FY2023 Project for Ministry of the Environment Government of Japan

FY2023 City-to-City Collaboration Program

for Creating a Carbon-free Society

(City to City collaboration project for the promotion of decarbonized cities and realization of co-benefits in Koror State, Republic of Palau.)

〔Kitakyushu City- Koror state Collaboration Project〕

Survey Report

March 2024

ATGREEN Co., Ltd.

Table of Contents

Abbreviation

Abbreviation	Formal name
ADB	Asian Development Bank
COVID-19	Corona Virus Infectious Disease, emerged in 2019
EV	Electric Vehicle
EVMJ	EV Motors Japan
GHG	Green House Gas
INDC	Intended Nationally Determined Contributions
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
LED	Light-Emitting Diode
MPIIC	Ministry of Public Infrastructure, Industries and Commerce
MRV	Measurement, Reporting and Verification
PIAC	Palau International Airport Corporation
PPR	Palau Pacific Resort
PRR	Palau Royal Resort
PPUC	Palau Public Utilities Corporation
PRR	Palau Royal Resort
PV	Photovoltaics
SDGs	Sustainable Development Goals
WS	Workshop
3R	Reduce/Reuse/Recycle

1 Objective and Overview of Research Project

1.1 Project objective

According to the Report of Working Group III of the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in 2022, approximately 70% of global GHG emissions originate from cities, and it is essential to accelerate climate action in cities to achieve the 1.5-degree target set in the Paris Agreement. In Japan, the national government and cities are working together to create more than 100 leading decarbonization regions under the Regional Decarbonization Roadmap formulated in June 2021, with the aim of achieving zero-carbon cities, and are promoting efforts to expand these regions throughout Japan.

In order to realize a decarbonized society in the world as a whole, it is necessary to accelerate the movement toward building a sustainable decarbonized society, especially in Asia, where economic growth is remarkable, and there is a growing international movement to support urban initiatives to decarbonize cities, which are places of activity that support social and economic development.

As an example, the Ministry of Environment of Japan launched the Clean Cities Partnership Program (C2P2) with JICA in February 2023, based on this project, in order to address today's challenges faced by cities around the world from multiple perspectives. This program will provide comprehensive and synergistic support to partner cities to address urban challenges including climate change, environmental pollution, circular economy, and nature positive issues by further mobilizing technology and funds in collaboration with Japanese local governments, private companies, and financial institutions. It will also promote collaboration with other key stakeholders, including the G7 and other like-minded countries and international development finance institutions.

This project targets the state of Koror in the Republic of Palau, where Japanese research institutes, private companies, universities, and others with experience and expertise in decarbonization will conduct a research project to support local efforts to create a decarbonized society and the introduction of facilities that will contribute to the creation of a decarbonized society, mainly through Kitakyushu City in Fukuoka Prefecture, which is a partner in this project.

1.2 Project overview

1.2.1 Project overview

(1) Sectors and fields covered in this study

This project will investigate the following target areas with the aim of supporting the establishment of institutions and the introduction of equipment projects that will contribute to the decarbonization of the State of Koror, Republic of Palau. (Table 1-1 and Figure 1-1)

Table 1-1 ：Project overview

Sectors of Study	Outline of Implementation
Decarbonizing sector of State Government Buildings (Administrative Projects Section)	Study of emission reduction targets in public facilities
	Study of specific renewable energy installations and battery storage possibilities in state public facilities
Waste Management sector	Study on introduction of woody biomass boiler (Decentralized model / Intensive model) using pruned branches, etc. generated by public engineering works, resort hotels, restaurants, etc. as fuel
Transportation sector	Introduction of EV for tourism and public transportation
	Study on the concept of 100% renewable energy ratio in the waste resource circulation flow, including EVs for collection and transportation vehicles

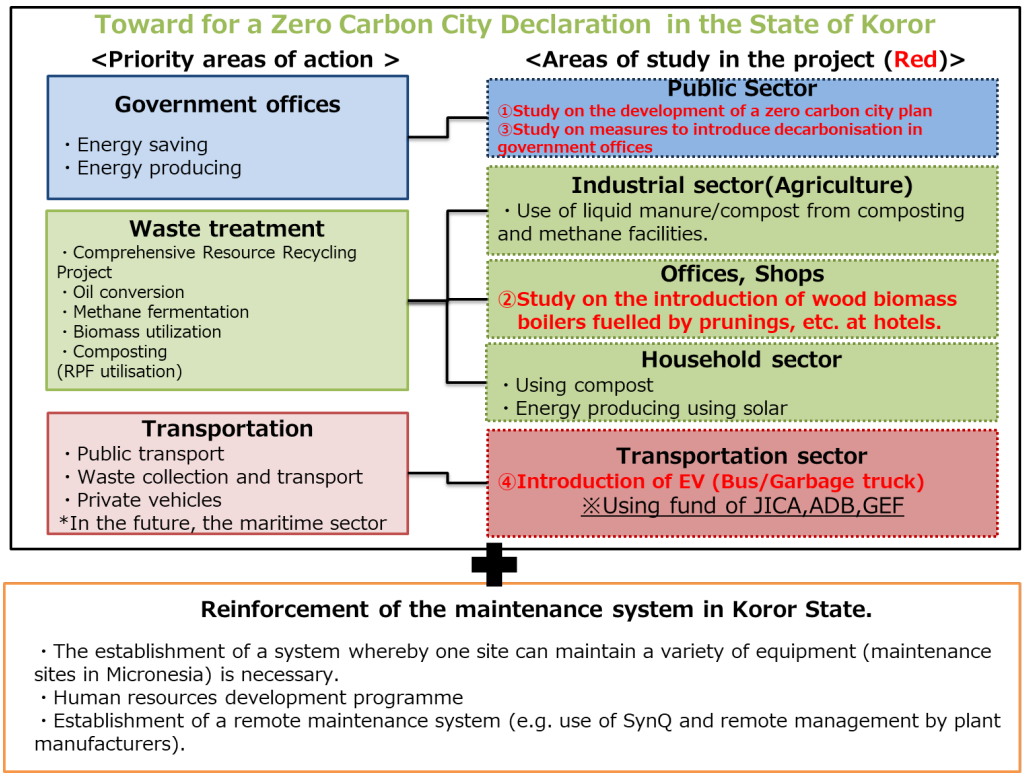


Figure 1-1 ：Project implementation diagram

(2) Areas covered in this study

Koror State and surrounding areas, Republic of Palau

1.2.2 Implementation method

(1) Survey Details

Table 1-2 below shows detailed information about this study in each of the sectors and fields listed in the previous section.

Table 1-2 ：Content of surveys in each sector

Decarbonizing sector of State Government Buildings (Administrative Projects Section)
1) Study emission reduction targets for public facilities Study the pattern of emission reduction targets in the state's public buildings (equivalent to Japan's Administrative Projects Section) and discuss with the Koror state government on priority areas and timeframes for setting reduction targets. 2) Study on introduction of renewable energy and energy-saving equipment in state government buildings Examine elements of technologies for introducing renewable energy (e.g., solar power), batteries, and energy conservation that will contribute to achieving the above goals. 3) Investigation and study of cost models, implementation systems, and investment recovery models for the introduction of renewable energy and energy conservation equipment Based on the above results, a hypothetical implementation system and cost estimation will be conducted for a more cost-effective business model that reflects local needs, and initial investment costs and the number of years required to recover accumulated losses will be estimated. 4) Study to resolve maintenance and other operational issues Similar to the EV of Phase 1, a system to resolve issues related to maintenance in island countries will be studied while organizing local issues (e.g., consistency with communication status) and measures to be taken when introducing and utilizing online maintenance tools. 5) Review and preparation for application to the JCM equipment subsidy project, and study of MRV methodology proposal Based on the research from 2) ~ 4), conduct interviews with and review the equipment subsidy project and other funds (JICA, ADB, etc.), and study the MRV methodology proposal.
Waste Management sector
1) Confirmation of the status of woody biomass generation and utilization, and identification of local needs for the introduction of woody biomass boilers Conduct interviews regarding the status of biomass such as pruning branches generated at local public engineering works, resort hotels, and restaurants (properties, amount of biomass present, amount available, etc.). In addition, interviews will be conducted on the current status of linen drying, technical requirements, needs, and

feasibility study of a business model for the introduction of a wood biomass boiler for the main purpose of linen drying.

2) Investigation of cost model, implementation system, and investment recovery model
Based on the above results, a hypothetical implementation system and cost estimation will be conducted for a more cost-effective project model that reflects local needs, and initial investment costs and the number of years required to recover accumulated losses will be estimated.

3) Study to resolve maintenance and other operational issues
While organizing local issues (e.g., consistency with communication status) and measures to be taken when introducing and utilizing online maintenance tools, a system to resolve maintenance issues in island countries will be studied.

4) Review and preparation for application to JCM equipment subsidy projects, and study of MRV methodology proposal
Based on the research from 1) ~ 3), conduct interviews with and review the equipment subsidy project and other funds (JICA, ADB, etc.), and study the MRV methodology proposal.

Transportation sector

1) Conducting consultations and coordination in ongoing projects with fund donors for the introduction of EV bus driving demonstration vehicles
JICA plans to conduct a driving demonstration of EV buses as part of the "Palau Environmentally Conscious Transportation System Development Project" for which JICA solicited applications in February 2023, and is currently holding discussions for the introduction of such vehicles, and will conduct follow-up on these discussions.

2) Discussions and coordination on fund formation and program application with potential fund donors for the introduction of EV bus driving demonstration vehicles
UNEP is working with the Koror State Waste Management Office and the Intercity Collaboration Team in this case to apply for the introduction of a zero-carbon mobility demonstration project using the GEF-8 Fund. In addition, activities to obtain the ADB budget, which had been in the works, are progressing. A survey to be conducted by the ADB will begin shortly and we will follow up on this.

3) Study to resolve maintenance and other operational issues
While organizing local issues (e.g., consistency with communication status) and measures to be taken when introducing and utilizing online maintenance tools, a system for resolving maintenance issues in island countries will be studied.

(2) Field surveys

Two field surveys were conducted this year as follows

【1st field survey】

Item	Details
Dates	14 January to 19 January 2024 (Only some members end on 17th or 18th)
Survey team	・Hiroyuki Sato (Vice chairman and Chief Engagement and

	Partnerships Officer, AMITA HOLDINGS Co., Ltd.) ・Eiichi Yamato (Team Manager Overseas Business Team, AMITA CORPORATION) ・Seiya Tominaga (General Manager, AT GREEN Co., Ltd.) ・Sho Koizumi (Chief Consultant, ATGREEN Co., Ltd.)
Sites visited and persons interviewed	15 January ●Koror State Waste Management Office ・Mr. Katsuo Fuji (Consultant, Koror State Waste Management Office) ●Garden Palace Hotel ・Mr. Naohisa Ooya (Operations Manager) ●Palau Pacific Resort (PPR) ・Mr. Seiji Sone (Property Operation Manager) ●COVE Resort Palau ・Mr. Kazuo Osada (Hotel Manager) 16 January ●Koror State Government(Visits and workshops) ・Mr. Eyos Rudimch (Governor) ・Mr. Leslie Tewid (Director, Public Works) ・Mr. Selby Etibek (Recycle center manager) ・Mr. Katsuo Fuji (Consultant, Koror State Waste Management Office) ●Embassy of Japan in the Republic of Palau ・Mr. Hiroyuki Orikasa (Ambassador Extraordinary and Plenipotentiary) ・Ms. Tamaki Yoshida (First Secretary) ●Koror State Waste Management Office ・Mr. Katsuo Fuji (Consultant, Koror State Waste Management Office) 17 January ●Japan International Cooperation Agency (JICA) Palau Office ・Mr. Ryutaro Kobayashi (Director) ●Palasia Hotel Palau ・Mr. Nientai (Facilities Manager) ●Palau royal resort ・Mr. Shinichi Arakawa (General Manager) 18 January ●Palau Public Utilities Corporation ●Koror State Waste Management Office ・Mr. Katsuo Fuji (Consultant, Koror State Waste Management Office)

【2nd field survey】

Item	内容
Dates	27 February to 29 February 2024
Survey team	Sho Koizumi (Chief Consultant, ATGREEN Co., Ltd.)
Sites visited and persons interviewed	●Palau Public Utilities Corporation ・Mr. Roberto (Manager) ・Ms. Linda ・Mr. Robert ・Mr. Kaipo (Interpretation)

1.2.3 Implementation period

1 November 2023 to 10 March 2024

1.2.4 Project implementation system

The project implementation system is outlined in Figure 1-2 and Table 1-3 below.

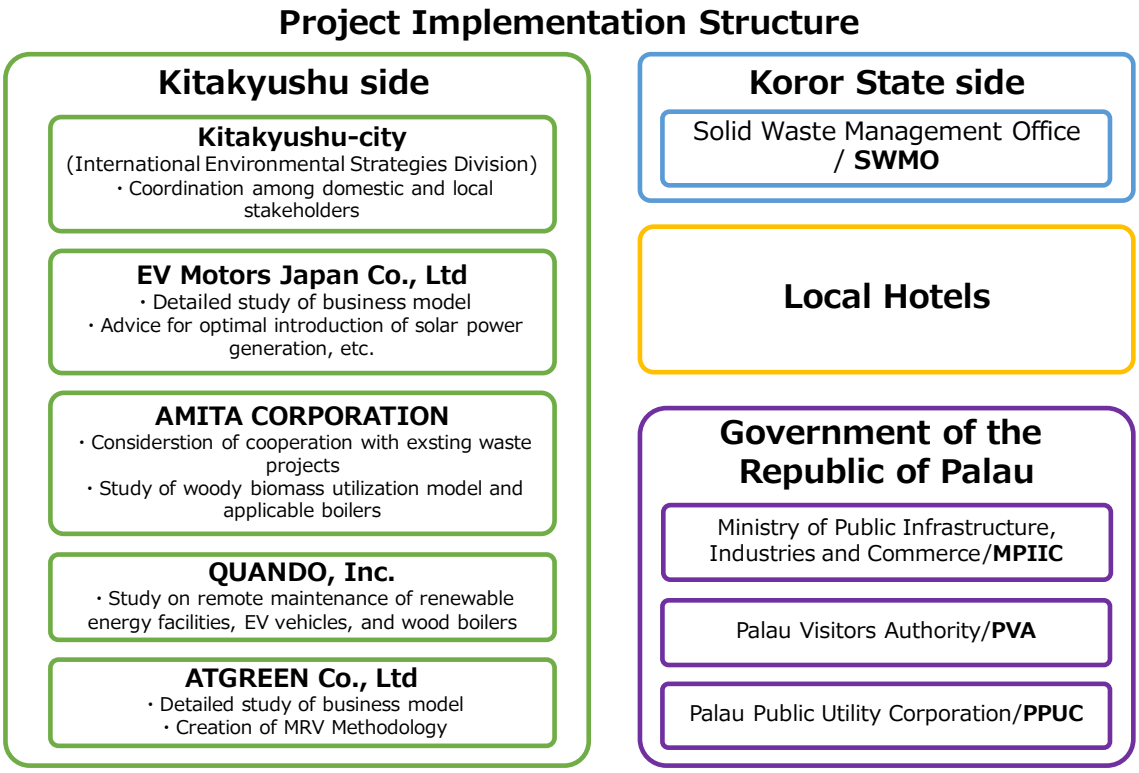


Figure 1-2：Project implementation system

Table 1-3 ：Overview of organizations in Japan and project roles and responsibilities

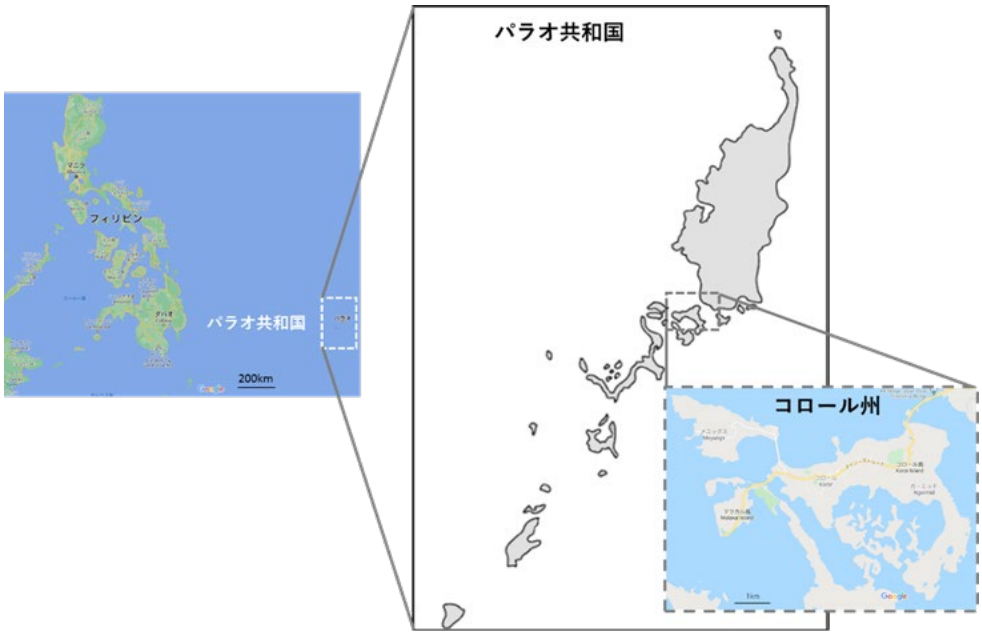
Organisation	Overview of organisation and projects/operations	Project roles and responsibilities
ATGREEN Co., Ltd. (Project lead)	Business offering consulting services in the fields of the environment, energy, waste, etc.	・Project lead ・Project model study
Kitakyushu City Environment Bureau (International Environmental Strategies Division, Overseas Environmental Project Department)	Local authority that aims to transfer the decarbonisation technologies and expertise of local companies through international city-to-city collaboration Selected by the OECD as an SDGs Model City in recognition of its advanced initiatives in various fields, including resource recycling, decarbonisation, energy use, social welfare, SDGs, other.	・Overall coordination of city-to-city collaboration ・Promotion of G to G collaboration ・Sharing of extensive experience and knowledge on the environment and SDGs
EV Motors Japan Corp.	Company engaged in the sales and maintenance of commercial EV vehicles (buses, trucks, etc.) and charging stations	・Review of project balance sheet mode ・Advice on building optimal installation models for renewable energy equipment and storage batteries
AMITA CORPORTION	Business engaged in providing solutions to increase the sustainability of companies and municipalities (waste disposal, recycling, consulting)	・Study on potential for collaboration with existing resource circulation PJ ・Study of woody biomass utilization model and applicable boilers
Quando Inc.	Company engaged in the development and sales of remote maintenance systems Selected as one of 50 supporting companies in the Startup City Acceleration Program (SCAP) implemented by the Japan External Trade Organization (JETRO), Cabinet Office and Ministry of Economy, Trade and Industry	・Study on the effectiveness of remote maintenance systems to resolve maintenance labor shortages in island countries and identification of challenges

In addition, the project is being studied with the cooperation of a boiler manufacturer that also operates a linen business and a nursing care business as related businesses in considering specifications and prices for biomass boilers.

1.3 Project background

1.3.1 Overview of Koror State, Republic of Palau

The Republic of Palau is located at 7.5150° N, 134.5825° E in the northern hemisphere of the western part of the Pacific Ocean, along the western edges of Micronesia and the Caroline Islands. The capital was relocated from Koror to Ngerulmud in Melekeok State on Babeldaob Island in 2006. The country has a total population of 17,501 (as of 2012), with 11,655 people, or 66.7%, concentrated in Koror State, which is the subject of this study. As an island nation, Koror faces a number of challenges in terms of waste disposal, external dependence for food and energy, and an economy centered on foreign investment. The tourism industry accounts for over 50% of the nation's GDP, and environmental protection is a priority because of Palau's dependence on its marine environment, which includes rich coral reefs and fish species that are unique to the tropical region.(Figure 1-3)



(地図出所：Google Map)

Figure 1-3：Location of the Republic of Palau and Koror State

【Climate change measures】

Palau is a member of the Secretariat of the Pacific Regional Environment Programme (SPREP), and is promoting climate change action. Palau developed its Intended

Nationally Determined Contributions (INDC) in November 2015. An overview of the INDC is below(Table 1-4).

Table 1-4 ：Overview of INDC[1]

Item	Contents
Implementation period	Starts in 2020, ends in 2025
Reductions	Emission reduction targets in the energy sector with additional reductions from the transport and waste sectors
Base year	2005: Emissions in this year were 88,000 t-CO_2
Reduction targets	Aims to achieve the following targets by 2025 ・Reduce greenhouse gas emissions by 22% from 2005 levels ・Increase the share of renewable energy to 45% ・Energy savings target of 35% from 2005 levels

【Energy policies and plans】

Palau has been implementing the “Pacific Islands Greenhouse Gas Abatement through Renewable Energy Project (PIGGAREP)”, a mitigation project in the energy sector to promote the use of renewable energy, since 2007.

Palau is focused on mitigation measures to shift away from energy dependence on fossil fuels. This is an issue of paramount importance for Palau in terms of power generation costs, as the country is unable to secure fossil fuels without importing them from overseas. Palau has drawn up a roadmap to expand the introduction of renewable energy, shifting away from diesel power generation, which accounts for about 98% to 99%[2] of energy generation in the country to date, and has set a target of 45% of electricity generated by 2025 to be covered by renewable energy. As part of this target, five PV projects (equivalent to 2.5 MW) have been introduced through the JCM Model Project subsidy scheme to date, and PV-based renewable energy is continuing to be introduced with support from the governments of New Zealand and South Korea, and

[1] Republic of Palau INDC (http://prdrse4all.spc.int/system/files/palau_indc.final_copy.pdf)

[2] Okinawa Enetech Co., Ltd. (2015), Survey to Gather and Verify Information for Aid Measures to Improve Energy Security in the Pacific Region Power Sector, Japan International Cooperation Agency

other stakeholders. The Palau government is also inviting international competitive bids for a PV microgrid construction project through the Asian Development Bank (ADB).

However, grid connections for large-scale PV systems such as these can prove problematic in terms of short- and long-term fluctuations, with challenges seen in the need to absorb excess power and sudden fluctuations in output. The introduction of microgrids runs the risk of further destabilising the power structure, as power generated by existing diesel-powered generation facilities has also resulted in frequent power outages due to aging facilities, inadequate maintenance and a lack of operational capacity.

In light of these perspectives, there is a compelling need to introduce and utilise renewable energy for private consumption, with consideration given to reducing the load on grids, an area in which Palau has also expressed a need.

In a separate study related to this project, a company called T-PLAN Inc. (in Nakatsu City, Oita Prefecture, Japan) proposed and launched a study in October 2022 to examine the development of a “Himeshima Model” in Palau, which combines mobility with a carport equipped with a solar power generation and energy storage system, under the JICA Private Sector Partnership programme (Business Model Formulation Survey with SMEs) (Figure 1-4). This initiative may serve as a potential solution to the issues in the tourism sector described below, so the possibility of collaboration with this project may be considered.

Figure 1-4：JICA Private Sector Partnership programme on small EVs

【Tourism sector】

Prior to the global COVID-19 pandemic (see below), Palau was the destination for 120,000 to 160,000 tourists each year, with about half of its total national income of JPY 25 billion originating from the tourism sector. Global warming and other environmental issues also simultaneously exert a strong impact on the tourism sector. Public transportation is not well-maintained and tourists are left with only the option of using taxis or hotel shuttle services. With only one main road (Main Street) on Koror Island, there are frequent traffic jams, mostly in the mornings and evenings.

【Waste sector】

In reflection of the importance of the 3Rs, the Koror State government established a recycling centre in 2004 as a way to enhance waste management. Organic waste is composted and sold at the centre, and a deposit system has been established to collect customs duties on imports of beverages and to cover collection/disposal costs for empty cans, bottles and PET bottles. Koror State is actively promoting waste recycling projects,

including the introduction of plastic oil conversion equipment in 2015. However, few types of waste can be recycled domestically due to the absence of industries in Palau that can utilise waste. There have also been reports of an increase in the volume of household and commercial waste to over 27 tonnes/day, due to an increase in imported goods and number of tourists.[3]

The M-Dock landfill, the final disposal waste site in Palau, is approaching the end of its remaining service life, which has been extended through several rounds of levelling construction work. Therefore, a new landfill was constructed in the state of Aimeliik with Japanese grant aid, and was completed in August 2020. In the past, each state operated its own disposal site where they landfilled their own waste, however, the new site is planned to be used to landfill all waste in Palau, with the exception of outlying islands. A critical issue facing the country is the need to take additional waste reduction measures through the 3Rs, in order to effectively use the limited landfill capacity of the new disposal site. Koror State also needs to further improve the efficiency of its waste disposal practices, as transferring waste for disposal to the new final disposal site in Aimeliik State will increase transportation costs.

Koror State's vision for a waste collection and recycling project is based on a waste sorting transhipment and storage facility that will both increase recycling rates and reduce waste disposal costs, while also simultaneously leading to the establishment of a global recycling system to resolve the issue of waste that cannot be domestically treated and disposed.

【Impacts related to the global spread of COVID-19】

COVID-19, which has spread like wildfire around the world, had a considerable impact on Palau. Stringent border control measures posed significant restrictions on overseas travel to the region. Although the entry of international visitors resumed (with conditions) in August 2020, there have been particularly grave impacts for the tourism industry. The

[3] CTI Engineering International Co., Ltd. (2018), Report on the Preparatory Survey on the Construction of a Waste Disposal Facility in Lao PDR, Japan International Cooperation Agency

number of tourists fell to 18,000[4] in 2020, about one-tenth of the 164,000 visitors to the country at its peak in 2015. This decline has led to large-scale unemployment in the tourism sector, with the government providing compensation to the unemployed. Financially, Palau receives aid from a number of countries, including financing from the U.S. and a sovereign loan from the ADB.

Effective 1 July 2022, Palau's travel advice and warnings on infectious diseases have been lowered from Level 2 to Level 1, and as of 3 November, airlines require the submission of vaccination certificates, but do not necessitate negative test results.[5] COVID-19 has also affected Palau's economy, and thus, its fiscal revenue, so the Palau Goods and Service Tax (PGST), a 10% value-added tax (equivalent to consumption tax in Japan) which will be imposed on almost all goods and services from January 2023, is affecting the lives of the people of Palau.

Currently, the number of tourists is returning, with the majority of tourists coming from Taiwan, the U.S., Australia, Japan, and South Korea. The number of Japanese tourists is still below 10,000 per year, but there are plans to start direct flights between Japan and Palau (about 4 hours) twice a week from August 2024, which is expected to increase the number of Japanese tourists. The number of Japanese in Japan decreased from 400 to 200 during COVID-19, but is now slightly increasing to 300 (mainly related to tourism and JICA projects).

1.3.2 Collaborative relationship between Kitakyushu City and Koror State

City-to-city collaboration between Kitakyushu and Koror has been in place since 2015 and is based on the foundation of the establishment of a resource recycling system. Activities to date are shown in Table 1-5 below.

Table 1-5 ： Past city-to-city collaborative activities between Kitakyushu City (and local businesses) and Koror State

FY	Project name	Project overview

[4] Ministry of Foreign Affairs, Basic data on the Republic of Palau (https://www.mofa.go.jp/mofaj/area/palau/data.html)

[5] Embassy of Japan in the Republic of Palau website, Information on Palau entry/exit and Japan entry (as of 3 November 2022), https://www.palau.emb-japan.go.jp/itpr_ja/11_000001_00364.html

2015	Project on the establishment of a comprehensive resource circulation system in island regions	・Jointly implemented with the AMITA Institute for Sustainable Economies (AISE) ・Conduct of surveys on landfill delivery volumes and setting the amount of material that can be disposed ・Review of specifications and costs for recycling facilities ・Review of business plans/schemes ・Consensus building with government/project stakeholders to realise the objectives of the project/business ・Visit by Palau officials to Japan and organisation of workshops ・Surveys on cultivating energy resource crops
2016	Project on the establishment of a comprehensive resource circulation system in island regions	・Jointly implemented with the AMITA Institute for Sustainable Economies (AISE) ・Conduct of additional studies and consensus building on project schemes and plans ・System design, acquisition of estimates, preparation for construction ・Signing of partnership agreement (between AMITA Institute for Sustainable Economies (AISE) and Koror State)
2017 2018	Feasibility study on the introduction of a comprehensive organic resource circulation system using small-scale methane fermentation technology in island areas	・Participation as outside human resources in the proposed corporation, Vioce Co., Ltd., with the AMITA Institute for Sustainable Economies (AISE) ・Study related to input materials for biogas facilities (food waste, resource crop napier grass, etc.) ・Establishment of food waste sorting and collection schemes ・Promotion of the use of liquid fertilisers ・Feasibility study on deploying systems to island areas ・Specifications and operational design of small biogas facilities optimised for local regions ・Awareness raising activities for local staff (activities to receive visitors to biogas facilities in Japan)
2019	Project on the development of a waste collection, sorting, and recycling system based on a transhipment and storage facility for sorting resources in Koror State, Republic of Palau	・Jointly implemented with AMITA CORPORATION and Beetle Engineering ・Construction of a transhipment and storage facility equipped with a resource sorting function, and establishment of integrated systems for resource sorting functions ・Consideration of international recycling system

2020 ～ 2022	Support project for the introduction of technology and establishment of measures to promote for carbon-free society and co-benefits in State of Koror.(City to city collaboration project between Kitakyushu-City of Kitakyushu and State of Koror, Republic of Palau) (Phase1)	・Conducted jointly with EV Motors Japan, Amita Corporation, Kitakyushu Urban Center of the Institute for Global Environmental Strategies, and ATGREEN Corporation. ・Conducted online interviews with state governments, waste offices, hotel operators, etc., regarding the introduction of EV to the tourism and waste collection and transportation industries, and verified local needs and effectiveness. ・Conducted discussions on obtaining funds for the introduction of EVs. ・Conducted a study on the current estimation of GHG emissions and the feasibility of decarbonization measures at public buildings in the province.

As per the table above, opportunities for exchange between the two cities are evolving, especially in the waste management sector. Kitakyushu has also been selected as an SDGs Future City by the Japanese Cabinet Office, as well as an SDGs model city by the OECD through its promotion of activities at the city level to achieve the targets set out by the SDGs. Koror State has also been involved in promoting activities to achieve the SDGs and is preparing to set up an SDGs-related department. Exchanges are taking place with knowledge being shared from Kitakyushu. In August 2022, Koror Governor Eyos Rudimch, three state legislators, and Katsuo Fuji, consultant to the State Waste Management Office and special advisor to the governor for economic development, visited Kitakyushu City and met with the mayor of Kitakyushu City. In addition, they test-drove an EV community bus at the headquarters of EV Motors Japan Corporation (Wakamatsu-ku, Kitakyushu City), a co-implementer of this project, and visited Amita Corporation, another co-implementer. In addition, ongoing communication is underway, including a return visit by Mr. Fuji to Kitakyushu City from the end of February to March 2024 to inspect EV Motors Japan and other companies in the city, as well as to hold discussions with Kitakyushu City regarding future collaboration.(Figure 1-5)

Figure 1-5：Mr. Fuji's (Consultant, Koror State Waste Management Office) inspection tour of Kitakyushu City (Photo taken at EV Motors Japan headquarters)

1.3.3 Overview of the 2020-2014 Project (Phase 1) and challenges

This project is an ongoing project that has been conducted since 2020. The following table summarizes the content, results, and challenges of the surveys and verifications conducted over the past three years. This year's work will follow the results and issues listed below, with the aim of further deepening and optimizing the project model.

Table 1-6 ：FY 2020 - FY 2022 City-to-City Collaboration Project for Zero-Carbon Society (Phase 1) Content of studies and verifications, outcomes and challenges

Tourism sector	Content of studies and verification	・Local traffic and passenger transportation conditions ・Laws and regulations related to the introduction and operation of EVs (tariffs, road traffic laws, etc.) ・Installation and operating conditions of photovoltaic power generation facilities/equipment ・Local needs for the introduction and operation of EVs (expected benefits, concerns, and important points) ・Studies and analysis on precedents in Japan and overseas (expected effects, challenges and measures for implementation and operation) ・Interviews on local technical requirements and examination of technologies to be introduced ・Development of hypotheses and testing project models, calculating CO_2 reduction effects ・Study on maintenance and utilisation systems ・Examination of project implementation structure and financing methods
	Outcomes	・Consideration of shuttle bus service model from airport (top candidate site for recharging base) to hotel ・Lack of public transport in the country shows that the project can be profitable if used by tourists ・Expression of high expectations for the project by stakeholders in Palau, which is in line with national policies ・Use of reused batteries can be expected to reduce the cost and increase capacity of storage batteries, which is a factor behind rising costs ・Importance of cooperation with the international airport, which serves as the starting points for tourists, to be studied in the future ・JICA is currently discussing the realization of an EV bus driving demonstration as part of the "Palau Environmentally Conscious Transportation System Development Project," for which JICA issued a public call for applications in February 2023.
	Challenges	・Reduction in initial costs ・Necessary to ensure a menu of support for the tourism industry, which has been hard hit economically by COVID-19 ・Securing parts for repair (tangible support) and human resources training for local maintenance technicians (intangible support) ・Need to build capacity and establish a system with expertise on operational systems due to lack of expertise in public transport ・Additional studies on the development of optimal models for subsidies and other forms of support, as well as on leasing and other financial schemes

		・Strengthening of cooperation with local stakeholders without traveling to the region
Waste collection and transport	Content of studies and verification	・Local waste collection and transportation conditions (vehicles in operation, collection areas, etc.) ・Status and progress of preliminary study on transhipment and storage facility for sorting resources ・Positioning of this study in the Koror State policy plan ・Laws and regulations related to the introduction and operation of EVs (tariffs, road traffic laws, etc.) ・Local needs for the introduction and operation of EVs (expected benefits, specifications) ・Survey and analysis on precedents in Japan and overseas (expected effects, challenges and measures for implementation and operation) ・Studies on technologies to be introduced ・Development of hypotheses and testing project models, calculation of CO_2 reduction effects ・Examination of project implementation system and financing methods
	Outcomes	・Study on the introduction of EVs for waste collection and transport (packer trucks) based at M-Dock ・Expectations that four packer trucks operating in the nearby collection and transport area and one large vehicle operating at the new landfill site (Aimeliik final disposal site) would be converted to EVs ・Expectations by Koror State for collaboration with the state's ongoing project to build a resource-recycling society ・Expectations for collaboration in the project to introduce EVs for waste collection and transportation vehicles as part of Koror's comprehensive project to create a resource-recycling society, in consultation with ADB
	Challenges	・Reduction in initial costs ・Selection of optimal driving models and battery capacities ・Need to secure as many subsidies as possible to reduce financial hardship, as this is a non-revenue generating project ・Securing parts for repair (tangible support) and human resources training for local maintenance technicians (intangible support) ・Ensure competitiveness with a view to bidding on the international scale ・Identification of unique local needs for larger vehicles, etc.
Other decarbonisation projects	Content of studies and verification	・Organisation of know-how and candidate seeds for environmental technology that can be delivered by Kitakyushu ・Interviews on energy efficiency and renewable energy

		needs for large-scale hotels for tourists ・Creation of added value through the carbonisation of waste tires ・Conversion of streetlights to LED lights ・Electric-powered vessels (e-ships, electric outboard motors) ・Offshore PV generation ・Recycling of lead-acid batteries ・Ocean thermal energy conversion (OTEC)
	Results / Facts found	・Identification of large hotels that are upgrading facilities ・Difficulty in disposing of waste tires and high disposal costs ・Confirmation of the installation of stand-alone LED lights in almost all areas along public roads in Koror ・Needs exist for electric-powered vessels for eco-friendly marine recreation activities ・No needs identified in terms of offshore PV power generation as there is no scarcity of land in Palau ・Collection of lead-acid batteries at this time for value and exported overseas, with domestic recycling expected to provide various benefits (extended service life, reduced economic burden, GHG emission reductions, increased used of PV power generation)
	Challenges	・Confirmation of details on hotel energy requirements and determine scale of equipment required ・Necessary to consider the introduction of LED packages with unified standards since the needs of public facilities have been confirmed ・Necessity for electric-powered vessels to meet various conditions (sailing speed, environment, power infrastructure, etc.). Practical applications are extremely limited in terms of battery performance and cost. ・Necessity for studies on reconditioning and use of lead-acid storage batteries, safety assurance, human resources development, establishment of inspection systems and criteria, institutional design, etc. ・Extremely high costs of ocean thermal energy conversion in relation to the amount of electricity demand ・Lack of understanding on current GHG emissions in Koror, so no effective measures are being considered at this time to reduce GHG emissions. With Palau's vulnerable electric power systems, many large consumers of electricity, such as hotels, use only privately generated electricity, which complicates efforts to ascertain the amount of power consumed.

2 Assessing the current situation, planning developments and reduction measures towards a decarbonized city in Koror State

From previous research, we know that the Palauan Government has designed targets for decarbonization towards 2025. However, there has been no movement towards designing targets for each state in relation to the national target. We have conducted activities to support the Koror State Government in the study of decarbonization measures in different sectors, and to link this to the setting of state targets. This chapter describes those activities.(Table 2-1 & Table 2-2)

Table 2-1 ：Stakeholders (Decarbonization sector in Koror state office buildings)

Organization Name	Abbreviation	Overview and Activities
Department of Public Works(Koror State Government)	—	Department in charge of Koror State Public Works. Counterpart for this survey towards decarbonization, with jurisdiction over SWMO.
Solid Waste Management Office	SWMO	Agency within the Koror State Department of Public Works responsible for waste administration practices. It is trying to combine waste recycling with improving the attractiveness of the city as a tourist destination, through a deposit system for beverage containers (CDL) and the construction of a glass workshop using waste glass.
Asian Development Bank	ADB	The Asian Development Bank (ADB) is currently implementing the Disaster Prevention and Clean Energy Financing Programme through a trust fund financed by the Government of Japan. This provides low-interest loan support for up to 10 years for the introduction of PV and solar water heaters for households with contributions from the Japan Fund for a Prosperous and Resilient Asia and the Pacific (JFPR), which is funded by the Japanese Government through the ADB.

Japan International Cooperation Agency (Palau Office)	JICA	Currently, JICA support the project is supporting a private company to conduct a feasibility study on a model combining mobility with carports with solar power generation and storage facilities in Palau. In addition, a demonstration introduction of electric bus public transport is being studied as part of the preparation of a master plan for public transport in the country.
Palau Public Utilities Corporation	PPUC	

Table 2-2 ：Stakeholders (Decarbonization sector in Koror state office buildings)

Hearing Target	Hearing Method
Department of Public Works(Koror State Government)	face-to-face
Solid Waste Management Office	face-to-face
Palau Public Utilities Corporation	face-to-face
Japan International Cooperation Agency Palau Office (JICA)	face-to-face

2.1 Status of previous studies and consultations

Interviews with the State of Koror on its initiatives to decarbonize are listed in Table 2-3 below.

Table 2-3 ：The efforts of Koror State for decarbonization

Item	Contents
Target Setting for Decarbonization	No clear goal setting exists.
Specific reduction action plan	No clear plan exists.
Current efforts	Promoting the following activities, mainly in the waste sector ● Composting ● Recycling for beverage container ● Utilization of energy from waste plastic through oil conversion
Issues (policy)	The following points are perceived as issues ● Current greenhouse gas emissions are not yet understood. ● The amount of reduction in the specific initiatives described above is also not yet understood.
Emission Reduction Focus Areas	The following areas of reduction are considered important ● Emission reductions in the transportation sector, including traffic congestion, is a priority. ● Consumer (household/business) sector

	● Hotel / Resorts ● Power generation ● Waste management sector

The above results were obtained. Currently, Koror State is not able to grasp the situation, and therefore, Koror State is not able to effectively consider measures for reduction. Palau has a weak power grid, and many hotels and other facilities do not use power from the grid, but only generate their own power. It can be inferred that it is difficult to keep track of energy consumption, especially electricity consumption, from these points of view, and this is an issue that needs to be addressed.

On the basis of these backgrounds, the following points were raised as expectations from the Koror side.

- Assessing and evaluating greenhouse gas emissions in Koror State
- Recommendations to Koror State for emission reductions based on the assessment results

The issues raised by the Koror State are of great importance, as they are fundamental to the consideration of future decarbonization measures, and we will consider the framework for support.

2.1.1 Organizing the greenhouse gas emission bases of the Koror state government facilities

With the support of a local counterpart, a list was made of sectors and facilities that are major sources of emissions in the Koror State. (Table 2-4)

Table 2-4 ：Organizing the greenhouse gas emission bases of the Koror state government facilities

ID	Facility Name	Facility Overview
1	Koror State Capitol	The main office of Koror State, which houses the Governor's Office, the Legislature, the Ministry of Finance, the Building and Zoning Commission, and the Public Lands Authority.
2	Koror State Solid Waste Management Office	Recycling Center

3	Dept. of Conservation & Law Enforcement	Law Enforcement Office, Environmental Conservation Office, Boat Mechanic Shop
4	Dept. of Public Works	Facilities located in Malakal, Department of Public Works. Consists of administrative offices, maintenance shop, carpentry shop, small engine maintenance shop, electrical and HVAC shop, welding and body shop, gas station, and employee housing
5	Dept. of State & Cultural Affairs	Cultural Affairs Department, Youth Department, Animal Shelter & Clinic (Paws), and the Koror State Exercise Gym are located there.
6	House of Traditional Leaders	There is a meeting hall with offices and administrative offices for the Traditional Chiefs of Koror State.
A	Koror State Streetlights	Koror State All secondary road-oriented streetlights in Koror State are covered

Energy use by six departments is a major source of emissions. Another major source of emissions is the energy use of streetlights on secondary roads.

2.1.2 Estimated energy-derived CO_2 emissions from the Koror State government

CO_2 emissions were estimated based on the energy consumption of each facility and equipment described in the previous section. The energy consumption of each facility is shown in Table 2-5.

Table 2-5 ：Energy consumption of Koror State government-related major facilities

ID	Facility Name	Gasoline	Diesel	Heavy Oil	Electricity (Purchase)	Electricity (Self Consumption)
		kl	kl	kl	kWh	kWh
1	Koror State Capitol	18	0	0	145,000	0
2	Koror State Solid Waste Management Office	32	12	0	168,000	0
3	Dept. of Conservation & Law Enforcement	190	0	0	53,000	0
4	Dept. of Public Works	90	50	0	9,000	0
5	Dept. of State & Cultural Affairs	15	0	0	55,000	0
6	House of Traditional Leaders	5	0	0	23,000	0
7	Koror State Streetlights	0	0	0	225,000	0

The estimated energy-derived CO_2 emissions from the energy consumption of each facility are shown in Table 2-6 below.

Table 2-6 ：Energy-derived CO_2 emissions from major facilities and equipment related to the Koror State government

ID	Facility Name	Gasoline	Diesel	Heavy Oil	Electricity (Purchase)	Total (t-CO_2)
		t-CO_2	t-CO_2	t-CO_2	t-CO_2	
1	Koror State Capitol	41.8	0.0	0.0	77.3	119.0
2	Koror State Solid Waste Management Office	74.2	31.0	0.0	89.5	194.7
3	Dept. of Conservation & Law Enforcement	440.8	0.0	0.0	28.2	469.0
4	Dept. of Public Works	208.8	129.0	0.0	4.8	342.6
5	Dept. of State & Cultural Affairs	34.8	0.0	0.0	29.3	64.1
6	House of Traditional Leaders	11.6	0.0	0.0	12.3	23.9
A	Koror State Streetlights	0.0	0.0	0.0	119.9	119.9
Total		812.0	160.0	0.0	361.4	1,333.3

The estimated emissions of the main facilities in Koror were 1,333.3 t-CO2.

As reduction measures at each facility, they were adjusting air conditioning temperatures and turning lighting on and off. The basic measure was to improve the operation.

As for the streetlights, they are switching to LED type lights one after another.

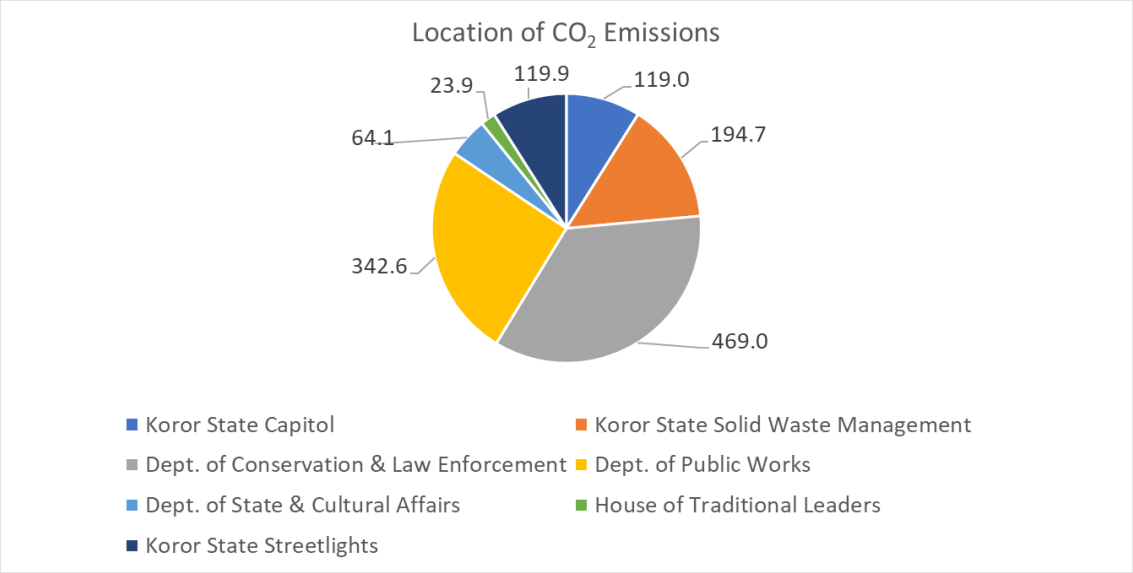


Figure 2-1 ：Percentage of CO_2 emissions location

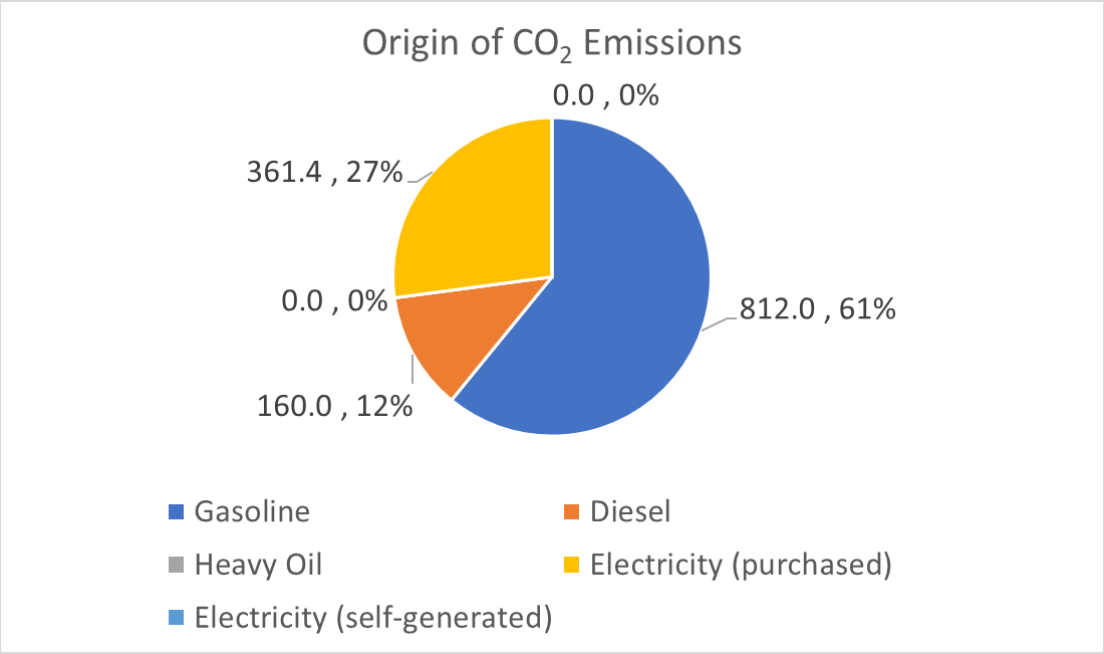


Figure 2-2：Percentage of CO_2 emissions origin

The Department of Environmental Protection and Law Enforcement was the largest emitter. This is probably due to the fact that most of the emissions are gasoline-derived (vehicles and boats). The Department of Public Works was next, with gasoline-derived (vehicles and boats) emissions also accounting for a large portion of emissions. Emissions from electricity are mostly from street lighting, the Koror State Waste Management Office, and the Koror State Office Building.(Figure 2-1)

Emissions from gasoline accounted for 61% of the total emission sources. If diesel fuel is included, it accounts for 73%. Electricity accounted for 27%. (Figure 2-2)

2.1.3 Study of greenhouse gas emissions reduction potential of state government-related facilities

While taking into account the emissions situation surveyed in the previous section, the area where it is easier to realistically consider introducing technology is the non-shipping emissions of the transport sector. For vessels, although electric-powered vessels are technically available, there are challenges in their adoption in Koror State, where vessels are used to travel to the Rock Islands and secondary islands, due to the range issues. The status of studies on reduction technologies for two sites in Koror State, the Koror State

Office Building and the Recycling Centre, was confirmed in previous years.

＜Koror State Office Building＞

Method	Status of implementation and consideration to date
Renewable Energy(Solar)	No implementation / Wish to implement
Renewable Energy(Biomass)	No implementation and not planned
Other energy (Waste to Energy, etc.)	Energy generation from plastic oil
Storage batteries	No implementation and not planned
Replacement of air-conditioning	Wish to implement
Replacement of LEDs	Ongoing for implementation / Wish to implement
Energy saving actions (Adjust air conditioning, turn off lights frequently)	Ongoing activities in progress

＜Recycle center＞

Method	Status of implementation and consideration to date
Renewable Energy(Solar)	No implementation / Wish to implement (Plans to implement to the transportation and storage station under consideration)
Renewable Energy(Biomass)	No implementation and not planned
Other energy (Waste to Energy, etc.)	Energy generation from plastic oil
Storage batteries	No implementation and not planned
Replacement of air-conditioning	Not planned
Replacement of LEDs	Ongoing activities in progress
Energy saving actions (Adjust air conditioning, turn off lights frequently)	Ongoing activities in progress

The following studies are confirmed to have been carried out at each facility and site as studies of more specific activities.

1) Study on the introduction of photovoltaic fields in the Koror State Office building.
2) Renewal of the centralized air-conditioning system in the Koror State Office building.
3) One solar installation at the recycling center at present, but the inverter (assumed to be the PCS) is not working, according to the site.

These are all points where cost is the main factor preventing initiatives from being taken forward.

2.2 Workshop held(Discussion with situation and intentions for decarbonization of the Koror State Government)

Discussions and workshops were held with the Koror State Government and the Koror State Waste Management Office on the contents of previous years' surveys and the way forward.

(1) Workshop with State Government (Governor and Director of Public Works)

A workshop was held with the Governor of Koror, Eyos Rudimch, and the Director of the Public Works Department, Leslie Tewid, to exchange views on the future direction of the decarbonization study based on the content of the previous studies.(Table 2-7

Table 2-7 ：Overview of Workshop

<Outline of the workshop>
Date: 16th, January. 2024
Time: 10:00 a.m.— 11:15 a.m.
Location: Meeting room at Koror State Office
Participants :
<Koror State side>
Eyos Rudimch (Governor of Koror State Government)
Leslie Tewid (Director of Public Works, Koror State Government)
Selby P. Etibek(Koror Solid Waste Management Office Manager, Koror State Government)
Katsuo Fuji (Adviser of Koror Solid Waste Management Office)

<Kitakyushu side>

Hiroyuki Sato (AMITA HOLDINGS CO., LTD. / Vice Chairman and Chief Engagement and

Partnerships Officer)

Eiichi Yamato (AMITA CORPORATION /Team Manager of International Business Team)

Sho Koizumi(ATGREEN Co., Ltd /Chief Consultant of Consulting Section)

Seiya Tominaga(ATGREEN Co., Ltd/ Director and General Manager of Consulting Section)

＜Timeline＞

Time	Contents	Presenter
10:00 (5 minutes)	Opening remarks	Kitakyushu side
10:05 (25 minutes)	Introduction to Our Study - Research Policy - Survey Contents - Expected Outcome - Challenges	ATGREEN
10:30 (40 minutes)	Free Discussions Theme: Biomass, Cleaning service at Hotel, EV, SDGs,Decarbonization Contents: Expectations, concerns, issues, considerations	All participant
11:10 (5 minutes)	Closing remarks	Koror State

Figure 2-3：Scenes at the event

Through the stakeholder consultations, reference was made to the following points.

- Appreciation was expressed for the current understanding of CO2 emissions in Koror.
- Koror State considers that it would be better to start with the public office building and study one facility at a time, and then expand to other facilities, rather than covering all facilities from the beginning.
- The Koror State Office Building is considering the use of solar power and storage batteries, as well as energy from refined oil (equivalent to diesel oil) from the waste plastic oil refinery, with a view to operating the building with an independent energy source that does not rely on grid electricity as much as possible.
- Koror has perovskite photovoltaic cells donated by another country and is considering how to utilize them (they are currently in storage).
- The use of woody biomass is a good idea. For biomass, it would be good to consider cooperation with the PPUC

(2)Solid Waste Management Office in Koror State(SWMO)

Meetings were also held with the Koror State Waste Management Office to discuss decarbonization measures in the office. The introduction of solar power generation equipment and storage batteries for the introduction of EV waste collection and transport vehicles are currently being considered for the construction of a comprehensive resource recycling system. In addition, SWMO has started to generate electricity using refined oil from its waste plastics oil refinery, and plans are in place to use the power stored from solar power generation for standby power in the glass workshop at night, while using the generator as the power source during the day.

2.3 Proposed measures to reduce greenhouse gas emissions in Koror State with potential efficiency gains.

Based on the Koror State's intentions, a study on the installation of solar energy in state buildings was carried out. A study was conducted on the installation of solar panels on the roofs of government buildings in Koror.

<Conditions of the study＞

- Installation of panels on the south-facing roof of the Koror State Office Building.
- The installation site is shown in Figure 2-4 (approx. 10 m x 10 m = 100 m^2 x 2 locations = 200 m^2).
- The installed capacity was set at 40 kW in consideration of 5 m^2 per kW, including the securing of a margin area.
- The amount of sunshine in Palau is about 190 W/m^2 (140 W/m^2 in Tokyo)[6], which is expected to be sufficient.
- The unit price of grid electricity is 42.7 cents/kWh (64.05 JPY/kWh at 150 yen to the dollar), which is the latest value heard from the PPUC.

Figure 2-4：PV installations in Koror State Office Building.(Plan)

(Map Source：Google Map)

[6] European Centre for Medium-Range Weather Forecasts (https://sites.ecmwf.int/era/40-atlas/images/full/B05_LL_YEA.gif)

The expected annual power generation for the installed PV capacity is estimated based on figures from the PVWatts[7] Calculator (roof-mounted case), which can calculate expected power generation based on sunshine data from various countries. The highest amount of electricity was generated during the relatively dry season around March, with an expected annual output of around 52,118 kWh. The installed capacity of 40 kW is not considered to be excessive (at least in terms of weekday operation), as the power consumption at the Koror State Office Building is estimated to be approximately 72 kW during weekdays and 11 kW during nights and holidays, based on the equipment list and usage pattern data of the Koror State Office Building. However, the use of storage batteries to store electricity should be considered for the surplus of electricity during weekends and holidays. One reason for this is that it is difficult to return power to the grid due to power supply instability caused by frequency fluctuations in the PPUC grid. Assuming that all of this power generation replaces the grid electricity in Palau, the CO2 emission reduction is calculated to be 27.7 t-CO2/year. (The emission factor for Palau is 0.533 t-CO2/MWh from the table of CO2 emission factors (tCO2/MWh) for electricity in the JCM facility subsidy project in FY2023 under the Facility Subsidy Project of the Bilateral Credit System Financial Support Project of the Ministry of the Environment). The actual emission factor for diesel power generation in Palau is estimated to be around 0.805-0.631 tCO2/MWh based on actual power generation efficiency (33-41%), but since the baseline is too low in that case, this figure, which is the factor at 49% power generation efficiency, was used in the equipment subsidy project and this estimate also follows it.

[7] NREL PVWatts Calculator (https://pvwatts.nrel.gov/pvwatts.php)

PVWatts Calculator

RESULTS

52,118 kWh/Year*

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)
January	4.68	4,420
February	5.01	4,266
March	5.22	4,906
April	5.01	4,493
May	4.51	4,191
June	3.94	3,555
July	4.16	3,872
August	4.56	4,227
September	4.66	4,209
October	5.18	4,821
November	5.17	4,628
December	4.80	4,530
Annual	4.74	52,118

Location and Station Identification		
Requested Location	palau	
Weather Data Source	(INTL) KOROR ISLAND, PALAU	15 mi
Latitude	7.33° N	
Longitude	134.48° E	

PV System Specifications	
DC System Size	40 kW
Module Type	Standard
Array Type	Fixed (open rack)
System Losses	14.08%
Array Tilt	20°
Array Azimuth	180°
DC to AC Size Ratio	1.2

Figure 2-5：Expected PV generation (according to PVWatts Calculator)

If the entire amount can be effectively utilized for self-consumption, it is expected that the cost of procurement from the grid from the PPUC will be reduced by approximately USD 22,250 (approximately JPY 3,338,000/In the case of 150 yen to the dollar) annually, based on the latest PPUC electricity price (42.7 cents/kWh) as already mentioned. This means that even if the unit cost per unit kW is set at 450,000 JPY (250,000 JPY/kW for equipment and construction, 200,000 JPY/kW for transport and tariffs), the investment is expected to pay off in the sixth year. In addition to this, further cost benefits can be expected by utilizing various funds such as the JCM equipment subsidy project and ADB. In addition, from a resilience perspective, the use of storage batteries is also considered effective, and a model for utilizing the island's energy sources is expected to be developed by combining power generation using waste plastic oil-derived fuel, which is already being prepared in the Koror state.(Figure 2-6)

Image of energy utilization model for Koror State Office Building

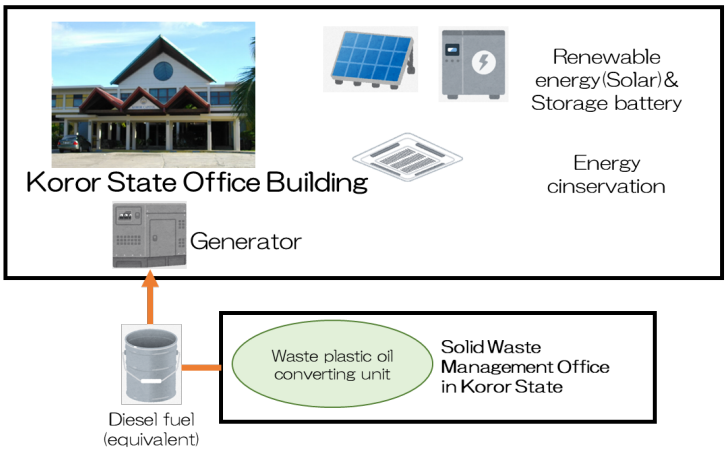


Figure 2-6：Image of energy utilization model for Koror State Office Building.

2.4 Study of monitoring methods and applicable methodologies

Solar JCM projects have already been implemented in Palau in the past and the methodology JCM_PW_AM001_ver01.0 'Displacement of Grid and Captive Genset Electricity by a Small-scale Solar PV System" has been developed. Therefore, it is considered fundamental to use this methodology when applying for JCM equipment subsidy projects. However, when using storage batteries, this methodology cannot be used as it is because it is necessary to take into account losses during storage, etc. Therefore, it is necessary to formulate a new methodology separately. This will be a matter for future consideration.

This section describes matters related to the concept of the project reductions based on the methodology JCM_PW_AM001_ver01.0 'Displacement of Grid and Captive Genset Electricity by a Small-scale Solar PV System'.

$$ER = EM_{BL} - EM_{PJ}$$

Table 2-8 ：Concept of emission reductions

Code	Definition	Unit
ER	Emission reductions	tCO_2/per year
EM_{BL}	Baseline emissions	tCO_2/ per year
EM_{PJ}	Post-project emissions	tCO_2/ per year

As the project involves the installation of photovoltaic installations, the generation of renewable energy from these installations and the substitution of grid electricity, the baseline emissions are the emissions from the use of grid electricity and the post-project emissions are the emissions from the creation of renewable energy sources. The latter is considered as zero (N/A) as it is a renewable energy source.

Post-project emissions are calculated using the following equation.

$$EM_{PJ} = EL_{PJ} \times CEF_{electricity.t} = N/A$$

Table 2-9 ：Calculation for post-project emissions

Code	Definition	Unit
EM_{PJ}	Post-project emissions	tCO_2/ per year
EL_{PJ}	On-site consumption of electricity generated by photovoltaic installations after project implementation	kWh/ per year
$CEF_{solar\text{-}electricity.t}$	CO_2 emission factor for photovoltaic electricity (zero)	tCO_2/kWh

Baseline emissions are calculated using the following equation.

$$EL_{BL} = EL_{PJ}$$

Table 2-10 ：Calculation for baseline emissions

Code	Definition	Unit
EL_{BL}	Baseline use of grid electricity	kWh/per year
EL_{PJ}	Onsite consumption of electricity generated by the photovoltaic installation after project implementation	kWh/per year

The calculation of baseline emissions is based on the following approach

$$EM_{BL} = D_{BL} \times CEF_{electricity.t}$$

Table 2-11 ：Calculation for baseline emissions

Code	Definition	Unit
EM_{BL}	Baseline emission	tCO_2/per year
EL_{BL}	Baseline use of grid electricity	kWh/ per year
$CEF_{grid\text{-}electricity..t}$	CO_2 emission factor for grid power	tCO_2/kWh

sed on these concepts and assuming an annual electricity generation of 52,118 kWh, the expected amount of CO_2 reduction from the introduction of photovoltaic installations was as follows.(Table 2-12)

Table 2-12 ：Expected amount of CO2 reduction from the introduction of photovoltaic installations

Equipment capacity	Expected amount of CO_2 reduction
40kW	27.7t-CO_2/per year

Typical monitoring parameters are the items in Table 2-13.

Table 2-13 ：Monitoring parameters

Items	Unit
Electricity generated by photovoltaic installations	kWh
Private consumption of the above electricity generated	kWh

In this project, it is assumed that the entire amount of electricity generated by the photovoltaic power generation equipment is consumed on site, but if the entire amount of electricity generated cannot be consumed on site, such as if there is a surplus, the electricity consumption needs to be assessed excluding this amount. Therefore, when assessing the reduction of greenhouse gas emissions, it is necessary to know how much of the generated electricity was consumed onsite, or was either discarded without being consumed onsite or returned to the grid. In this respect, it is envisaged that the data from the PCS is recorded and managed using data loggers or similar.

2.5 Schedule for the following years and beyond

The schedule for future project implementation is envisaged in Table 2-14 below. Activities will first be carried out to set reduction targets while studying emission reduction measures for state government buildings. At the same time, discussions with the GEC (Global Environment Centre) and fund donors with ADB will be carried out with a view to the possibility of installing equipment, and activities will be carried out with a view to both studying decarbonization measures and installing equipment

Table 2-14 ：Schedule for the following years and beyond

Items	FY2023		FY2024		FY2025	
	Previous	Next	Previous	Next	Previous	Next
Identification of current public facility emissions						
Study emission reduction						

measures for public facilities						
Setting emission reduction targets for public facilities						
Identify emissions in specific sectors (e.g. transport and accommodation)						
Study emission reduction measures and set targets for specific sectors (e.g. transport and accommodation)						
Identification of emissions in expanded areas of the state						
Establishment of targets for the expanded state						
Study the feasibility of installing equipment in public facilities						
Discussions with fund donors						
Activities for introduction						

2.6 Summary and future issues

The following is a summary and future issues of the research conducted in this chapter on the current situation, planning and reduction measures for a decarbonatization city in Koror State.

<Summary>

- It was found that emissions from fuel derived from vehicles and vessels account for most of the CO_2 emissions in Koror State Office.
- For electricity, it was found that emissions from state buildings and waste management offices and from street lighting accounted for most of the emissions
- It was found that the state has a desire to start considering decarbonization-related measures in public office buildings first, and then roll them out horizontally to other facilities
- The study examined the substitution of grid electricity by photovoltaic generation as a concrete decarbonization measure, it found that a payback effect of around six years is expected under the conditions of the current estimates, partly due to the increase in the unit price of electricity

＜Future issues＞

- Consideration of installed capacity to be balanced with the generation of electricity using refined oil from the oil refineries being considered by the state

- Installed capacity of storage batteries in relation to the above
- Measures to reduce the burden of installation costs and discussions with fund donors
- Compilation of decarbonization measures for state public buildings and preparation of draft target setting

3 Feasibility Study on Project Formation (Introduction of biomass boilers for decarbonization and co-benefit generation using woody biomass)

Within the state of Koror, the center of the Republic of Palau, which is a tourism-based country, there are many tourist hotels, mainly Japanese and Taiwanese. Many of these hotels are large-scale resort hotels with many trees and tropical plants. In the past year's survey, we received comments from the people involved in these hotels that they generate enough pruned branches to fill a truck on a daily basis. The following are excerpts from interviews conducted in previous years.

【Details of interviews with large hotels】

- The company currently uses prunings and other materials as fertilizer (compost that is naturally fermented and returned to the soil) and does not use them as energy
- The plant is growing vigorously, so a 2-ton truck is used to transport one vehicle every day
- By planting palms, it is possible to secure coconut shells as a heat source
- Currently, hot water is generated by a heat exchanger from the radiator of the generator.
- Steam is also needed for the dryers used for washing clothes (3 dryers, 2 irons, a pressing machine, and a laundry machine (the machines themselves are operated by electricity)), and steam is used to heat the clothes and remove oil stains
- Steam boilers (light oil was renewed about 10 years ago, and two boilers are in use. Further renewal should be considered in the future.

Since there are no major industries in Koror and the Republic of Palau, most GHG emissions are concentrated in the transportation sector, the business and other sectors such as hotels and restaurants, and the consumer and household sectors. Therefore, it is important to promote emission reduction activities in hotels in order to achieve the goal of a zero-carbon city, and to take action in response to the recent increase in green tourism. Based on this information, the introduction and utilization of biomass boilers is expected in each hotel, and this survey was conducted.

The country faces challenges not only in meeting its electricity demand, but also in

meeting its heat demand. It imports expensive gas entirely from overseas, which makes its energy costs high and vulnerable to external social influences. In this regard, energy self-sufficiency by utilizing fuels available on the island is expected to produce various co-benefits, as shown in Table 3-1 below, as well as decarbonization.

In this study, we focused on the use of woody biomass as a heat source for washing and drying linens, which is expected to be the highest heat demand in each hotel. The hypothetical models are: (1) a "distributed model" in which woody biomass boilers are installed in each hotel and woody biomass such as pruning branches generated in each hotel is used as fuel; and (2) an "intensive model" in which woody biomass and linens in each hotel are consolidated in one place, and linens are washed and dried using woody biomass as fuel. Currently, there are no existing services in Palau that specialize in laundry services, so the creation of a new laundry service will also be considered in the intensive model (Figure 3-1). The linens referred to here include sheets, bath towels, pillowcases, and other items provided in hotel guest rooms.

Table 3-1 ： Expected co-benefits along with decarbonization from biomass boiler installation (example)

Item	Contents
Stabilization of energy costs	Stabilization of energy costs through effective use of energy sources in the region
Effective use of local resources	Maximize effective use of a wide range of resources in the region
Job creation	Potential for jobs to be created by collecting and transporting biomass, operating boilers, etc.
New Business Creation	Possibility of creating business revenue opportunities by connecting to building a linen service business
Improving the image of the tourism sector	Positioning of green tourism as an action to materialize

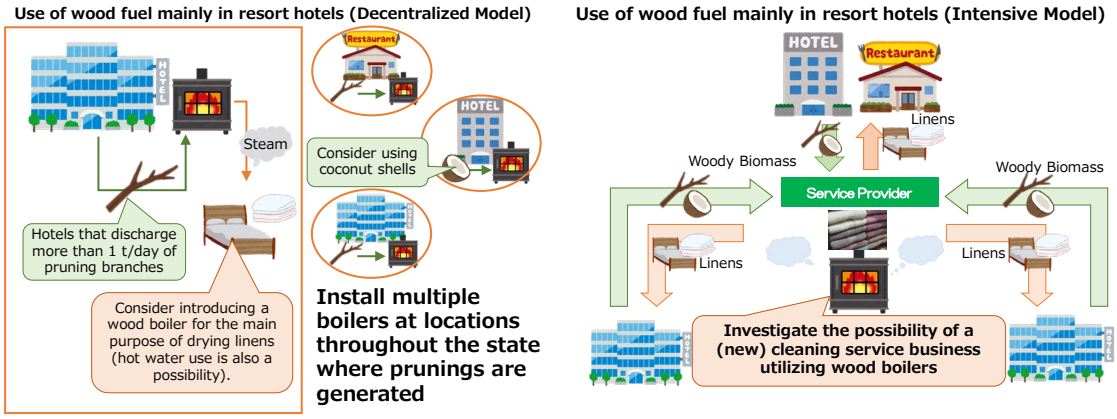


Figure 3-1： Hypothetical model of woody biomass utilization Decentralized (left) and Intensive (right)

Table 3-2 below summarizes the local stakeholders and organizations that are assumed to be involved in this study. Interview surveys were conducted with these stakeholders regarding local needs and the possibility of collaboration with this project. The PPUC was also added to this study because it was confirmed during this study that the PPUC is also a large woody biomass emitter.

Table 3-2 ： Assumed Stakeholders (Biomass Utilization Sector)

Organization	Details
Palau Pacific Resort (PPR)	One of the three major local hotels (165 guest rooms). Tokyu Land Corporation is the parent company.
Palau Royal Resort (PRR)	One of the three major local hotels (157 guest rooms). It is Taiwan-affiliated but managed by Okura Nikko Hotels.
Palasia Hotel Palau	One of the three major local hotels (165 guest rooms). Taiwanese-affiliated.
COVE Resort Palau	A medium-sized hotel (74 guest rooms). A Japanese national is the manager. Australian-affiliated.
Garden Place Hotel	A small hotel (12 guest rooms). A Japanese is engaged as the manager.
Palau Public Utilities Corporation (PPUC)	A public corporation that manages and operates the electric power system in Palau. Every day, the company prunes trees along roads throughout the country to prevent trees from getting caught in power lines and breaking the lines.
Roadrunner Palau	The only private company in the country that performs yard cleaning.

3.1 Woody biomass generation and utilization in hotels and public engineering

The amount of woody biomass generated by each hotel and public works is summarized in

Table 3-3 below. The results of the detailed interviews revealed that the initially expected amount of 2 t/day in PPR was not generated. However, the amount that is basically landfilled or truncated could contribute to the decarbonization of the state if it could be recovered efficiently. The amount of waste generated is only roughly estimated by the hotel in terms of vehicle units (one 2-ton truck), etc., so the figures have a wide range of estimates. However, in cases where the waste is carried out to the state of Aimeliik, the weight may be measured by truck scale and converted into data, so close examination of these figures will be an issue in the next fiscal year.

In addition, the tropical rainforest has a variety of tree species and sizes, and herbaceous biomass is also mixed in. The boiler manufacturer that cooperated with us in the study of boiler specifications commented that combustion of different tree species can be handled in a wide range, unless the calorie content is extremely different (e.g., wood and plastic). In addition, the company commented that combustion of herbaceous materials is possible by flattening them when they are fed as a measure against ash.

Table 3-3 ： Woody biomass generation and treatment in hotels and public engineering

Organization	Woody biomass generated (wet※ - t/year)	Frequency /Method of treatment	Characteristics, occurrence, etc.	Remarks
Palau Pacific Resort (PPR)	6～9	2-3 times a month/ Fertilized and used as fertilizer	Tree species is a hybrid	Occurs mostly after typhoons (hard ground prevents deep root growth)
Palau Royal Resort (PRR)	25	Every few days / Landfill disposal	Predominantly palm trees	Has a dedicated gardening department (2-3 people)
COVE Resort Palau	24～48	Once a week / Landfill Disposal	Mixed with cut grass, coconut shells, etc.	
Palau Public Utilities Corporation (PPUC)	32～97	Daily/rounded down (partially used by states)	Sizes vary from branches to logs	Occurrence throughout the country
Roadrunner Palau	4～7	2-3 times a month / Landfill Disposal	Sizes vary from branches to logs	Providing home garden tree trimming services.
Total amount generated (wet - t/year) (wet - kg/day)				92～187 251～512

※Assuming a moisture content of 55% in the raw wood state

As a result, it can be said that the hypothetical decentralized model is difficult to realize because of the small amount of wood generated by each hotel, and that the hypothetical intensive model is more realistic.

3.2 Washing and drying of linens in hotels

Table 3-4 below summarizes the status of linen washing and drying at each hotel. As a trend, medium to large hotels have dedicated laundry staff. In terms of energy, large hotels use a steam boiler with light oil for drying, while medium to small hotels use electricity for drying. The cost is higher for electricity, but the actual cost difference is even smaller for diesel oil because of the additional boiler maintenance and technician labor costs required in addition to these results.

Interviews were also conducted on the quantity of linens owned by each hotel, but all hotels indicated that it was difficult to estimate the number of sheets.

Table 3-4 ： Current linen washing and drying practices in each hotel

Organization	Number of rooms	Washer /Dryer (unit)	Laundry staff (persons)	Energy used for heat supply	Purchased energy for heat supply (USD/month)
Palau Pacific Resort (PPR)	165	Each 3	5	Diesel	Unrecognized
Palau Royal Resort (PRR)	157	Each 3~4	3～4	Diesel	4,520
Palasia Hotel Palau	165	Each 3~4	3～4	※	※
COVE Resort Palau	74	Each 2	2	Electricity	5,200
Garden Place Hotel	12	Each 2	None (staff who are available will perform the work)	Electricity	300

※Unknown because the interview was conducted but the respondents declined to respond

3.3 Local needs, possible schemes, and issues in the PJ for introducing wood biomass boilers

Table 3-5 below summarizes the needs of stakeholders, expected effects, and challenges

of participation in the intensive model. The majority of the hotels are short of staff (currently staffed by a large number of foreign workers, including Filipinos). We found that there is a certain need for an intensive cleaning service that can help solve this problem. In the case of Garden Place Hotel, the number of employees is small to begin with, so the hotel has devised a resource management strategy, positioning the laundry service as a coordinating task for employees who are available. This kind of innovation is likely to be common in small hotels (10 to 20 guest rooms) that do not have dedicated laundry staff, and the use of laundry services in hotels of this size is expected to spread only after the use of laundry services in medium to large hotels has spread to a certain extent.

Regarding the operation of the intensive cleaning service, some said that if there is a time lag between when a hotel deposits linens with the service and when they are returned, it is necessary to increase the linen inventory, and that the cost and ingenuity to prevent the linens from being mixed with those of other hotels is an issue. Since this service does not currently exist in Palau, it is necessary to carefully design the system construction in cooperation with a company that has know-how in Japan when the implementation of the service is considered.

On the woody biomass supply side, the PPUC is currently basically truncating 87-265 kg of wood per day (Figure 3-2), a situation that has led to constant complaints from residents, so the PPUC is very positive about participating in the hypothetical model. However, the PPUC also has serious problems with staffing and vehicle shortages (also a major reason why lumber is being truncated). During this interview, the manager of the department in charge of the project commented that the PPUC could cooperate in collecting and consolidating the logging sites in Palau if a large transport vehicle could be introduced. This model may be feasible if an EV truck for wood hauling can be introduced to the PPUC in conjunction with the project to convert waste collection and hauling vehicles to EVs, which has been under consideration since Phase 1 and is currently being followed up.

Table 3-5 ： Needs, Expected Benefits, and Challenges in Participation in the Intensive Hypothetical Model

Organization	Assumed Roles in the Model	Current willingness to participate in the project	Expected benefits	Challenges to project participation
Palau Pacific Resort (PPR)	Biomass supply / Cleaning Service Users	Consideration depending on conditions	Cost Reduction (energy and labor	Procurement and maintenance of large laundries (intensive)

			costs)	
Palau Royal Resort (PRR)	Biomass supply / Cleaning Service Users	Consideration depending on conditions	Cost Reduction (energy and labor costs)	Timing of project implementation (renewal of existing boilers is a good time to do so)
Palasia Hotel Palau	Cleaning Service Users	No possibility at present	—	—
COVE Resort Palau	Biomass supply / Cleaning Service Users	High probability	Elimination of staffing shortages	Creation of cost advantages
Garden Place Hotel	Cleaning Service Users	Consideration depending on conditions	Cost Reduction	Linen return speed and management by hotel (intensive)
Palau Public Utilities Corporation (PPUC)	Biomass supply	Much possible under certain conditions	Decrease in resident complaints	Insufficient vehicles and personnel
Roadrunner Palau	Biomass supply	High probability	Reduction of current processing costs (labor and fuel)	Coordination of roles with PPUC

Figure 3-2： Wood with PPUC truncated after pruning.

3.4 Consideration of implementation and operation model

Based on the above results, the model to be introduced and considered for operation in this study is shown in Figure 3-3. The hypothetical model to be adopted is an intensive model, in which woody biomass is aggregated in cooperation with hotels, PUCCs, and private wood harvesters, and then used as fuel for steam boilers for linen cleaning services mainly in medium to large hotels (50 to 160 guest rooms). Since it is considered a high hurdle to establish a new facility for cleaning services, a joint operation system was envisioned in which a biomass boiler is installed in the laundry room of an existing hotel and a service for cleaning and drying linens of other hotels is provided on a contract basis.

- We received assistance from Company A, a boiler manufacturer that leases linens to hospitals and nursing care facilities, in estimating the amount of steam and woody biomass required for this model and in selecting a boiler with appropriate specifications. Company A is using its own RPF boiler in the cleaning process, and since the scheme is similar to this model, we received advice on this model from a perspective specific to cleaning applications.

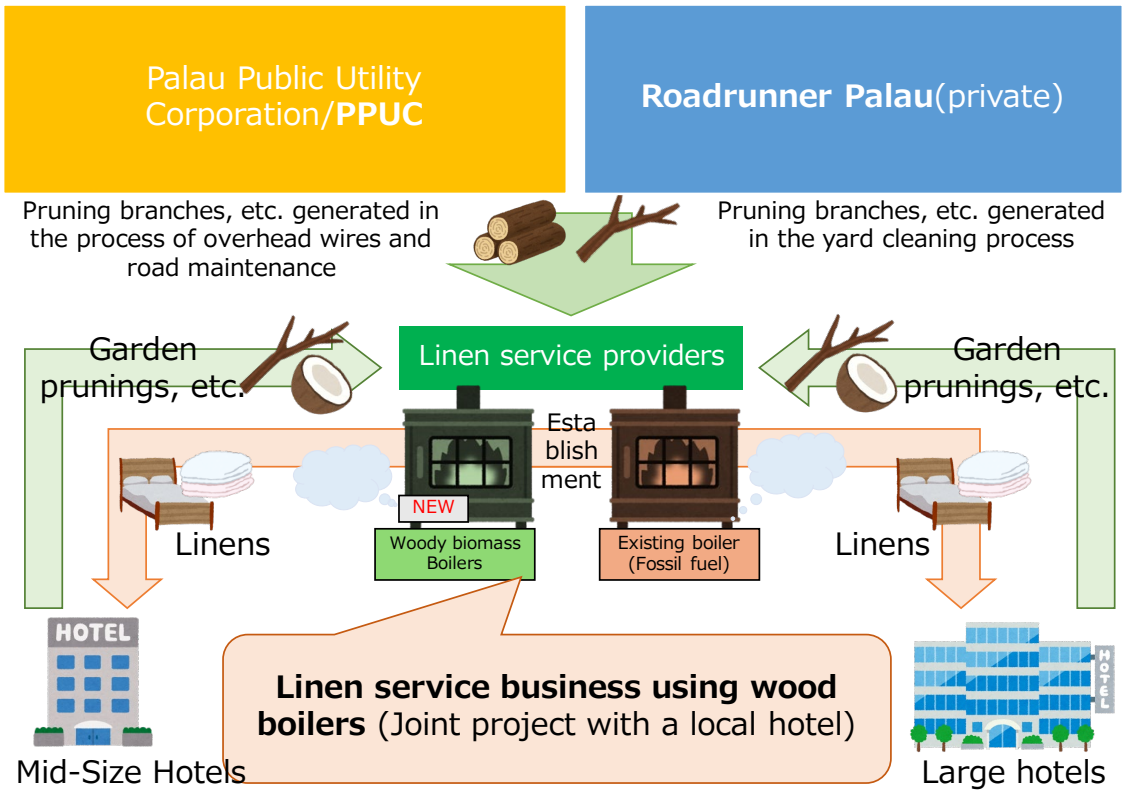


Figure 3-3： Models to be considered for introduction and operation (woody biomass and linen intensive)

3.4.1 Consideration of Applicable Boilers

1) Estimated linen demand

As mentioned in section 3.2, all of the hotels interviewed indicated that it was difficult to estimate the quantity of linens they own. Therefore, we estimated the quantity of linens owned by each hotel based on the quantity of linens per room (Table 3-6) and the number of rooms in each hotel (Table 3-7). As mentioned earlier, the target audience for the provision of cleaning services was medium to large hotels, and two cases were set for room occupancy rates: 75% (optimistic scenario) and 30% (pessimistic scenario).

Table 3-6 ： Linens Quantity per Room (Estimated) and Quantity Estimates under Optimistic and Pessimistic Scenarios

Types	Linen quantity per room (sheets)	Replacement ratio	Optimistic scenario (sheets)	Pessimistic scenario (sheets)
Bath Towel	4	75%	1,832	722
Wash Towel	2	100%	1,221	481
Face Towel	4	75%	1,832	722
Bath mat	1	75%	458	180
Sheets	2	50%	611	241
Pillow cases	4	50%	1,221	481
Futon cover	2	50%	611	241
Bathrobes※	2	75%	848	339
		Total	8,517	3.407

※Applicable only for rooms 50 and above

Table 3-7 ： Hotels and Number of Rooms for Linen Analogies

Eligible Hotels	Number of rooms
Palau Royal Resort (PRR)	157
Palau Pacific Resort (PPR)	165
Palasia Hotel Palau	165
COVE Resort Palau	74

Airai Water Paradise Hotel & SPA	73
West Plaza Hotel at Lebuu Street	70
PALAU CENTRAL HOTEL	50
Palau Hotel	48

2) Estimation of required steam volume

Based on the fact that biomass boilers should be used up to 60% of the peak as turndown, the amount of steam was estimated based on the average of the optimistic and pessimistic scenarios. It is assumed that the existing fossil fuel boilers will be used to compensate for the shortfall in steam.

In the linen cleaning factory operated by Company A, the maximum amount of steam from the washing and drying machines used is approximately 3,000 kg/h for 40,000 towels/day. On the other hand, the average hotel linen quantity in Palau is about 20,000 towels/day (4 towels for bath towels and 8 towels for sheets, duvet covers, and bathrobes). If the number of times of washing is assumed to be three times a day, the number of sheets washed per time is about 7,000, and the amount of steam required to be supplied from the biomass boiler is estimated to be about 500 kg/h.

3) Consideration of applicable boilers

The assumed fuel and boiler equipment (manufactured by Company A) are summarized in Table 3-8 below.

Table 3-8 ： Fuel and boiler equipment to be introduced in this model

Item	Contents	Item	Contents
Name	Wood chips (planned)	Structural Standards	Multi-pipe once-through boiler (Small once-through boiler)
Shape	L 50mm or less pin chips	Steam generation	Converted steam capacity max. 500kg/h
Heating value	3,000kcal / kg (Dry Base)	Steam pressure	Max. 0.98MPa
Moisture	35% (max. 40% or less)	Combustion chamber fireproofing Insulation method	Air-cooled wall structure
Ash	Less than 3% (Dry Base)	Turndown	Appropriate turndown

Sulfur	Shall not include
Chlorine	0.6% or less

	up to 40
Ancillary system	Multi-stage combustion system

3.4.2 Consideration of Business Profitability

The following is a summary of the preconditions for the business profitability study, including those already mentioned.

- Linen service will be outsourced as a joint project with the partner (existing hotel operator)
- Biomass boilers will be installed alongside the existing fossil fuel boilers of the partner company.
- Approximately 30% of the total linen volume of medium and large hotels (more than 50 rooms) in Palau will be recovered.
- This project is expected to be implemented in cooperation with the Waste Management Office of the State of Koror, a partner in the "Establishment of a Comprehensive Resource Recycling System" project. In addition to reducing the initial investment, the collaboration with the existing project in Koror is expected to bring benefits to both parties, such as commonization of operations for crushing, mixing, and storage of woody biomass, and deepening the relationship with the existing hotel operators.
- Unit price of outsourced services was set in consideration of sufficient outsourcing benefits for laundry costs (washing and drying) in medium to large hotels.

Table 3-9 below summarizes the facilities and equipment that are expected to be newly introduced.

Table 3-9 ： Facilities and equipment expected to be newly introduced in this model

Facilities and Equipment	Quantity	Remarks
Biomass boiler (500 kg/h of steam)	1 unit	Estimate based on 50% JCM equipment subsidy (Including export and installation costs, etc.)
Simple building	1 building	For contract laundry
Commercial washing machine	1 unit	Contract laundry
Medium-sized wood chipper	1 unit	

Semi-outdoor building	1 building	For crushing, mixing and storage of raw materials
Medium truck	2 units	Used/linens collection and delivery, chips and incinerator ash transportation

Based on the above assumptions and the introduction of facilities and equipment, the evaluation of business profitability showed that the investment can be recovered in about six years. The amount of wood chips (35% moisture content) input was estimated to be about 300 kg/day (125 kg/hour x 2.2 hours).

3.4.3 CO_2 Reduction Effects

For the GHG emission reductions associated with the substitution of woody biomass boilers for light oil boilers, refer to the methodology "EN-R-001 Ver2.1 Substitution of fossil fuels or grid electricity by biomass solid fuel (woody biomass)" in the J-Credit System in Japan. The reductions shall be monitored for project activities in which a biomass boiler is installed to replace an existing light oil boiler, thereby replacing the use of light oil. The monitoring parameters are the items in the table below.(Table 3-10)

Table 3-10 ： Data used to estimate reductions

Item	Value	Unit	Remarks
Biomass input	300	kg/day	Biomass feedstock used per day
Number of operating days	365	days	365 days
Lower Heating Value of Biomass	3,100	kcal/kg	Hardwood with 35% water content
Lower Heating Value of light oil	8,549	kcal/L	Figures published by Japan's Agency for Natural Resources and Energy
Amount of diesel oil substituted	0.11	kL/day	From calorific value and feedstock input
Emission factor of light oil	2.58	t-CO_2/kL	Basic Act on Global Warming Countermeasures
Number of units introduced	1	unit	Considered as a single intensive boiler

Since the composition of local wood is not known at this time, the calorific value is estimated for hardwoods. Reference emissions are those associated with the use of diesel oil. Since there is no emission data for the composition of diesel oil in Palau, the emission factor (2.58 t-CO2/kl) used in Japan for reporting under the Global Warming Prevention Law was used. The current result is 102.44 t/year.

3.4.4 Consideration of monitoring methods

There is no past experience of JCM projects for biomass heat supply in Palau. Regarding the substitution of fossil fuels with biomass fuels, the methodology EN-R-001 Ver2.3 "Substitution of Fossil Fuels or Grid Electricity by Biomass Solid Fuels (Woody Biomass)" has been developed for the J-Credit System in Japan. Therefore, when applying for JCM facility subsidy projects, it is considered fundamental to develop a new methodology with reference to this methodology.

In this section, we describe the contents of the items related to the concept of this project reduction based on the methodology EN-R-001 Ver2.3 " Alternative to fossil fuels or grid electricity by biomass solid fuels (woody biomass)". The methodology describes detailed conditions for the application of the methodology, so the main points are described below.

- Condition 1: Projects that use fossil fuels or grid electricity prior to project implementation are eligible for this methodology
- Condition 2: This methodology only covers the portion of heat consumed by the project implementer that has installed heat source equipment using biomass solid fuel for its own consumption
- Condition 3: The feedstock for the biomass solid fuel subject to this methodology is limited to woody biomass that will not be used for material or energy use if the project is not implemented*. Grass and coconut (including coconut shells) do not qualify as woody biomass
- Condition 4: Conditions related to construction waste (use of construction waste for home heating is not allowed)
- Condition 5: Additional applicable conditions specified in each relevant methodology shall be met when renewing or installing new equipment as well as replacing fossil fuels with biomass solid fuels. (Even when a boiler renewal project is implemented, the project must be a new boiler installation project if the conditions of this methodology are met.)

Condition 3 may be a bottleneck in this project. This point needs to be confirmed with the

executive body of the JCM facility subsidy project in the future.

The following is a summary of the concept of emission reductions based on this methodology.

$$ER = EM_{BL} - EM_{PJ}$$

Table 3-11 ： Concept of Emission Reductions

Code	Definition	Unit
ER	Emission Reductions	tCO_2/year
EM_{BL}	Baseline Emissions	tCO_2/year
EM_{PJ}	Post-Project Emissions	tCO_2/year

Since this project is an alternative to fossil fuels by installing a woody biomass boiler and generating renewable thermal energy from the boiler, the baseline emissions are from the use of fossil fuels and the post-project emissions are from the use of solid biomass fuels. The main emission activities are as described above, but additional emissions from transportation and use of fuel conversion facilities are also included as ancillary emission activities.

Post-project emissions are calculated by the following equation.

$$EM_{PJ} = EL_{PJ.M} + EM_{PJ.S}$$

Table 3-12 ： Calculation of post-project emissions

Code	Definition	Unit
EM_{PJ}	Post-project emissions	tCO_2/year
$EM_{PJ.M}$	Major emissions after project implementation	tCO_2/year
$EM_{PJ.S}$	Incidental emissions after project implementation	tCO_2/year

The monitoring of incidental emissions shall be conducted when $EM_{PJ.M}=0$ and the impact of the incidental emissions on the expected emission reductions is significant (5% or more). (Monitoring can be omitted if the impact is between 1% and 5%. If monitoring is omitted, the impact must be calculated and multiplied by the emission reductions so that the reductions do not become a challenge assessment. In addition, the total amount of omitted monitoring must not exceed 5%. (If the impact is less than 1%, the calculation can be omitted.))

Baseline emissions are organized based on the following concept

$$Q_{BL,heat,input} = Q_{PJ,heat,input} = F_{PJ,biosolid} \times HV_{PJ,biosolid}$$

Table 3-13 ： Baseline Emissions Concept

Code	Definition	Unit
$Q_{BL,heat,input}$	Heat used in the target facility in the baseline (heat input)	GJ/year
$Q_{PJ,heat,input}$	Heat used in the target facility after project implementation (heat input)	GJ/year
$F_{PJ,biosolid}$	Unit calorific value of biomass solid fuel after project implementation [wet basis]	t/year
$HV_{PJ,biosolid}$	Unit calorific value of biomass solid fuel after project implementation [wet basis]	GJ/t

Baseline emissions are calculated based on the following approach (when a new boiler is installed)

$$Q_{BL\ heat\ output} = Q_{PJ\ heat\ output} = F_{PJ\ biosolid} \times HV_{PJ\ biosolid} \times \varepsilon_{PJ}/100$$

Table 3-14 ： Calculation of baseline emissions

Code	Definition	Unit
$Q_{BL\ heat\ output}$	Heat produced by the target facilities in the baseline	GJ/year
$Q_{PJ\ heat\ output}$	Heat produced by the target facilities after project implementation	GJ/year
$F_{PJ\ biosolid}$	Unit calorific value of biomass solid fuel after project implementation [wet basis]	t/year
$HV_{PJ\ biosolid}$	Unit calorific value of biomass solid fuel after project implementation [wet basis]	GJ/t
ε_{PJ}	Energy consumption efficiency of the subject facility after project implementation	%

The general monitoring parameters are listed in Table 3-15 below.

Table 3-15 ： Monitoring Items

Monitoring of activity amount (after project implementation)
Fuel consumption for transportation of biomass feedstock
Fuel consumption for all biomass fuel conversion processes
Electricity consumption for all biomass fuel conversion processes
Weight of biomass solid fuel produced for the project
Fuel consumption for transportation of biomass fuels
Fuel consumption in additional facilities
Electricity consumption at additional facilities
Amount of biomass solid fuel used in the facility [wet basis].
Heat generated by the facility
Amount of hot water or steam heated in the facility
Monitoring coefficients
Unit calorific value of fuel used for transportation of biomass feedstock
CO_2 emission factor per unit calorific value of fuel used to transport biomass feedstock
Unit calorific value of fuels used for all biomass fuel conversion processes
CO_2 emission factor per unit calorific value of fuels used for all biomass fuel conversion

processes
CO_2 emission factor of electricity
Unit calorific value of fuels used for transportation of biomass solid fuels
CO_2 emission factor per unit calorific value of fuel used for transporting biomass solid fuel
Emission factor per unit calorific value of fuel used to transport biomass solid fuel
Emission factor per unit calorific value of fuel used in additional facilities
Unit calorific value of biomass solid fuel used in the facility [wet basis]
Unit calorific value of biomass solid fuel used in the facility [dry basis]
Moisture content of biomass solid fuel (wet basis)
CO_2 emission factor per unit calorific value of the fuel used in the baseline facility.
Energy consumption efficiency of the facility in the baseline
Temperature difference of hot water heated in the facility before and after heating
Enthalpy difference of steam heated in the facility before and after heating
Specific heat of hot water
Density of hot rate

3.4.5 Consideration of Project Implementation Structure

As mentioned previously, the establishment of a new implementation facility is considered to be a high hurdle, so a joint project scheme with existing hotel operators and other collaborating businesses is envisioned.

In addition, a representative of Roadrunner Palau, the only private company in Japan that undertakes yard cleaning operations, also expressed interest in participating in this project as an operator. The company also generates approximately 500 kg of logged wood twice a month, which is delivered to a final disposal site in the state of Aimeliik for landfill disposal. The distance from Koror State to the disposal site is great, and the company intends to reduce fuel and labor costs for the vehicles. Since there may be other private operators with this type of interest, we believe that we should conduct a deeper investigation in the next and subsequent years.

3.5 Maintenance system and utilization system

Maintenance has been voiced as the biggest challenge by each stakeholder. Maintenance challenges exist in both the hardware and software aspects. The hardware issues are mainly related to the cost of maintaining spare parts, etc., while the software issues are related to the training of maintenance personnel, etc.

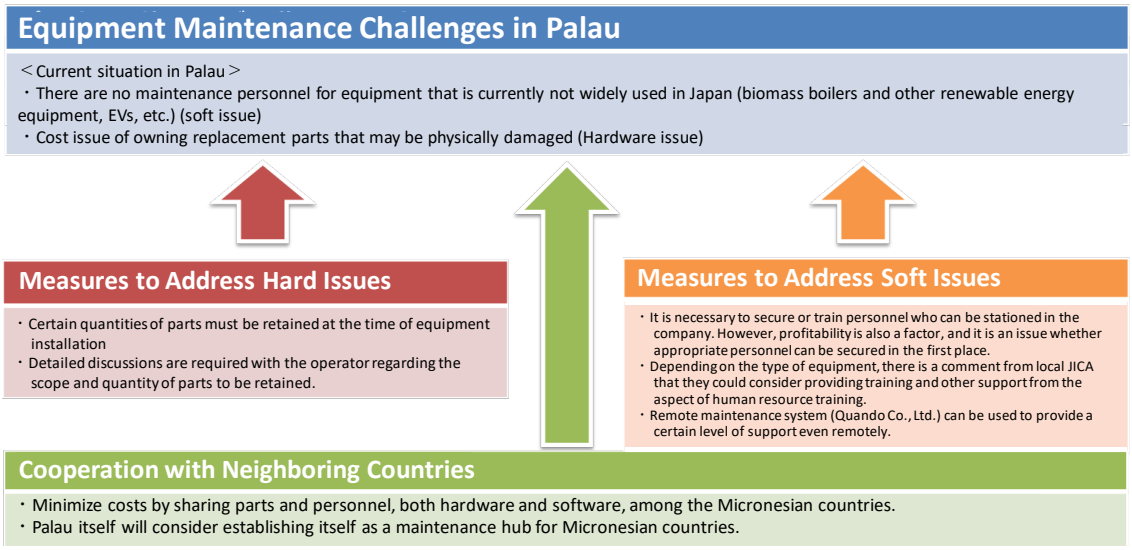


Figure 3-4： Hardware and software issues and proposed measures for maintenance

Local parties considering implementation of the project are aware of the need to retain some of the hardware parts. However, it is also pointed out that it is necessary to discuss details with manufacturers regarding the retention of detailed parts, and it is also considered necessary to sort out the cost burdens and other issues.

On the other hand, the software side issues require the stationing and training of maintenance personnel, which cannot be resolved in a short period of time. JICA has commented that, depending on the type of equipment, it may be possible to consider support for training sessions on this point. In addition, it is considered necessary to take measures for both hardware and software by providing online support, such as by utilizing "SynQ Remote" provided by Quando Inc. within the survey team.

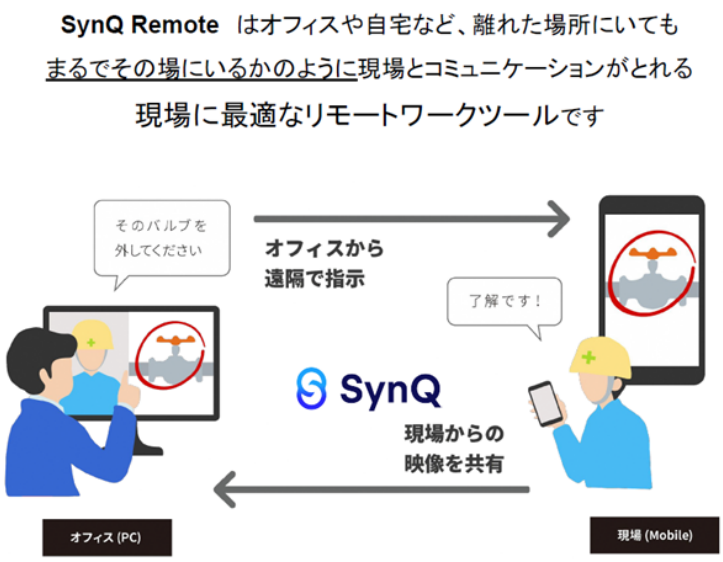


Figure 3-5： Conceptual diagram of the remote maintenance tool provided by Quando Inc.

3.6 Consideration of financing

As for financing, the Republic of Palau's tourism industry, which is a core industry, has been hit hard by COVID-19 and is finally beginning to recover, making it difficult for both the public and private sectors to generate funds. On the other hand, it is considered essential to add value to the tourism sector in order to revitalize the country's economy in the future.

Therefore, it is essential to secure subsidies to reduce initial costs. Specifically, we are considering applying for JCM equipment subsidies, and clarification of this point is an issue to be considered in the following fiscal year and beyond, in parallel with the establishment of a business structure.

3.7 Consideration of Project Implementation Schedule

Based on the results of this year's survey, the following Table 3-16 is assumed to be the implementation schedule for the wood biomass and linen intensive cleaning service project.

Table 3-16 ： Future project implementation schedule

Item	FY2023		FY2024		FY2025	
	Previous	Next	Previous	Next	Previous	Next
Scrutiny of biomass availability						
Scrutiny of boiler						

specifications						
Market research and scrutiny of linen business						
Study and establishment of project implementation system						
Cost and introduction model scrutiny						
Consideration for obtaining various types of subsidies						
Application for JCM equipment subsidies and other						
Project implementation						

3.8 Summary and future issues

A summary of this year's survey results and future issues are described below.

＜Summary＞

- The amount of woody biomass generated by hotels, private yard cleaning companies and public works is 251~512 kg/day wet weight (92~187 t/year)
- For hotels, there is a certain need for outsourcing cleaning services due to staff shortages, especially in medium to large hotels.
- The PPUC could cooperate in the collection and consolidation of logged timber through this project if large transport vehicles could be introduced in order to respond to the many complaints about the timber that is currently being truncated.
- In addition to the above situation, the amount of woody biomass is too large to be used independently at each woody biomass generation point. Therefore, the model to be considered for introduction and operation in the future is a model in which both woody biomass and linen are consolidated and a cleaning service using biomass heat supply is implemented (intensive model)
- Based on the scale of the linen service business estimated in this study, the business profitability of the intensive model was evaluated as being able to recover the investment in about 6 years, and a certain level of profitability was expected. The amount of wood chips input is estimated to be about 300 kg/day (125 kg/hour x 2.2 hours), which can be covered by the amount of wood biomass currently available.

＜Future issues＞

- The amount of woody biomass generated is only known in rough figures such as vehicle units (one 2-ton truck), which is an estimated range of figures. However, it is possible that in cases where the waste is being taken to a final disposal site in the state of Aimeliik, the weight is being measured and datamined using truck scales. In the next year, we would like to examine the numbers and conduct further source investigations.
- The linens recovery rate was somewhat over-specified for the envisioned biomass boiler because it was designed based strictly on the practicality of securing wood chips and the needs for laundry outsourcing. It is necessary to further optimize the boiler in terms of additional woody biomass potential, laundry outsourcing needs, boiler efficiency, etc., which will be investigated in the next fiscal year. We would also like to investigate heat demand destinations other than hotels and study the feasibility of deployment.
- Laundry costs were estimated based on major hotels using light oil boilers, but estimates were also obtained for small and medium-sized hotels using electric dryers, which are more advantageous in terms of cost. On the other hand, electricity costs are expected to increase by approximately 23% from 2024, and additional research should be conducted in the future to determine whether a proposal with overall benefits can be made, including cost acceptability.
- The tourism industry is the most important sector in Palau, and in order to continue to be recognized as an internationally advanced tourism destination, it is essential to develop branding and communications along with ambitious sustainability initiatives. This initiative will be positioned as a "Sustainable Tourism Program" for future zero-carbon tourism, and we will consider promoting values other than cost, with a view to fostering a movement involving tourism associations, businesses, and government agencies.

4 Follow-up to obtain funding for the introduction of commercial EV vehicles

We have been conducted studies and investigations into the introduction of commercial EV vehicles in this city-to-city collaboration project. Specifically, the conversion of buses to EVs (considering their use as public transport from the tourism sector) and the conversion of waste collection and transport vehicles to EVs.

4.1 Status of studies and discussions to date

<Tourism and public transport sector>

In the tourism and public transport sector, the introduction of an operational model that uses solar power and storage batteries for recharging has been studied, as shown in Figure 4-1. The buses are expected to have approximately 30 passengers, a battery capacity of 114 kWh and a cruising range of 230 km.

Figure 4-1 : Image of the introduction of EV buses in the tourism and public transport sector

It is envisaged that these buses will be used as public transport during the daytime for transport to the capital, Markyok, and as school buses, while at night they will be used to transport tourists, thereby increasing their operation and improving profitability.

<Waste collection and transport sector>

The introduction of an operational model that uses solar power + storage batteries to recharge the batteries has been considered in the waste collection and transport sector, as well as in the waste collection and transport sector. The intended installation site is in the State of Koror, specifically at the Waste Management Office (SWMO). The envisaged waste packer vehicle has a load capacity of 1,995 kg, vehicle importance of 8,280 kg, battery capacity of 110 kWh and a range of less than 180 km. Currently, Koror State

collects waste with four packer trucks and plans to convert about two of these to EVs. It is envisaged that the surplus electricity will be used for nighttime power at the glass workshop, as already mentioned.(Figure 4-2)

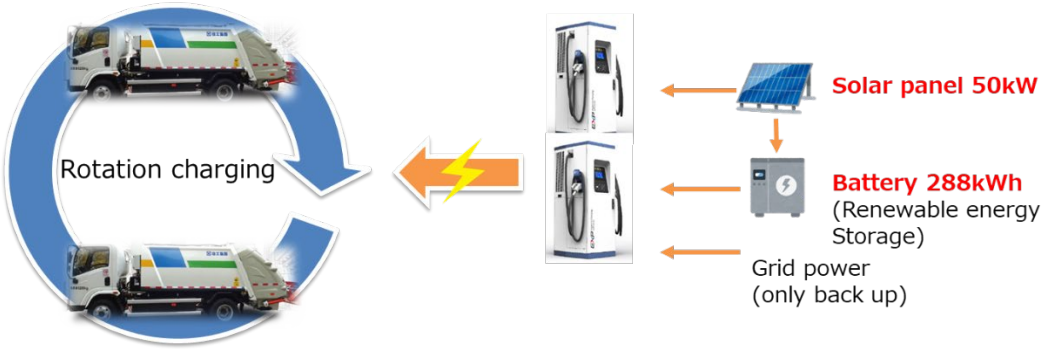


Figure 4-2 : Image of the introduction of EV buses in the waste collection and transportation sector

4.2 Current considerations

Discussions with fund donors are underway to introduce commercial EVs on the basis of the studies carried out so far. An overview of these is given here.

4.2.1 Introduction of EV buses in the tourism and public transport sector

Given the situation of the Palauan tourism industry, which is still recovering from the damage caused by the COVID-19 pandemic, it is still difficult to motivate local operators to bear the cost of EV vehicles, which are more expensive than regular vehicles, and related equipment costs such as PV and storage batteries. Currently, the Japanese Ministry of Land, Infrastructure, Transport and Tourism (MLIT) and the Palauan Ministry of Public Infrastructure, Industry and Commerce (MPIIC) are working together to review the Palauan National Transport Master Plan. One specific project is the Palau Environmentally Friendly Transport System Development Project, which was publicly advertised by JICA in February 2023, and within this project there is a plan to conduct an EV bus driving demonstration. The possibility of introducing EV buses has been discussed in consultation with relevant parties in this regard, but the demonstration in this project will not be carried out as it has not been possible to dispel concerns about the burden of battery replacement costs and maintenance. However, as emissions from the transport sector are one of the main sources

of emissions in Palau, we will continue to promote the introduction of the system in test runs and other situations.

4.2.2 Introduction of EV buses in the waste collection and transportation sector

Since the time of the survey in previous years, the Koror State Waste Management Office has been positive about the introduction of EV vehicles to reduce the burden of transport costs to the national Aimérique final disposal site and to establish a lower environmental impact waste transport and treatment flow. The ADB Public-Private Partnerships Department, which has been in discussion with Koror State, and UNEP, which has newly expressed interest in the project, have received a proposal to introduce a zero-carbon mobility demonstration project using GEF-8 funds, and are working with the Koror State Waste Management Office and the intercity collaboration team on the application. The project is currently underway. Discussions with the fund donor will continue and follow-up will be carried out to promote the project.

4.3 Schedule for the next and subsequent years

Table 4-1 envisages a timetable for the future.

Table 4-1 ： Schedule for the next and subsequent years

Items	FY2023		FY2024		FY2025	
	Previous	Next	Previous	Next	Previous	Next
Scrutiny of costs and implementation models						
Study on obtaining various types of assistance, including fund donor discussions						
Application for support programmes						
Project implementation						