this ex-post evaluation study for the planned and the actual periods.

[5] Sub-rating for Effectiveness is to be put with consideration of Impact.

Table 4: Operation and Effect Indicators of This Project

	Baseline	Target	Actual			
	2011	2017	2014	2015	2016	2017
		3 Years After Completion	Completion Year	1 Year After Completion	2 Years After Completion	3 Years After Completion
Reserve Supply Capacity [Note 1] (MW)	0	10.49	18.0	18.0	18.0	17.5
Days of Restricted Power Supply (day/year)	15 [Note 2]	0	0	0	0	0
Number of Outages	-	-	33	50	40	60
Total Hours of Outages (hour)	-	-	22	40	7	25

Source: Data provided by JICA and the executing agency

Note 1: Reserve Supply Capacity = Equipment Capacity – Maximum Output

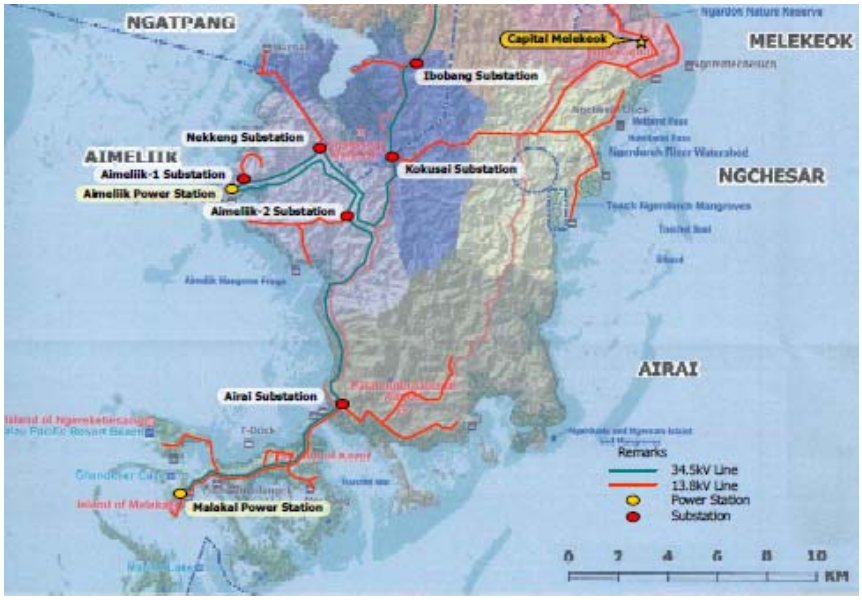
Note 2: Estimate for 2011. The figure is a sum of the days when supplies were restricted because of troubles with generation equipment

While the generating capacity of Aimeliik Power Plant, where this project was implemented, became zero after the occurrence of the fire in 2011, it has become 10MW (5MW/unit x 2 units) after project implementation. The maximum output of Malakal Power Plant, the other power plant, was 20MW at the time of ex-post evaluation, making the combined maximum total output of the power plants supplying power to Palau's urban areas 30MW. As the actual maximum power consumption (peak demand) was approximately 12.5MW, the reserve supply capacity at the time of ex-post evaluation was 17.5MW. The target can be said to have been achieved as it has far exceeded the target of 10.49MW. As for the days of restricted power supply, the target was achieved as no supply restrictions due to a shortage of generating capacity have occurred since this project was implemented.

In contrast, the number of outages occurred 60 times a year (an average of 5 times per month) comprising a total of 25 hours (an average of 25 minutes per outage) in 2017. However, all causes of these outages were due to the vulnerability of transmission and distribution networks to strong winds, contact of trees with power lines, and collision of cars with power poles, causing troubles to transmission and distribution lines. It was confirmed that the outages were not due to any factors caused by insufficient power generation related to this project[6].

In light of the above, quantitative targets are judged to have been achieved as a whole.

[6] JICA has been executing Technical Cooperation for Development Planning: 'The Project for Study on Upgrading and Maintenance Improvement of National Power Grid' in 2017-2018 in Palau, in which a development plan on the renewal of transmission and distribution systems has been formulated and techniques on the operation and maintenance of transmission and distribution lines have been transferred.



Source: Extracted from the Preparatory Survey Report

Figure 1: Transmission and Distribution System in Koror Island and Babeldaob Island (southern half)

3.3.1.2 Qualitative Effects (Other Effects)

At the time of planning of this project, the following qualitative effects were expected after implementing the project:

- Periodic overhauls of generation facilities would become possible, obviating serious accidents;
- By securing reserve capacities of generation facilities, reductions in generation outputs can be supplemented by reserve generators in case of sudden accidents.

Through these effects, it was anticipated that power supply restrictions would be avoided.

According to the executing agency, a sufficient reserve supply capacity has been secured after implementing this project, enabling maintenance activities, including overhauls of power generators by turns. No serious accidents at facilities have occurred and power supply restrictions have been avoided.

Aimeliik and Malakal Power Plants have generators, as shown in Table 5, and two generators at Malakal Power Plant, located closer to Koror Island which is a center of economic activities and where power demand is high, and one generator at Aimeliik Power Plant are regularly operated. When one of the generators at Malakal Power Plant undergoes maintenance, both generators at Aimeliik Power Plant are operated. Malakal Power Plant has six other generators making it possible to sufficiently meet the demand

when the four main ones (two at Aimeliik Power Plant and two at Malakal Power Plant) have sudden failures or accidents, even though the six other generators are not suitable for continuous operation because of low output and dilapidation.

Table 5: Power Generators at Aimeliik Power Plant and Malakal Power Plant

Breakdown	Output (KW)	Remarks
Aimeliik Power Plant		
Mitsubishi No. 6	5,000	Continuous operation (procured through this project)
Mitsubishi No. 7	5,000	Continuous operation (procured through this project)
Malakal Power Plant		
Niigata No.14	5,000	Continuous operation
Niigata No. 15	5,000	Continuous operation
Mitsubishi No.12	2,500	Procured in The Project for Upgrading of Electric Power Supply (1996)
Mitsubishi No.13	2,800	Procured in The Project for Upgrading of Electric Power Supply (1996)
Wartsila	1,200	
CAT#1	1,200	
CAT#2	1,200	
Mitsubishi (small units)	1,800 (450 x 4 units)	Procured with Emergency Grant Aid (2011)
Total	30,700	

Source: Compiled from the document provided by the executing agency

Based on the above, three out of four generators for continuous operation have been operated after implementing this project and it is therefore possible to periodically overhaul one of them by turns. No serious accidents have occurred, and it was confirmed that the generators were stably operated at the time of ex-post evaluation.

While the maximum combined output of Aimeliik and Malakal Power Plants is nominally a total of 30MW, a supply capacity of 20MW is practicable under normal operation. Among the generators shown in Table 5, the generators at Malakal Power Plant except for the 5MW generators have low individual outputs and are only used for emergency purposes, while the old ones are not suitable for continuous operation. Therefore, two generators (Niigata No.14 and No.15) purchased by the PPUC immediately after the fire at Aimeliik Power Plant have been in continuous operation at Malakal Power Plant. With the generators at Aimeliik Power Plant procured through this project, there are four generators in total, each with 5MW generating capacities, and one of them can always be inspected and repaired. By procuring generators with 10MW generating capacities through this project, it can be said that stable power supply has been

realized.

3.3.2 Impacts

3.3.2.1 Intended Impacts

It was expected as an impact that implementing this project would 'contribute to economic development, industrial promotion, and the improvements of the lives of residents through a stable power supply'. As it is a very broad macro-level impact, GDP growth rates were checked and the indicators related to tourism (a key industry of Palau) were grasped.

Table 6: GDP Growth Rates and Tourism-related Indicators

	2012	2013	2014	2015	2016
GDP growth rate	2.6%	-4.5%	6.9%	10.6%	1.6%
GDP growth rate per capita	4.5%	-3.9%	7.0%	9.6%	0.0%
Growth rate of accommodation and food service activities	11.3%	-3.4%	14.7%	25.7%	-9.9%
Number of tourists (persons)	118,928	110,823	125,674	168,767	146,634

Source: *2016 Statistical Yearbook*

The growth rates of Palau's accommodation and food service activities have fluctuated substantially in recent years, affecting the overall GDP growth rates significantly. However, the number of tourists has largely been increasing. With the increase in the number of tourists, the number of hotels in the urban areas of Palau at the time of ex-post evaluation was 79 with 2,028 rooms in total. This project caters much of power supply to those hotels.

In the ex-post evaluation, an interview survey[7] with a total of 12 companies including hotels, shops, a clinic, an airline, a communication company and so on was conducted, in which all the respondents commented that power outages had decreased and the power supply had been stabilized though it was not necessarily at a sufficient level. As to the impacts to their businesses, a number of positive impacts were raised, such as a reduction in cases of having to run backup generators, enabling of installations of ATMs, and an increased number of refrigerating equipment in shops owing to sufficient power supply. On the other hand, there were comments pointing out that communication and refrigerating equipment had been damaged because of voltage fluctuations and power

[7] An interview survey conducted in Koror and Airai states with 12 businesses (owners or managers of their maintenance, 5 males and 7 females) who cooperated in this survey, among which were hotels having 100 rooms or more, a communication company, a clinic, large wholesalers, and shops along the main street.

outages.

Based on the above, this project can be said to be contributing as a whole to economic development and industrial promotion through stable power supply, underpinning economic activities in the urban areas of Palau. Also, it was confirmed in the interviews with businesses that there were impacts leading to business cost reductions and business expansions through stabilization of power supply.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

At the time of planning of this project, it was judged that undesirable impacts to environment through project implementation would not be serious, and there were no issues in relation to the JICA Guidelines for Environmental and Social Considerations. In fact, an environmental approval, necessary for implementing this project, was issued by the Palau Environmental Quality Protection Board (hereinafter referred to as 'EQPB') during the preparatory survey of this project in February 2012. In addition, it was expected that environmental standards[8] employed for projects in Japan and by World Bank would be met after the completion of this project by taking measures such as appropriate designing of chimneys, installation of shutters to the power house and so forth.

According to the executing agency, EQPB and project consultants, no negative environmental impacts had been observed both during and after the project[9]. With regard to air pollution and noise, while no monitoring activities using measuring equipment were conducted, the EQPB observed them at the site and collected information on whether there were any complaints. The judgment of no negative impacts has been made based on such results. Regarding the quality of water, the water discharged from Aimeliik Power Plant has been collected and tested every month through the monitoring of EQPB's officer in charge; there have been no particular problems pointed out[10].

Moreover, the generators procured through this project have better fuel efficiency compared to the ones installed previously, and a result was obtained from the executing agency showing that the amount of fuel consumption improved from that of the previous generators by an average of approximately 15.5%.

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[8] In this project, it was planned to adopt a measure that NOx emission standards in exhaust gas would be O_2: 13%, 950ppm or less, and the noise level of generating facilities would be 55dB or less in the daytime and 45dB or less at nighttime in nearby residential areas.

[9] It was heard that the executing agency and project consultants were always checking whether there were any negative impacts on the natural environment during the project. Upon project completion, it was confirmed through the executing agency and EQPB that there had been no particular issues pointed out.

[10] At Aimeliik Power Plant, the existing oil-water separator was replaced in order to separate the waste oil and water of the generators installed through this project.

Based on the above, it is considered that there are no problems as no negative impacts on environment have occurred through project implementation and there have been no impacts on residents.

(2) Resettlement and Land Acquisition

As this project was implemented within the existing premises of Aimeliik Power Plant, no land acquisition or resettlement cases were expected at the time of planning. It was confirmed in the ex-post evaluation survey that power generating facilities were actually constructed within the premises of the existing power plant, and neither resettlement nor land acquisition occurred because of project implementation. Therefore, it can be said that there were no problems.

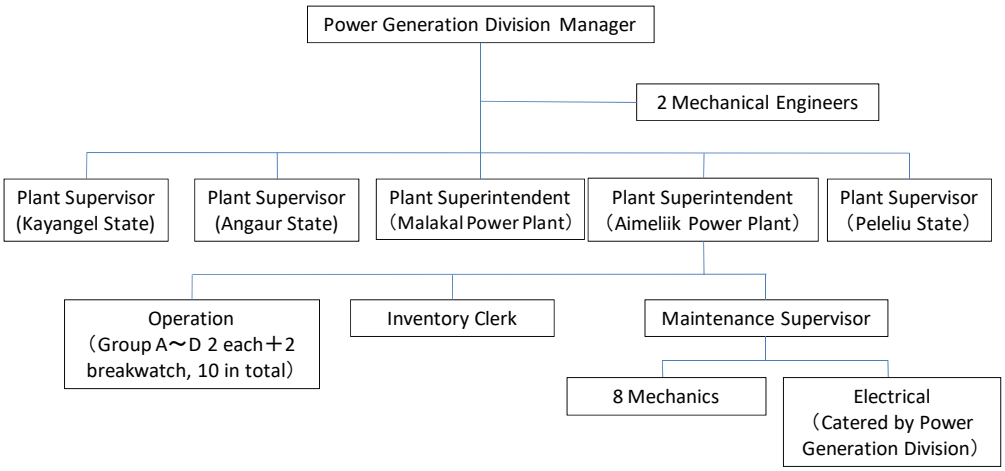
The quantitative indicators expected in this project were both achieved, and sequential overhauling of generators and a stable supply at the time of sudden breakdowns became possible by securing sufficient reserve supply capacities. Also, while it was difficult to indicate quantitatively, it can be said that this project has played a role in underpinning economic activities in the sense that this project has been supplying power stably to the urban areas of Palau. In fact, it was heard from businesses that cost reductions and business expansions became possible. There were no environmental or social problems observed as there were no negative impacts on the natural environment or resettlement / land acquisition cases observed.

In light of the above, it is judged that the effectiveness and impacts of this project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Institutional Aspects of Operation and Maintenance

Including the areas targeted in this project, the power supply in Palau is all catered by the PPUC (staff number: 291). The PPUC formerly served as a corporation to supply electric power only. However, it integrated water supply and sewerage works in June 2013 and became the newly formed PPUC. The PPUC is comprised of eight divisions, in which there are the Power Generation Division and the Transmission and Distribution Division as the divisions specializing in power. Aimeliik Power Plant belongs to the Power Generation Division, where 21 staff members oversee operation and maintenance. Among them, 10 staff members in charge of operation are divided into four groups, undertaking continuous operations of the power plant in three shifts (eight hours each).



Source: Document provided by the executing agency

Figure 2: Organization Chart of Power Generation Division and Aimeliik Power Plant

The Power Generation Division is headed by a manager who is an engineer from the Philippines with long-time experiences in the power sector[11]. While the majority of the mechanical staff members at Aimeliik Power Plant do not have technical academic degrees, the supervisor is an engineer with an academic degree, and it is considered that the engineers needed for operation and maintenance of the power plant have been secured. In recent years, it was heard that a focus of employment practice is placed on the graduates from the electricity and mechanical courses at Palau Community College.

Therefore, there are no issues in terms of operation and maintenance of the generation facilities and equipment developed through this project.

3.4.2 Technical Aspects of Operation and Maintenance

From the time of project planning, the PPUC had sufficient experience in operation and maintenance of diesel generators, and there were no technical issues in terms of operation and maintenance of the generation equipment procured through this project. According to the PPUC, while there are few staff members with specialized academic qualifications, they had enough skilled mechanics and electricians able to undertake emergency measures and overhauls working under the engineers of manufacturers. At the time of ex-post evaluation, comments were obtained from JICA's senior volunteer providing instructions to improve operations at the PPUC's power plant that there were no problems as to the skills for routine operation and maintenance.

On the other hand, skills development of PPUC staff members was mostly done through

[11] Among the 21 staff members at Aimeliik Power Plant, 3 members, including the superintendent, were from the Philippines.

OJT as a part of daily operations, and no systematic structure of training was observed. They occasionally have opportunities to send technicians to training programs offered by JICA. In addition, as there is no organization in Palau to develop technicians with professional knowledge, it has become essential to receive education overseas for obtaining a degree higher than the undergraduate level in specialized fields.

As described above, while it is difficult to secure academic degree holders in Palau, it is thought that there is a certain level of technical sustainability as there are no items that cannot be technically dealt with and a situation in which technicians cannot be secured has not developed.

3.4.3 Financial Aspects of Operation and Maintenance

The PPUC's financial balance in recent years (only for electricity) is shown in Table 7.

Table 7: Operating Balance of the PPUC

(Unit: thousand US dollars)

	2014	2015	2016
Operating Revenue	27,650	21,829	20,642
Electricity Generation	27,308	21,057	19,807
Other	634	772	908
Uncollected Electricity Charges	-292	0	-73
Operating Expenditures	26,801	23,385	18,340
Fuel for Generation	18,732	14,555	10,135
Other Expenses for Generation	3,503	3,830	2,436
Transmission and Distribution	813	935	1,251
General Administration	920	856	973
Engineering Services	554	496	335
Depreciation	2,187	2,615	2,672
Renewable Energy	92	98	538
Operating Balance	849	-1,556	2,302
Non-operating Revenue	152	-163	1,012
Government Contributions	13,131	-	92
Net Profit	14,132	-1,720	3,406

Source: Document provided by the executing agency

The PPUC's operating balance recorded a deficit on a net profit basis in 2015, but recorded surpluses in 2014 and 2016. Also, much of depreciation is from the facilities and equipment of grant aid projects, and it was confirmed that the cash flow of the PPUC did not reveal problems[12]. The large amount of surplus in 2014 is due to the capital contribution from the government, which is due to the cost of this project being partly allocated, which is

[12] While the PPUC occasionally purchases power generators by themselves, large-scale projects were mainly implemented with support from Japan. The PPUC has not made large-scale investments by themselves.

to be gradually depreciated. While there are no government subsidies injected into the PPUC, the 'Uncollected Electricity Charge' is the unpaid amount mainly by government agencies. Despite significant improvements in recent years, it was heard that accumulated unpaid amounts owned by the water supply and sewerage works division still remained[13].

While the electricity tariff accounts for the majority of the PPUC's revenues, the PPUC is not authorized to determine the tariff. The electricity tariff is periodically revised in line with fuel prices. For example, the tariff for residences (in the case of 0-150KWh), which had been US 21.1 cents per 1KWh, was reduced to US 19.7 cents in January 2018. As fuel prices can fluctuate significantly depending on the international market, it appears important to revise the electricity tariff without delay in response to price changes to maintain operations without making losses.

The maintenance costs of the facilities and equipment for power generation are included in the 'Other Expenses for Generation' of the operating balance of the PPUC, whose recent trend is shown in Table 8. According to the PPUC, the maintenance costs necessary for stable power generation, including overhauls, have been disbursed.

Table 8: Maintenance Costs of Facilities and Equipment for Power Generation

(Unit: thousand US dollars)

	2013	2014	2015	2016
Maintenance costs of power generation facilities and equipment	2,205	2,868	2,600	1,682

Source: Document provided by the executing agency

Based on the above, as for the financial situation, it is necessary to strengthen the collecting on accumulated unpaid bills. However, it has been judged that there were no particular issues at the time of ex-post evaluation as the maintenance costs for generation facilities and equipment have largely been sufficiently disbursed.

3.4.4 Current Status of Operation and Maintenance

The power generators and facilities at Aimeliik Power Plant developed through this project were all operating in good condition at the time of ex-post evaluation with smooth procurement of spare parts. It was confirmed that the operating data were recorded every hour and the items to be inspected and maintained periodically were also recorded.

With regard to the overhauls, which are large-scale maintenance activities, it was

[13] The Water Supply and Sewerage Works Division began paying the accumulated unpaid charges in 2014, after the Electricity Division and the Water Supply and Sewerage Works Division merged in 2013 to become the newly formed PPUC. However, 70% of the accumulated unpaid charges by customers recorded by the PPUC are those of the Water Supply and Sewerage Works Division.

considered desirable to conduct them every 4,000 hours for the upper part of the generator and every 8,000 hours for the entire generator. However, the overhauls were not necessarily conducted precisely within those intervals and tended to be delayed. But those delays were not the ones which could cause serious problems for operation in the future. Operating hours were recorded, and the preparation works for the next overhaul were in progress[14].

Therefore, there were no issues in terms of operation and maintenance conditions of the facilities and equipment of this project, and requisite power was being supplied. There were also no problems in procuring the spare parts that could affect the operation of the generators, and the generators as a whole were managed in good condition.

In light of the above, while the efforts on the improvement of staff capacities were not necessarily sufficient, there were no problems in terms of organizational and financial aspects as well as operation and maintenance status as a whole. It was observed that the technical aspects had a certain degree of continuity and it can be said that operation and maintenance is sufficiently conducted. Therefore, it can be judged that the sustainability of the effects generated in this project is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

In this project, diesel-operated generation facilities and equipment were developed to alleviate power shortages in the urban areas of Palau. The relevance of this project is high as it was both consistent with the development plan and development needs of Palau at the time of both planning and ex-post evaluation and was also consistent with Japan's ODA policy at the time of planning. As for implementation of the project, the project outputs were largely as planned, and the project costs and periods were within the plan. Therefore, the efficiency is high. With regard to project effects, reserve power supply capacities were sufficiently secured, and the occurrences of power supply restrictions caused by power generation equipment were eliminated, leading to stable power supply in the urban areas of Palau. It was also heard that the reduction of business costs and the expansion of businesses were realized because of stable power supply, confirming that economic activities, including tourism, had been underpinned. Furthermore, there were no issues in terms of negative impacts on the natural environment as well as resettlement and land acquisition. As a whole, the effectiveness and impact of this project are high. Regarding operation and maintenance, there were no major problems in terms of all institutional, technical, financial aspects as well as the operation and maintenance status.

[14] The generators installed in this project were scheduled to undergo overhauls by turns in July and August 2018. It was expected that the overhaul would take 1 month each.

Therefore, sustainability is judged to be high.

In light of the above, this project is evaluated to be highly satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

In the ex-post evaluation, it was seen that the efforts on the improvement of staff capacities were not necessarily sufficient, while no particular problems were seen in terms of technical aspects of operation and maintenance of PPUC power plants. In order to accumulate the technical knowledge within the corporation for the future, it is considered important to establish a training structure for the staff with a central focus on the technicians on power generation at Aimeliik Power Plant and Malakal Power Plant. Among the training programs, some can be acquired only overseas, while others can be implemented in country. Therefore, for the programs that can be implemented domestically, it is desirable to immediately establish and carry out a training program on the skills considered necessary for PPUC technicians.

4.2.2 Recommendations to JICA

While there were no problems with the conditions of power generation by the PPUC, it was confirmed in the ex-post evaluation that power outages caused by the vulnerability of transmission and distribution networks for supplying generated power to users were occasionally occurring. Although some opinions were heard from businesses in the urban areas of Palau that instances of power outages generally improved compared to previous years, it is considered important for generating the effects of this project to provide support on strengthening transmission and distribution networks in consideration of the introduction status of renewable energy so that a stable power supply can be realized for a long term. In this sense, the Technical Cooperation for Development Planning: 'The Project for Study on Upgrading and Maintenance Improvement of National Power Grid', commenced in FY2017, is a timely project.

4.3 Lessons Learned

<u>The need to develop human resources through a region-wide scheme</u>

In this project, it was confirmed that the executing agency did not necessarily have a sufficient structure to develop human resources. As Palau is a country with an approximate resident population of 20,000 and there is no tertiary institute offering undergraduate academic degrees, it is difficult to develop and secure technicians in various fields independently, and one of the means to solve such issues is the utilization of foreign technicians. However, it is

desirable from the perspective of accumulating technical capacities for the long-term to develop sufficient key technicians among the Palauan nationals. In the neighboring countries, the Federated States of Micronesia and the Marshall Islands have small-scale populations, similar to Palau, making it difficult to establish systematic structures independently. Therefore, it is considered effective in specific sectors such as electric power, to provide regular support separately for improving their capacities regionally by utilizing the experiences of vocational cooperation in such neighboring countries. In this way, a certain size as a project can be secured and knowledge and skills can be accumulated within the organization. In such cases, it would be effective to provide the support not only as a project supported solely by JICA but also as a project in cooperation with the Pacific Power Association, which is a regional energy organization in the Pacific islands region. Through such efforts, it is considered that the sustainability of the effects of grant aid projects implemented by JICA will be secured in a more stable manner.

(End)