

Project commissioned by the Ministry of the Environment in FY2022

**City-to-City Collaboration for Zero-Carbon Society  
in FY2022**

**(Support Project for Developing a Sustainable Eco-friendly  
Smart City: An Intercity Collaboration between Urasoe City  
and Airai State)**

**Report**

**March 2023**

**Japan NUS Co., Ltd.**

**Urasoe City**



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Table of Abbreviations

Abbreviation	English	Japanese
ADB	The Asian Development Bank	アジア開発銀行
AIFFP	Australian Infrastructure Financing Facility for the Pacific	オーストラリア・インフラストラクチャー・ファイナンス・ファシリティ
BCP	Business Continuity Plan	事業継続計画
BEMS	Building and Energy Management System	ビル・エネルギー管理システム
COP26	The 26th Conference of the Parties	第26回気候変動枠組条約締約国会議
DR	Demand Response	需要応答
DX	Digital Transformation	デジタル変革
EPC	Engineering, Procurement and Construction	設計・調達・建設
GHG	Greenhouse Gas	温室効果ガス
HEMS	Home Energy Management System	ホームエネルギーマネジメントシステム
IPP	Independent Power Producer	独立系発電事業者
IRENA	The International Renewable Energy Agency	国際再生可能エネルギーアソシエーション
JANUS	Japan NUS Co., Ltd.	日本エヌ・ユー・エス株式会社（本都市間連携提案事業者）
JCM	Joint Crediting Mechanism	二国間クレジット制度
JICA	Japan International Cooperation Agency	独立行政法人国際協力機構
PPA	Power Purchase Agreement	電力販売契約
PPUC	The Palau Public Utilities Corporation	パラオ電力公社
PV-TPO	Photovoltaic Third-Party Ownership	太陽光第三者所有モデル
PWA	Palau Energy Water Administration	パラオ政府財務省エネルギー・水管理組織
LED	Light Emitting Diode	発光ダイオード
MG	Motor and Generator	モーター発電機
NDBP	The National Development Bank of Palau	パラオ開発銀行
NDC	Nationally Determined Contribution	国が決定する貢献（国別温室効果ガス削減目標）
SPPP	Solar Pacific Pristine Power Inc.	ソーラーパシフィック・プリスティン・パワー
TPO	Third Party Ownership	第三者所有モデル
REO	Reliance Energy Okinawa Corp.	株式会社リライアンスエナジー沖縄
VPP	Virtual Power Plant	仮想発電所

WiFi	Wireless Fidelity	無線 LAN
4R	Reduce, Reuse, Recycle and Refuse	減らす、再利用、リサイクル、断る（ゴミ減量の考え方）

## **1. Background, Purpose and Implementation Structure of This Project**

### **1.1. Background and Purpose**

With a consensus document produced at the 2021 United Nations Climate Change Conference (COP26) held in November 2021, it was confirmed that a new global goal is to keep the increase in air temperature since the industrial revolution by no more than 1.5°C. In order to attain this goal, it is indispensable to accelerate initiatives at various levels, including provincial, municipal, and ward levels, in each country. The Japanese government, too, declared that it aims to realize a decarbonized society by decreasing the net emissions of greenhouse gases to zero by 2050, and the number of municipalities that have declared that they will decrease the net CO<sub>2</sub> emissions to zero increased rapidly to over 600 (as of April 30, 2022). Based on the roadmap for decarbonization in each region, which was formulated in June 2021, advanced measures have been designed in each region, and activities for spreading them nationwide are ongoing.

Accordingly, the roles of cities and local governments in discussing and implementing specific local climate change measures and projects are becoming increasingly important. In order to realize a decarbonized society all over the world, it is necessary to accelerate the movement toward building a sustainable decarbonized society, especially in Asia where economic growth is remarkable. There is a growing international movement to support the efforts of cities to decarbonize and lower the carbon footprint of their activities, as these cities are the places that support social and economic development.

In addition, amid the lingering COVID-19 pandemic, cities have to deal with the challenges related to the spread of the infection and readjust and discuss new measures to achieve sustainable development, so collaboration among cities to build new methods and new cities is extremely important. In this project, Japanese research institutes, private companies, universities, etc. as well as Japanese cities that have experience and know-how in building a carbon-free and low-carbon society will conduct a research project to support overseas local governments in their efforts to build a carbon-free or low-carbon society and to install equipment that will contribute to the realization of a carbon-free or low-carbon society.

In this survey, Urasoe City in Okinawa Prefecture will support decarbonization with the aim of promoting renewable energy and making it the mainstream while utilizing its experience in environmentally-friendly urban development including in terms of renewable energy and energy-saving technologies that are in high demand in Airai State in the Republic of Palau (hereinafter “Airai State”).

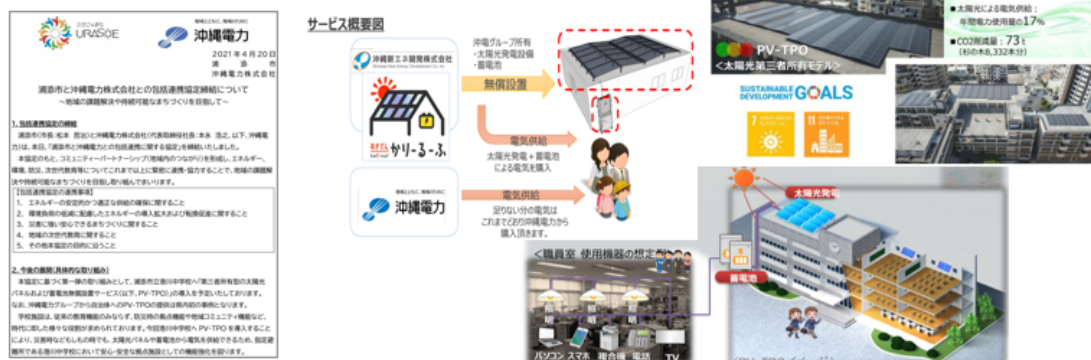
Specifically, upon obtaining the cooperation of SeED Okinawa LLC, a company in the Okinawa Electric Power Group which has signed a comprehensive cooperative agreement

with Urasoe City, we will consider promoting the PV-TPO third-party owned solar panel and storage battery free installation service which is being rolled out by the Okinawa Electric Power Group in Urasoe City. In addition, we aim to expand the use of renewable energy by introducing and promoting technologies in Palau tiltable wind power generation. Furthermore, upon obtaining the cooperation of the NEXTEMS in Urasoe City, which is conducting a demonstration experiment on the remote monitoring and control of distributed power sources and controllable loads, we will consider making renewable energy the mainstream and then consider a future reduction in greenhouse gas emissions. We assume we will utilize the JCM equipment subsidy program in the introduction stage of these. We will conduct the following activities in this survey in the formation of each project.

(i) Third-party Owned Solar Panel and Storage Battery Free Installation Service (PV-TPO)

Large solar independent power producers (IPPs) are being planned in Palau with a target of reaching a renewable energy ratio of 45% by 2025. It is essential to promote self-consumption solar power generation on the consumer side to promote renewable energy. The third-party owned solar panel and storage battery free installation service (PV-TPO) seems to be an effective measure. In particular, it is estimated that 3 MW will be introduced with the rooftop type which is the mainstream in Palau by 2025. That is three times the current level. We have also set a target of 9.4 MWh by 2025 for storage batteries whose introduction is currently lagging and are working on the development of that. Airai State has many public, commercial and industrial facilities including public schools. Therefore, it is expected that the horizontal roll out in Airai State of the third-party owned solar panel and storage battery free installation service (PV-TPO), which has a record of being introduced in Urasoe City, will be implemented with the cooperation of the state government.

地域課題解決や持続可能なまちづくりに向け、  
**沖縄電力と包括連携協定を締結**



「浦添市立港川中学校」へ、太陽光発電設備および蓄電池を無償設置し、電気を供給するサービス（PV-TPO事業）を導入。  
・災害時の拠点機能や地域コミュニティ機能をもつ学校施設において、災害時でも太陽光パネルや蓄電池から電気を供給できる為、安心・安全な拠点施設としての機能強化に貢献。

**Figure 1: Overview of the PV-TPO Service Being Rolled out in Urasoe City**

We will consider the feasibility and effects in this survey by surveying the following items.

- We will sort out policies relating to measures to promote solar power generation in Airai State.
- We will identify potential sites and calculate the introduction size.
- We will search for local business operators who will take the lead in rolling out the PV-TPO service.

## (ii) Tiltable Wind Power Generation Field

Palau has ample wind power resources. Nevertheless, wind power generation has not spread. That is because it has issues characteristic of a remote island such as frequent typhoons and a shortage of engineers who can repair equipment. Okinawa Electric Power's tiltable wind power generation technology is ground-breaking renewable energy technology for such areas. This technology was introduced into the Kingdom of Tonga in 2018.

## トンガ王国へ可倒式風力発電所を導入



2019年トンガ王国へ5基の可倒式風力発電所を導入し、  
既存のディーゼル発電所の燃料費の年間150万TOP  
(Tonga pa'aneaで約7,500万円に相当)の節約に貢献



### Figure 2: Introduction of Tilttable Wind Power in the Kingdom of Tonga

The Government of Palau also has a high level of interest in tiltable wind power generation technology. For example, it made a request to Okinawa Electric Power for cooperation in FY2018. That means the groundwork to execute and realize this project in this survey is already there.

Accordingly, we will consider the feasibility and effects in this survey by surveying the following items.

- We will explore potential sites throughout the whole of Palau centered on areas where the power grid in Airai State is expected to be connected under the assumption of the state as the demand area.
- We will identify and organize the effects and issues of introducing tiltable wind power. We will then consider an introduction plan.

(iii) Introduction of High-efficiency Air Conditioning and Hot Water Supply Equipment (Energy Services) for Commercial and Public Facilities, and Potential Fields of Hydrogen Manufacturing

We will conduct a feasibility survey in anticipation of the introduction of high-efficiency air conditioning and hot water supply equipment in various facilities in the urban area of Airai State. At the same time, we will consider energy services (introduction of energy-saving equipment through third-party ownership) as a measure to promote this scheme.

In addition, we will consider promoting the use of hydrogen based on the FY2021 Three-country Collaboration Project for the Manufacture and Use of Hydrogen (Three-country Collaboration Project for the Manufacture and Use of Hydrogen in the Bilateral Credit Scheme Funding Support Program).

- We will identify facilities with high energy demand in Airai State and then consider a range of energy-saving ideas based on the energy usage situation.
- We will consider the possibility of introducing the home-use fuel cell Ene-Farm and use including in transportation and ships as a hydrogen utilization destination.

(iv) Grid Stabilization Field in Anticipation of the Introduction of the Proposed Technologies and Services

Integrated control with various power sources across the country is needed for the introduction of the three technologies/services (PV-TPO, tiltable wind power and energy services) in this proposal. Moreover, introducing a control system (area aggregation) for



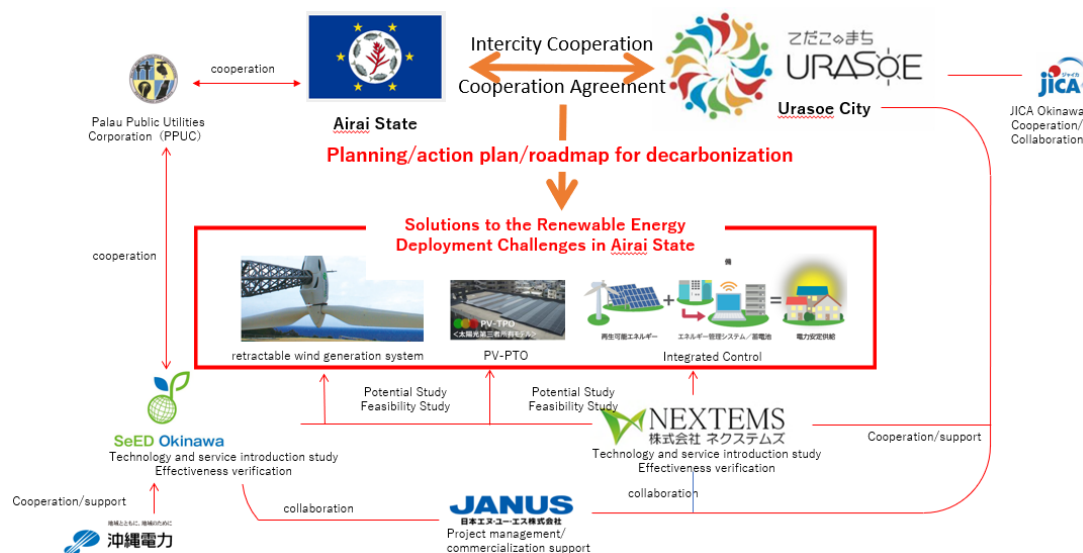
controllable loads on the consumer side such as the PV-TPO service and energy services will also contribute to grid stabilization on the demand side. Therefore, it can be expected to lead to further grid stabilization. We will consider the feasibility of grid stabilization in this survey by surveying the following items.

- We will consider optimal grid stabilization measures such as the introduction of storage battery equipment while obtaining the cooperation of the Palau Public Utilities Corporation (PPUC) and Okinawa Electric Power for grid stabilization measures relating to tiltable wind power.
- We will consider the possibility of introducing an area aggregation system as an electric power supply and demand control measure.

#### (v) Policy Proposals

We will introduce our efforts and exchange opinions including on energy saving, waste disposal and environmental education which have been undertaken in Urasoe City to promote decarbonization measures in Airai State. We will use plans formulated by Urasoe City as examples including the Basic Environmental Plan and the Urasoe City Global Warming Countermeasures Plan.

These business concepts are shown in the figure below.



**Figure 3: Intercity Collaboration Business Structural Chart**

## **2. Commercialization Plan Consideration**

### **2.1. Overview of Palau and Climate Change Countermeasures**

The Republic of Palau (hereinafter “Palau”) is a republican state consisting of islands in the Micronesian region of the Pacific Ocean. It has an area of 459 square kilometers. That is equivalent to about 70% of the 23 districts of Tokyo. Its population is approximately 18,000. That makes it the fourth least populated country in the world. The capital is Melekeok. It is located on the east coast of the country’s largest island of Babeldaob.

The capital was relocated from Koror State in 2006 due to reasons such as to ease overcrowding and to disperse the economic functions of the country. Koror State is still home to the majority of the population. It is home to the largest city in the country with hospitals and broadcasting stations making it the heart of economy and commerce. Airai State, home to the second largest city in terms of population in the country, has an international airport and its population is growing as a commuter town adjacent to Koror State and the capital of Melekeok. It is an area with a high interest in environmentally-friendly urban planning including renewable energy and energy saving technologies.

Palau has many things in common with Okinawa Prefecture including the climate, food, the ocean and weather disasters such as typhoons. In addition, a unique culture has formed here while the influence of Japan and America still remains against a backdrop of historical rule by Japan and then later by America. It is on a path close to the crossroads Okinawa Prefecture has reached today through historical changes.

It is said that more than 40% of the approximately 11,000 Japanese residents living in Palau in the 1940s were from Okinawa Prefecture. There are still many Palauan people with roots in Okinawa Prefecture who are descendants from them.

In recent years, Governor Tamaki of Okinawa Prefecture issued a congratulatory message upon the inauguration of the President of Palau in 2021. It was announced at that time that the two sides would promote exchanges and joint efforts for the resources and technologies they possess. Okinawa Prefecture and Palau entered into a memorandum of understanding to strength their friendly relations in August 2022. Furthermore, Okinawa Electric Power received a letter requesting technical cooperation in regards to its tiltable wind power technology from the Minister of Energy of Palau. The company then dispatched engineers to Palau to investigate the situation. Friendly relations have continued since then.

The Okinawa Electric Power Group is enthusiastically working on technical cooperation overseas. The JICA Okinawa program has been accepting overseas trainees every year since FY2003. It is aiming to improve the skills of the engineers who will play

a leading role in each country. The program has accepted a total of 181 trainees from a total of 51 countries up to the 19<sup>th</sup> year of the program in 2022. Of those, Okinawa Electric Power has accepted six trainees from Palau.

JICA Okinawa has been running a program since approximately 40 years ago to accept approximately 400 trainees a year from overseas. The program has so far accepted 13,000 trainees from 164 countries. It has accepted a total of 121 trainees from Palau. Two trainees from Palau are currently undergoing training in the program as of July 2022. That means the program is contributing to personnel and technical exchanges between Palau and Japan.

The head offices of JICA Okinawa and Okinawa Electric Power are located in Urasoe City. The city has a cooperative relationship with them. In particular, Okinawa Electric Power entered into a comprehensive cooperative agreement with the city in 2021. It is proactively working on the utilization of environmentally-friendly energy such as by introducing solar power into public facilities under this agreement.

The energy policy of Palau states that the country will do the following as climate change countermeasures in its National Energy Policy 2010: (1) adapt to physical changes in the environment and respond to current and future risks and (2) cooperate with greenhouse gas (GHG) reduction measures and international GHG emission measures.

Palau, which is 100% reliant on imports for its energy, is aiming to do the following as measures to reduce its imports of petroleum products: (1) promote energy-saving measures, (2) diversify energy and introduce renewable energy and (3) improve energy security and supply reliability.

**Table 1: Environmental and Energy Issues in Airai State in Palau**

1. Promotion and stable supply of renewable energy: Palau has set a target (NDC) of increasing its renewable energy ratio to 45% by 2025. Nevertheless, the ratio was stuck at 3% as of 2019. There are limits on the contribution of large-scale solar power generation. Accordingly, there is an urgent need to promote renewable energy combined with wind power and small solar power generation.
2. Energy-saving efforts: It is expected that the demand for electric power will increase in 2025 by 37.6% compared to 2016. Therefore, Palau is striving to position energy saving measures as an important national policy. In particular, energy services which lead to the promotion of energy-saving in facilities which consume lots of energy such as public, commercial and industrial facilities (efforts to reduce CO <sub>2</sub> by introducing energy-saving equipment through third-party ownership) are effective efforts.
3. Grid stabilization measures accompanying the expansion in the introduction of renewable energy:

It is expected that the importance of grid stabilization efforts will increase with the spread and expansion of renewable energy. It is thought that the introduction of micro-grid control technologies such as supply and demand adjustment for each site will be effective grid stabilization measures in demand-intensive areas away from diesel power plants especially.

It can be said that the environmental policies of Palau are consistent with decarbonization efforts through the intercity collaboration project.

Accordingly, we plan to proceed with the feasibility survey and project development with the cooperation of Urasoe City in the intercity collaboration project aiming to solve issues through related technologies possessed by companies in the city in addition to policy support to spread and promote the above efforts.

In addition to energy-saving efforts, waste disposal and recycling, Urasoe City is promoting environmentally-friendly energy services through the PV-TPO third-party owned solar power panel and storage battery free installation service from the Okinawa Power Group. Airai State has a high level of interest in knowledge about such policy realization and target setting.

As mentioned above, Okinawa Electric Power, which has entered into a comprehensive agreement with Urasoe City, has conducted a field survey in the past based on a request from the Government of Palau to introduce and promote technologies in the country for tiltable wind power generation. It has built a technical cooperative structure since then. SeED Okinawa LLC is a group company of Okinawa Electric Power. It was established to promote the overseas business expansion of the Okinawa Electric Power Group. It is possible to utilize the technologies and knowledge relating to the introduction and expansion of renewable energy in small remote island systems in Okinawa Prefecture which the group has cultivated so far, as well as Okinawa Electric Power's cooperative relationship with Palau. Moreover, NEXTEMS, which is located in the city, is working on selling solar power generation systems, storage batteries and equipment such as EcoCute, and demonstration experiments for distributed power sources and remote monitoring and control of controllable loads. It is possible to expect application by the company utilizing its control technologies and construction record to make energy-saving the mainstream.

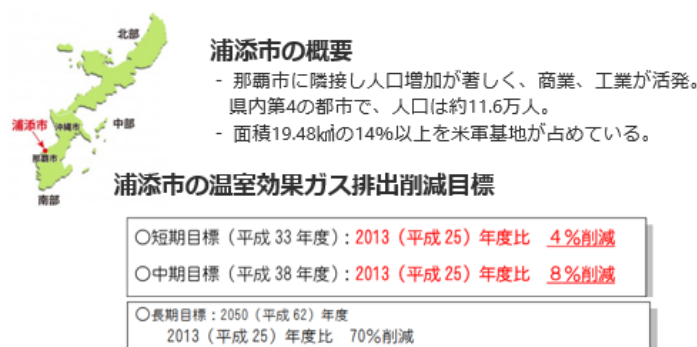
In addition, Urasoe City's 5<sup>th</sup> Comprehensive Plan positions international exchange as Measure 2-8 and states it will jointly promote international cooperative business with JICA Okinawa which is located in the city. JICA Okinawa, which is based in Urasoe City, accepts many Palau trainees for training experience in the prefecture. That means it is possible to consider cooperation with Urasoe City as a bridge to Okinawa Prefecture.

We will aim to contribute to the climate change issues and environmental issues in Palau through public-private partnerships with the goal of realizing cooperation that also includes collaboration with JICA Okinawa in addition to knowledge relating to the policies of Urasoe City and the technologies of SeED Okinawa and NEXTEMS in this intercity collaboration project.

## 2.2. Urasoe City, Climate Change Countermeasures and Relationship with Palau

Urasoe City formulated its 2<sup>nd</sup> Basic Urasoe City Environmental Plan which envisions a desirable environment of the city being one which lives in coexistence with the environment that will lead to the next generation while nurturing its rich nature and culture. This plan sets basic targets for harmonious coexistence between humans and nature, preservation of a good living environment, construction of a recycling-oriented society, conservation of the global environment, and construction of a joint participation society. The city is working collaboratively, independently and proactively on those targets.

In addition, it is expected that the population of Urasoe City will increase in the future. The city has formulated the Urasoe City Global Warming Countermeasures Action Plan based on a sense of crisis that it is estimated greenhouse gas emissions in the future will increase significantly in the transportation, commercial business and commercial private household sectors especially if no additional global warming countermeasures are taken. We will present specific efforts by citizens, companies, tourists and the city there and set targets for CO<sub>2</sub> reduction for each item. In addition, we will promote awareness to citizens and business operators such as by holding global warming prevention exhibitions and energy-saving talks.



### 浦添市環境基本計画（2020~2026）

第4次浦添市総合計画等との連携のもと、「豊かな自然と文化を育み、次世代へつなぐ環境共生都市・浦添」を実現するため、推進体制を構築し、市民・市民団体・事業者・市（行政）の具体的な取り組みを掲げる。

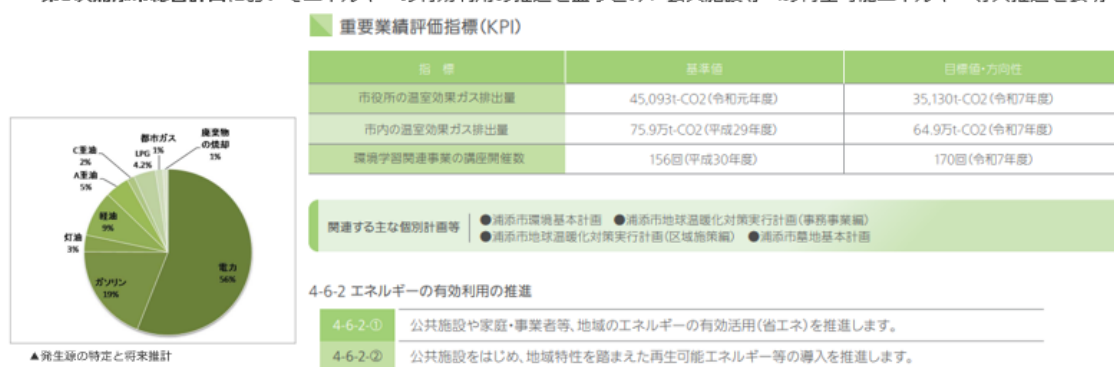
### 浦添市地球温暖化対策実行計画（2017）

削減目標を定め、省エネ化、省エネ行動、エコドライブ、4Rなどに市民、企業、観光客一体となり取り組む。

**Figure 4: Overview of Urasoe City and Overview of the Global Warming Countermeasures Action Plan**

In addition to energy-saving actions, the city is promoting the use of energy-saving products, the use of solar water-heaters, the switch to high-efficiency equipment such as LED security lights and the use of renewable energy including solar power generation based on its action plan. Moreover, the city is also working to develop a smart city aiming to reduce carbon dioxide emissions across the entire region by utilizing HEMS, BEMS and other energy management systems, and renewable energy, fuel cell and other distributed energy.

- ・ 第5次浦添市総合計画においてエネルギーの有効利用の推進を盛りこみ、公共施設等への再生可能エネルギー導入推進を表明



浦添市内の現状把握、政策分析、導入技術、計画策定等を実施し、低炭素化社会の実現に向けた目標達成に向けて、各種計画に基づき、市民、企業、市、観光客と一体となり推進。

**Figure 5: Targets and Promotion Measures Related to Decarbonization in the 5<sup>th</sup> Urasoe City Comprehensive Plan**

Moreover, Urasoe City is reducing waste to lead to a decrease in carbon dioxide emissions in regards to garbage incineration which rises with an increase in population. In particular, the city is promoting the 4R in addition to appropriate waste disposal from the need to eliminate combustible plastic waste.

The role of Urasoe City in this project is to grasp the issues of Airai State together with companies in the city based on its achievements and the expectations from local people. It is assumed that support will be given to drafting the policy to realize sustainable city management and that there will be consideration from an administrative viewpoint for the realization of that.

The National Energy Policy 2010 has been proposed as the energy policy of Palau. This policy advocates cooperation with GHG reduction measures and international GHG

emissions measures. In particular, it aims to achieve the promotion of energy-saving measures, the diversification of energy and the introduction of renewable energy from the point of view of measures to reduce petroleum product imports in Palau which relies 100% on energy imports. We have formulated a roadmap to introduce renewable energy as a plan to contribute to climate change. The goal of this is to cover 45% of the electric power generated with renewable energy by 2025. It is expected that the electric power generated in 2025 will be approximately 115 GWh. Accordingly, it will be necessary to cover at least 52 GWh with renewable energy to achieve this goal. We propose measures to mitigate against climate change in this road map through a wind conditions survey for wind power generation, a survey of the intensity of solar radiation, analysis and estimation of the amount of solar power generated and the amount of electric power demanded, and the implementation of optimal power generation systems in 2020 to 2025 and power generation mix in 2020 to 2025. However, with the target year of 2025 approaching, it cannot be said there is sufficient introduction of renewable energy. Accordingly, it is necessary to accelerate the pace of those efforts.

Meanwhile, Okinawa Electric Power has stated it will introduce and expand its PV-PTO business toward the realization of net CO<sub>2</sub> emissions by 2050, stabilize the grid using storage batteries and control technologies, construct virtual power plants and demand response utilizing digital transformation, construct a renewable energy micro-grid resilient against disasters, and expand the use of green fuels. Urasoe City is also aiming for zero carbon by 2050 through cooperation with the Okinawa Electric Power Group. Therefore, it is possible to expect a domino effect with a commitment to carbon neutrality by Palau through this proposal.

The Okinawa Electric Power Group, including its associated companies such as the joint applicant to this project of NEXTEMS, have a track record in solar power generation system, storage battery, EcoCute and other equipment sales, and distributed power source and control load remote monitoring and control. Above all, its initiative to Promote Renewable Energy Service Provider Business in Miyakojima has received high praise as a top runner in the aggregation business. For example, it received the highest honor of the Minister of Economy, Trade and Industry Award in the Advanced Business Model Category at the New Energy Foundation's FY2019 New Energy Awards. It also has a policy to consider overseas expansion of digital implementation through this intercity collaboration.

## **2.3. Introdicable Technologies and Survey Results**

### **2.3.1. Third-party Owned Solar Panel and Storage Battery Free Installation Service (PV-TPO)**

Palau is also planning a large-scale solar IPP based on its target of achieving a renewable energy ratio of 45% by 2025. Nevertheless, it is essential to promote self-consumption solar power generation on the consumer side to promote renewable energy. That means the third-party owned solar panel and storage battery free installation service (PV-TPO) seems to be an effective measure.

In particular, it is estimated that 3 MW will be introduced with the rooftop type which is the mainstream in Palau by 2025. That is three times the current level. Palau has also set a target of 9.4 MWh by 2025 for storage batteries whose introduction is currently lagging and promoting the developing of that.

Airai State has many public, commercial and industrial facilities including public schools. Therefore, we considered horizontal roll out in Airai State of the third-party owned solar panel and storage battery free installation service (PV-TPO) which has a track record of being provided in Urasoe City.

#### **(1) Overview of the PV-TPO Service**

The Okinawa Electric Power Group has set a target of net zero CO<sub>2</sub> emissions by 2050. It is rolling out a PV-TPO (third party ownership) service as a measure effective in this. The company has a track record of targeting junior high schools and other facilities located in Urasoe City which has entered into a comprehensive cooperative agreement with the company while focusing on the karE-roof service centered on detached homes in the prefecture.

The content of the service is a so-called “roof rental” business model. The company installs solar panel equipment and storage equipment free of charge. It then supplies electric power and collects fees from users. This service is being deployed nationwide by Shindenryoku. However, proactive deployment by a major electric power group is rare. It is essential to further promote renewable energy toward net zero CO<sub>2</sub> emissions. Against, this backdrop, an issue is the impact on the grid from the expansion of distributed renewable energy expected in the future. Accordingly, the Okinawa Electric Power Group will roll out this as a set with storage batteries which adjust the output fluctuations under the aim of increasing the renewable energy ratio while curbing the impact on the grid.

The PV-TPO service will basically take the form of users self-consuming the electricity generated on the roofs of their homes. The equipment owner will jointly install solar



panels with an output of 7.8 kW and storage batteries with a capacity of 4.5 kWh. There is no burden on users to introduce and maintain these. They will be operated with the equipment collected on a 15-year contract.

Moreover, the installation of storage batteries is also being considered as a measure against disasters. It will be possible to obtain a power source at 100 V even in the event of a power outage due to a disaster by installing an emergency outlet in storage batteries. There is the capacity to be able to use a refrigerator, television and smartphone for about two days when fully charged.

The introduction of this equipment into Urasoe Municipal Minatogawa Junior High School has entered the start of operation as the first project which forms part of the service for municipalities. A 65-kW system will be installed in this junior high school. The plan is to be able to supply electricity to cover approximately 17% of the electric power used by the school. It will be possible to function as a safe and secure base facility through the supply of electric power from storage batteries in the event of a power outage due to a disaster such as a typhoon. It will contribute a reduction in CO<sub>2</sub> emissions by approximately 73 tons a year as a CO<sub>2</sub> emissions reduction effect.



**Figure 6: Overview of the PV-TPO Service Introduced in Urasoe City**

In addition, the company is working on efforts to promote renewable energy in a way that places little burden on households and business operators. For instance, by introducing systems at the same size in rental car stations in the prefecture.



**Figure 7: Example of the PV-TPO Service in a Rental Car Station**

These efforts will also lead to measures against disasters at the same time as realizing the promotion of renewable energy which does not place a burden on the grid. Therefore, we examined feasibility in this study considering that it is a service with leeway to also be promoted in Palau which has similarities in terms of grid constraints and impact on disasters.

We assume that we will provide support in technical and service terms to solar power-related business operators in Palau in this service.

## (2) Solar Power Generation Business in Palau

As mentioned above, efforts are underway to promote solar power generation at the core of the promotion of renewable energy in Palau. This is starting to spread both in the public and private sectors. There are five examples of utilizing JCM equipment subsidies. All these examples feature solar power generation.

**Table 2: Examples of JCM Equipment Subsidy Program in Palau**

Project Name	Operating Status	Project Registration Status	GHG Emissions Reduction Effect (t-CO <sub>2</sub> Per Year)	Number of Credits Issued (t-CO <sub>2</sub> )
Introduction of a 1 MW Rooftop Solar Power Generation System in a Supermarket	Operating	Unregistered	871	
Installation of a 0.4 MW Rooftop Solar Power Generation System in a Supermarket	Operating	Registered	285	
Installation of a Small Solar Power Generation System in a School Project	Operating	Registered Issuing credits	111	145
Installation of a Small Solar	Operating	Registered	320	440

Power Generation System in a Commercial Facility Project II		Issuing credits		
Installation of a Small Solar Power Generation System in a Commercial Facility on an Island Country	Operating	Registered Issuing credits	259	296
Total			1,846	881

Australia is in the process of undertaking a large project as a movement for the introduction of solar power generation other than JCM. It is providing 22 million dollars in financing to support the construction of the first solar and storage battery equipment (“the Project”) at the scale of practical use in Palau to Solar Pacific Pristine Power (SPPP) through the Australian Infrastructure Financing Facility for the Pacific (AIFFP).<sup>1</sup> This project consists of 15.28 MWp solar power generation equipment and a 12.9 MW storage battery system. It will become the largest solar farm in the Pacific region. Construction is currently underway. It is scheduled to begin operating in April 2023.

Moreover, the Asian Development Bank (ADB) is implementing the Disaster Resilient Clean Energy Financing Program as a small-scale project. This program provides loans so that mainly low-income households and female households can receive affordable loans for clean energy which is resilient to disasters. Approximately 900 households (of these, 450 are low-income households and 180 are female households) are being targeted by this program. The source of the funds also includes some Japanese foundations.

Borrowers who receive financing under this scheme can obtain the costs incurred in solar power generation kits and installation work at low-interest rates. The plan is to reduce the electricity bills which are said to account for 25% of disposable income and to set those savings aside for repayment.

Although these related projects are running side-by-side, a third-party ownership (TPO) business model has not been confirmed. It is believed that promoting this as a new business model for the PPUC power generation and distribution operator and the EPC solar power generation operator will contribute to further increasing the rate of renewable energy.

This survey considered the possibility of deployment by interviewing local stakeholders and identifying buildings where installation is possible.

### (3) Promotion Feasibility Survey

According to the census in 2020 by the Palau Bureau of Statistics, there were 5,056 homes

<sup>1</sup> Australian Infrastructure Financing Facility for the Pacific (AIFFP)  
<https://www.aiffp.gov.au/investments/investment-list/palau-solar-plant-investment>

in Palau with 756 of those being located in Airai State. Of those, 114 homes used concrete, 613 homes used metal (galvanized sheet iron) and three used other materials for the roofing materials of the homes located in Airai State. In Palau as a whole, 884 homes used concrete, 3,959 homes used metal (galvanized sheet iron) and 213 homes used other materials. Accordingly, the ratio is consistent.

It is difficult to judge whether installation is possible from the classifications in the statistical data. Therefore, we inspected the roofing materials and roof shape in a field survey in January 2023. We considered whether it was possible to install solar power generation systems in the survey.

We surveyed homes along roads in Imeong and Negtbong States in addition to Airai State.

**Table 3: Residential Roofing Material Survey Results**

Survey Date	Area No.	Area Name	Housing: Galvanized Sheet Iron	Housing: Non-galvanized Sheet Iron	Commerciality Facility: Galvanized Sheet Iron	Commercial Facility: Non-galvanized Sheet Iron	Public Facility: Galvanized Sheet Iron	Public Facility: Non-galvanized Sheet Iron
Jan 14	(1)	(Area name unknown)	16	4	3	3	1	
	(2)	(Area name unknown)	5		4	4		
	(3)	(Area name unknown)	39	2	5	2		
	(4)	(Village: area name unknown)	34	26	13	6		2
	(5)	Airai Bai	2					
	(6)	Airport to east side	9					5
	(7)	Cheldoech Glass Bread	5	2				
Jan 15	(8)	Imeong to Bkulangriil	39	2	7			1
	(9)	Ngetbong	26				2	2
		Total	175	36	32	15	3	10



**Figure 8: General Housing Shape and Surveyed Sites**

The results of the survey showed that the roofs of many homes are made with low-strength galvanized sheet iron. That suggested the possibility it was necessary to also consider reinforcements and repairs when installing the solar panels. On the other hand, power consumption in general homes in Palau is 400 to 450 kWh per month according to interviews with the PPUC. Therefore, there is also a possibility of handling that consumption by installing panels in roofs in part.

We interviewed Palau Solar to understand the actual situation in more detail. Palau Solar is a solar power generation constructor based on the aforementioned ADB program.

It is located in Airai State. The company is currently providing and installing solar panel and power conditioner kits to users who apply to the loan program funded by ADB through the National Development Bank of Palau (NDBP). One kit is a 2.2 kW system. It is a set consisting of five panels and a power conditioner. It is possible to introduce up to two kits (4.4 kW) per house in this program. It is installing approximately 150 kits every six months with the aim of introducing 800 sets in two years. It has also been requested to install batteries at the same time. However, it is not currently doing so.

Palau Solar establishes and mounts wooden frames on metal roofs to install its kits. There have also been examples of it being able to install one or two kits with reinforcement.

#### (4) Introduction Effect

The PPUC or a IPP operator installs and owns the solar power equipment in multiple households and facilities and then collects the expenses for that with electricity bills. That is the mechanism of the PV-TPO service.

When applying the JCM scheme, it is difficult to commercialize small-scale projects at the household level. However, application is possible through integration with such

IPP operators. It is necessary to apply for the equipment subsidy program at the same time in the system. Nevertheless, it is possible to find leeway to utilize the system such as by integrating 100 households into one scheme after obtaining the understanding of the users for example.

The current system in Palau is a net metering system in the case of under 5kW. The electric power obtained through solar power generation is mainly used for self-consumption with it then being possible to utilize the remainder by connecting to the grid.

According to interviews with Solar Palau, the 2.2 kW kits are the mainstream in households. Therefore, we will consider cases in which 2.2 kW panels are installed in 100 households as a preliminary calculation of the effect here.

It is possible to perform the calculation with the following for the formula to calculate the amount of solar power generated.

Formula: Formula to Calculate the Amount of Power Generated

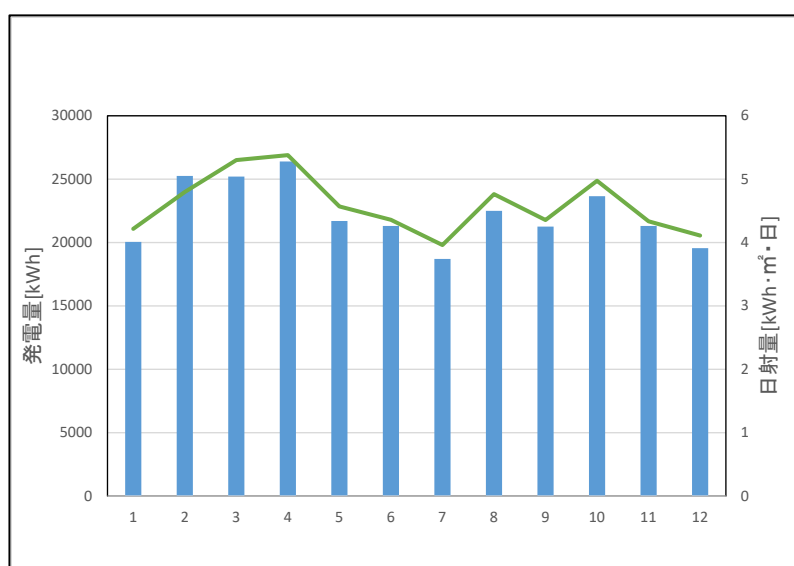
<p><b>発電量算出式</b> <math display="block">Epd = \frac{U \cdot P}{Po} \cdot K' \cdot Kpt \cdot K''</math></p>	$Epd$ :	発電量(kwh/日)
	$U$ :	日積算日射量(kwh/m <sup>2</sup> ・日)
	$P$ :	太陽電池容量(kw)
	$Po$ :	放射照度(1kw/m <sup>2</sup> )
	$K'$ :	補正係数(JIS)
	$Kpt$ :	温度補正係数
	$K''$ :	補正係数(JIS以外)

The amount of power generated per year is as follows according to the calculation performed based on the daily integrated intensity of solar radiation under the Clean Energy Introduction Plan Preparatory Survey Utilizing Solar Power in the Oceania Region report conducted in 2010 in the JICA project.



**Table 4: Preliminary Calculation of the Amount of Power Generated Based on the Daily Integrated Intensity of Solar Radiation in Palau**

月	日積算日射量	気温	Kpt	発電量		
	[kWh/m <sup>2</sup> /日]			日発電量 [kwh/日]	月当たり日数 [日/月]	月発電量 [kwh/月]
1月	4.01	28.2	0.907	680.1	31	21,084
2月	5.05	28.4	0.907	856.5	28	23,983
3月	5.04	28.3	0.907	854.8	31	26,500
4月	5.28	28.8	0.908	896.5	30	26,896
5月	4.34	28.6	0.908	736.9	31	22,844
6月	4.26	28.4	0.912	726.5	30	21,796
7月	3.74	27.8	0.913	638.5	31	19,795
8月	4.5	27.8	0.913	768.3	31	23,817
9月	4.25	28	0.913	725.6	30	21,768
10月	4.73	28.4	0.907	802.3	31	24,870
11月	4.26	28.6	0.907	722.5	30	21,676
12月	3.91	28.5	0.907	663.2	31	20,558
平均	4.45	28.3	合計		365	275,586
年間発電量		275,586				kWh/年



**Figure 9: Changes by Month in the Amount of Power Generated and Intensity of Solar Radiation**


The reduction effect is electric power substitution. The reduction in the amount of emissions is 146.8 t-CO<sub>2</sub> per year according to a grid emission coefficient of 0.533 t-CO<sub>2</sub>/MWh in Palau. That is 2,497 t-CO<sub>2</sub> over the 17-year service life of the equipment.

We referred to the results of an interview with Palau Solar for the introduction costs. The total project costs will be approximately 65 million yen. There are already at least four solar power generation projects in Palau. Therefore, the equipment subsidy upper

limit ratio is 30%. That means the subsidy upper limit is 19.5 million yen.

On the other hand, the amount of the subsidy upper limit remains at 16.6 million yen based on the amount of 4,000 yen per t-CO<sub>2</sub> of CO<sub>2</sub> emissions for each ton which is considered an approximation of the cost-effectiveness. It is necessary to deepen economic analysis on the feasibility of the model of collecting costs not covered by the subsidy in the form of electricity rates in terms of commercialization.

One of the characteristics cited for Palau is its extremely high electricity rates. For instance, although the electricity rates revised in October 2021 differ depending on the contract, they range from 34.4 US cents to 46.3 US cents (approximately 45 yen to 60 yen).



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Public Relations Office  
September 1, 2021

**NEW ELECTRIC RATES EFFECTIVE OCTOBER 1, 2021**

**Public Announcement**

This is a public announcement from the Palau Public Utilities Corporation (PPUC).

PPUC would like to inform the public that there will be a 14.3 cents increase to the fuel portion of electric rates effective October 1, 2021 in response to the increase of fuel price. See below table for the new rates:

Usage in KWH	Current Rate/KWH	New Rate/KWH (Effective Oct 1)
Residential (0-150 kwh)	20.1 cents	34.4 cents
Residential (151-500 kwh)	27.5 cents	41.8 cents
Residential (501+ kwh)	32 cents	46.3 cents
Commercial/Gov't/ROP (All users)	32 cents	46.3 cents

Note: Please be advised that fuel rate charged by PPUC is adjusted every quarter based on world market price of fuel. Next adjustment is January 2022.

For more information regarding this announcement, please contact PPUC Customer Service at 488-3870/3872.

Thank you.

**Figure 10: Table of Electric Rates by the PPUC**

Although it depends on the decision-making of the IPP business operator, after reducing the initial investment utilizing the JCM equipment subsidy, even if taking into consideration the remaining amount of investment and operation and maintenance costs, it is highly likely it will be possible to provide electric power services at a more competitive price than the above electricity rates.

If setting the rate at 40 yen per kWh when recovering 484 million yen which is a

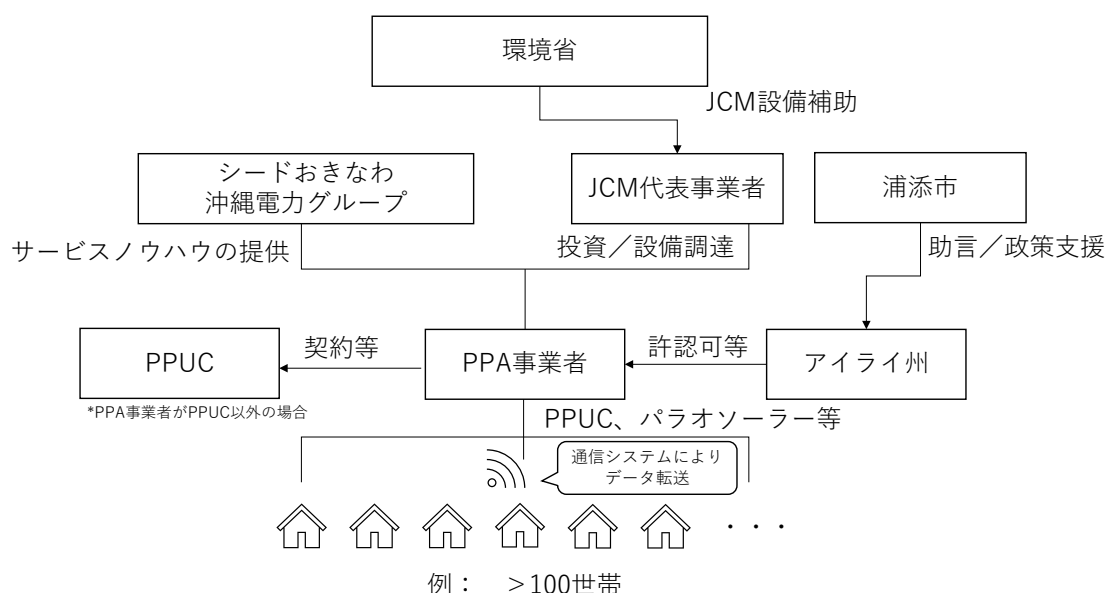


difference of 166 million that can be expected as the JCM subsidy from the approximately 650 million project costs, it will be possible to recover the initial investment in five years; that is eight years if setting the rate at 25 yen.

There is still plenty of leeway for promotion in economic terms. Therefore, we plan to proceed with further consideration together with local companies that have an interest in this business in the future.

It is assumed that monitoring will be an issue in the case of multiple installations. Nevertheless, according to our interview with Palau Solar, the power conditioners have a Wi-Fi connection function. They have adopted a system which enables monitoring of the power generation situation together with users and Palau Solar.

The figure below shows the plan for the structure of business currently being considered.



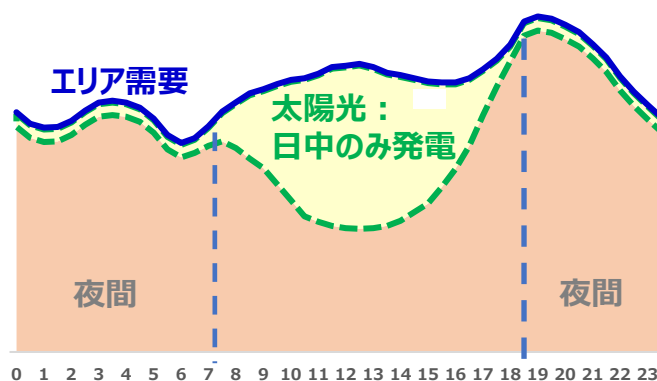
**Figure 11: Plan for the Structure of the JCM Equipment Subsidy Scheme in PV-TPO**

The concept of the structure currently being considered is for the Okinawa Electric Power Group to provide IPP operators with service and operation expertise with those operators then promoting that to households based on the license and contract of Airai State and the PPUC. A separate JCM representative operator will be appointed to participate in terms of investment in IPP operators and equipment procurement. That representative will be the recipient of the JCM equipment subsidy. Urasoe City will also provide advice to Airai State and provide policy support at the same time in relation to licensing and promotion.

Mega solar and other projects are currently underway in Palau. It is necessary to promote an expansion in the distributed renewable energy utilization ratio on the demand side at the same time as reducing the impact on the grid to achieve the renewable energy ratio of 45% which is the target of the policy. It can be said that this project is an initiative which will contribute to the use of renewable energy as far as possible on the demand side.

### 2.3.2. Tilttable Wind Power Field

As mentioned above, it is mostly solar power which has spread among renewable energies in Palau. We have also touched upon the fact that large-scale projects have been progressing with support from Australia, the ADB and Japan in recent years. On the other hand, although it is possible to expect an increase in the amount of solar power generated during the day in the dry season, the amount of power generated reduces or it cannot be generated during the rainy season or at night. That means there are many issues in terms of grid management and backup in promoting renewable energy with just solar power. Combined use with other renewable energy sources which can be expected to generate power at night and during the rainy season is essential to achieve the target of a renewable energy ratio of 45% by 2025 that is the policy target.



**Figure 12: Restrictions on Solar Power Generation in Electric Power Demand**

Wind power is a candidate as a source of renewable energy other than solar power. Palau has been confirmed to have abundant wind power resources. However, there are concerns that equipment damage due to typhoons will lower operating rates and increase repair costs with conventional wind turbines. Accordingly, they have yet to be introduced into the country. In addition, there are issues with maintenance and management in large-scale conventional turbines. For example, there are the issues of securing large cranes and

the workers necessary for construction and maintenance.

The Okinawa Electric Power Group has faced similar issues on the remote islands of Okinawa Prefecture. Consequently, it has developed tiltable wind turbines which solve such issues facing island regions. Tiltable wind turbines have a mechanism which allows strong winds to be avoided by tilting the support and wind turbine up to an angle of nearly 90 degrees. Moreover, large cranes are not necessary at the time of installation. That means it is also possible to install them in hilly areas. Work at the ground level is possible without having to work at heights during maintenance by tilting the wind turbines.

As stated at the beginning of this report, the Okinawa Electric Power Group has a track record of introducing seven tiltable wind turbines (total: 1,715 kW) in remote islands in Okinawa Prefecture. It also introduced five tiltable wind turbines (total: 1,375 kW) in Tonga in 2019.



**Figure 13: Tiltable Wind Power Generator and Tilting Maintenance**

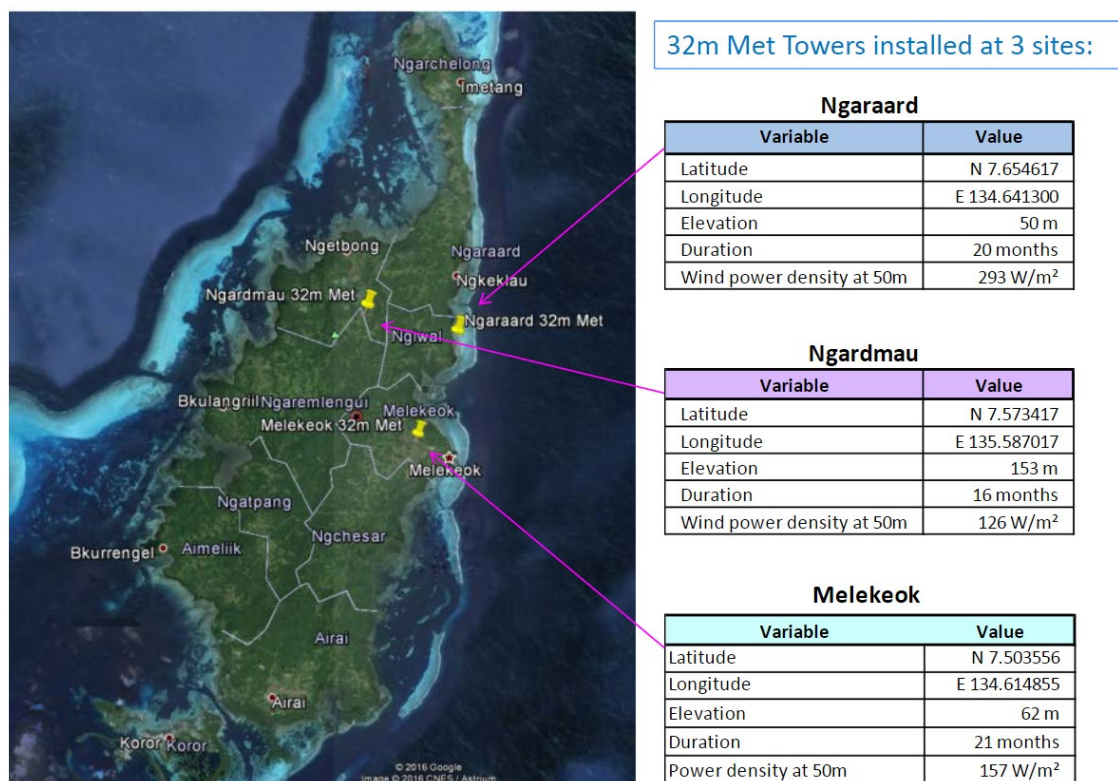
**Table 5: Introduction Record**

Island Introduced	Tiltable WT	Area	Population	Max Demand
Aguni	245 kW×1	7.6 km <sup>2</sup>	689	800 kW
Minami-Daito	245 kW×2	30.5 km <sup>2</sup>	1,257	1,900 kW
Tarama	245 kW×2	19.8 km <sup>2</sup>	1,099	1,200 kW
Hateruma	245 kW×2	12.7 km <sup>2</sup>	496	800 kW
Tongatapu	275 kW×5	260.4 km <sup>2</sup>	74,611	

According to a wind condition survey conducted in Palau, the wind conditions in the northern part of Babeldaob are relatively favorable. In addition, there is also plan to increase the grid capacity that has previously been an issue. Therefore, it is possible to find the possibility of introducing wind turbines here in the future.

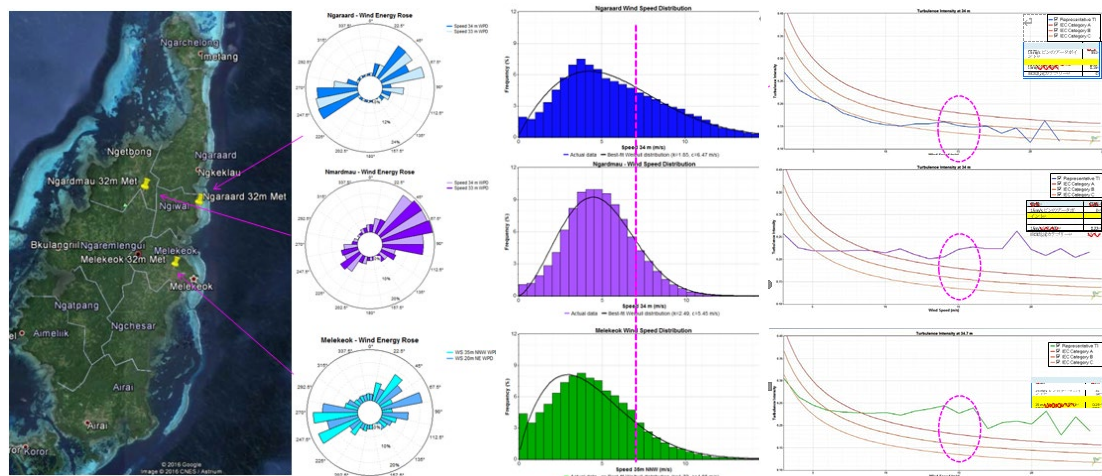
Multiple surveys have already been conducted on the wind conditions in Palau. We will consider potential sites by referencing survey results from 2016 by the National Renewable Energy Laboratory of the US Energy Agency among those.

Three observation points were established on Babeldaob in this survey. The wind conditions were then observed. The following shows the sites and measurement results.



**Figure 14: Wind Condition Survey Points and Measurement Results by the US Energy Agency**

The results of the wind direction at the three sites reveal there is also no wind from the southwest at the Ngwal site. It is assumed that this is due to the inland location and topography. On the other hand, wind from the northeast and southwest have been observed at Ngaraard and Melekeok which are located on the east coast. The intensity of wind from the southwest is slightly higher. The turbulence intensity factor is 0.11 at Ngaraard with this turbulence of 15 m/s. That is a low level.



**Figure 15: Wind Direction, Wind Speed Distribution and Turbulence Analysis at the Observation Sites**

It was predicted based on these previous surveys that the east coast where strong winds with relatively little turbulence blow in from the northeast sea would be the ideal site to install wind turbines.

Exploration was mainly conducted on these sites in the field survey. A site located at the tip of Babeldaob in the north was seen as particularly promising.

We obtained information from an interview with the PPUC that there has been an issue of sites which were seen as promising sites in previous wind condition surveys not being developed into projects due to land issues. Accordingly, we will consider the feasibility of commercialization by conducting a survey on land ownership and environmental assessment procedures together with a detailed survey of the wind conditions in the future.

Palau has a rich natural environment. Nature preserves have also been established because that is a tourist resource. The candidate sites in this project have not been designated as nature preserves. On the other hand, it is necessary to pay attention to cultural aspects such as traditional land inheritance. That means caution is required when it comes to land use. The use of land by the country and state is pragmatic. Therefore, we will make inquiries to the state governments of those sites to clarify the land ownership.





economy depends on the PPA contract with the PPUC. However, it seems realistic to assume a certain level of grant.

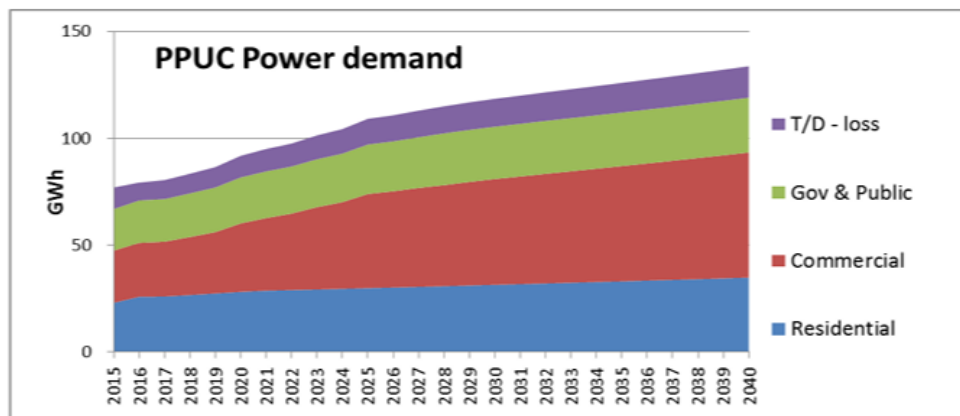
### 2.3.3. Introduction of Highly-efficient Air Conditioning and Hot Water Supply Equipment in Commercial and Public Facilities

Reliance Energy Okinawa in the Okinawa Electric Power Group is rolling out an energy service which contributes to reducing energy costs and lowering the environmental burden in large facilities in the prefecture. Specifically, the concept sees the company supplying to multiple buildings various energy supply equipment such as electric power and air conditioning cooling and heat which were generally installed and operated for each building in the past by installing it on a unified basis in an energy center. That enables power generation and waste heat utilization with energy generation and large-scale gas cogeneration by high-efficiency heat source equipment which is difficult to adopt in small buildings alone.

This concept also provides a backup environment in the event of a disaster. Therefore, it is a system which leads to strengthening the business continuity plan (BCP) response in buildings. That means it is expected to find needs for it in Palau as well. These are advanced systems with a high degree of excellence even in Japan. They have high potential for utilization in Palau,

Furthermore, the possibility of further promoting and utilizing hydrogen technologies for electric power and transportation as hydrogen use destinations is being considered in Palau where utilization of hydrogen manufactured in Australia is undergoing examination. We will also survey and consider technologies which utilize hydrogen in this project.

Looking at the demand for electric power in Palau, demand is generally on an upward trend. In particular, the increase in demand in the commercial sector is remarkable.



**Figure 17: Forecast Increase in Electric Power Demand in Palau**

In addition, looking at future demand by state, we see that electric power demand is predicted to continue increasing in the future in Airai State.

**Table 6: Forecast Demand for Electric Power by State**

単位：kW

	Amellik アイメリク	Airai アイライ	Koror コロル	Melekeok メルキーク	Ngaraard ガララド	Ngardmau ガラスマオ	Ngarenlengui アルモノグイ	Ngarpang ガッパン	Ngchesar エサル	Ngarchelong ガシロン	Ngwal ニワール	Total 合計
2020	0	28	245	0	0	0	0	0	0	0	0	273
2021	0	77	294	0	0	0	0	0	0	0	0	371
2022	0	126	392	0	0	0	0	0	0	0	0	518
2023	0	175	490	123	29	0	0	0	0	10	0	828
2024	0	224	588	149	39	0	0	0	0	20	0	1,020
2025	0	283	735	206	207	0	0	0	0	29	0	1,460
2026	0	288	735	235	216	0	0	0	0	39	0	1,513
2027	0	299	735	295	258	0	0	0	0	49	0	1,635
2028	0	304	735	368	267	0	0	0	0	59	0	1,734
2029	0	313	735	382	309	0	0	0	0	69	0	1,807
2030	0	321	735	396	319	0	0	0	0	78	0	1,849
2031	0	330	735	400	319	0	0	0	0	88	0	1,872
2032	0	339	735	404	319	0	0	0	0	98	0	1,895
2033	0	349	735	408	319	0	0	0	0	98	0	1,908
2034	0	354	735	412	319	0	0	0	0	98	0	1,918
2035	0	360	735	416	319	0	0	0	0	98	0	1,928

Under these circumstances, saving energy is also an important pillar of the electric power policy in Palau. On the other hand, government agencies and large commercial facilities have yet to introduce systematic energy saving. Energy saving is planned for public facilities, commercial facilities and homes in the future. For example, there will be a promotion of energy saving in buildings, lighting-related energy saving and energy-saving electrical appliances used in homes in government buildings and commercial facilities.

We conducted interviews with facilities where provision of this service is possible by first visiting Airai State in the field survey we conducted in January 2023.

The results suggested that there are not many buildings or groups of buildings which can be said to consume large amounts of energy even though an airport and commercial facilities are located in Airai State. The hotels located in the state are mainly villa type. In addition to not having many guest rooms, they are located where there are no large facilities such as supermarkets.

Therefore, we will proceed with a survey on Koror State where many commercial



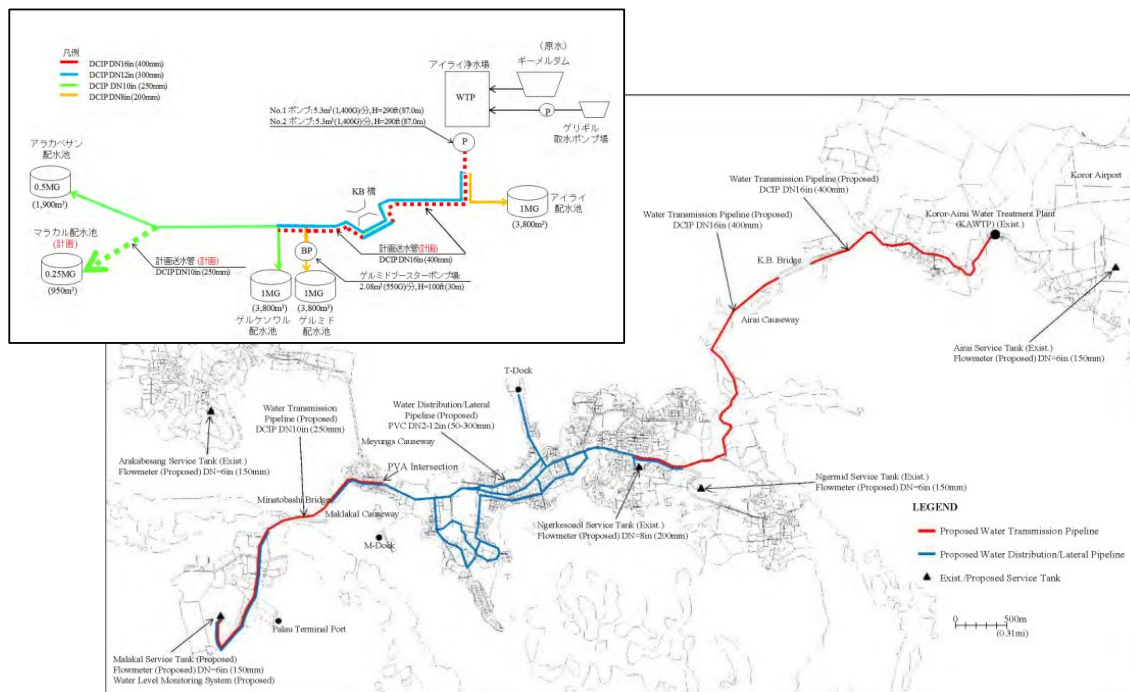
facilities are located in future surveys.

One effective energy-saving measure is for service operators responsible for energy supply and management taking charge of a group of buildings which consume a large amount of energy.

It is necessary to identify an area with high energy consumption demand corresponding to this to establish such an energy center. As you can see from the demand forecast above, demand in Palau is expected to expand in the future. Therefore, we will consider sites where energy demand will greatly expand as candidates based on large-scale development plans.

On the other hand, it is possible to curb energy consumption just by replacing individual equipment such as for air conditioning, hot water supply and lighting with energy saving equipment in commercial businesses and homes for energy saving. We can consider the possibility of replacement based on the usage of equipment currently being used in hotels, markets and restaurants.

Moreover, waterworks have been established in Palau. However, the source of the water is in Airai State. Consequently, electric power is used to drive the pumps. We were asked whether it would be possible to consider the introduction of small hydropower at the water intake site in the reservoir when holding interviews with the Airai State Government. Accordingly, we would like to also consider utilizing such renewable energy and setting it aside for the source to drive the pumps in the future. The poor flow rate stability of the rivers in Okinawa Prefecture means that hydroelectric power generation has not been developed there. However, there is a track record of installing small hydroelectric power generation utilizing the current of water being conveyed for irrigation and regulating reservoirs at Kurashiki Dam Management Office, Nishihara Purification Plant and Fukuchi Dam. We will consider the possibility of introducing small hydroelectric power in Palau utilizing this knowledge.



**Figure 18: Water Service Infrastructure in Palau**



**Figure 19: Reservoir Drawn from a Water Source in Airai State**

#### 2.3.4. Grid Stabilization Field in Anticipation of the Proposed Technologies/Services

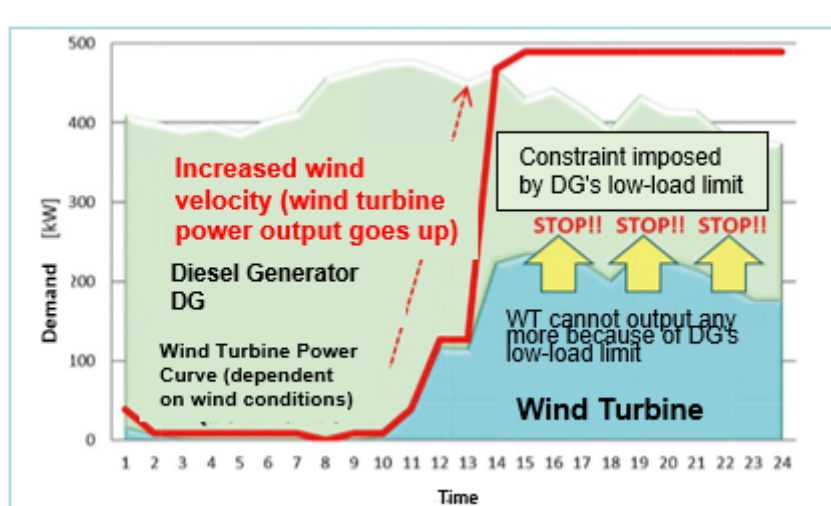
Japan has a history of supporting the establishment of the major energy infrastructure in Palau. For example, Japan has introduced solar power generation systems into schools and commercial facilities in the country. It is also currently rebuilding a major power plant and providing two large generators to Palau.

A lot of data and information have been accumulated in Japan in relation to these projects. Against this backdrop, plans are underway for grid stabilization equipment which includes storage battery equipment under the assumption of the introduction of renewable energy.

The following issues will arise in relation to grid operation when renewable energy spreads.

- Curb on the output of renewable energy due to restrictions on the lower limit of operation by diesel generators

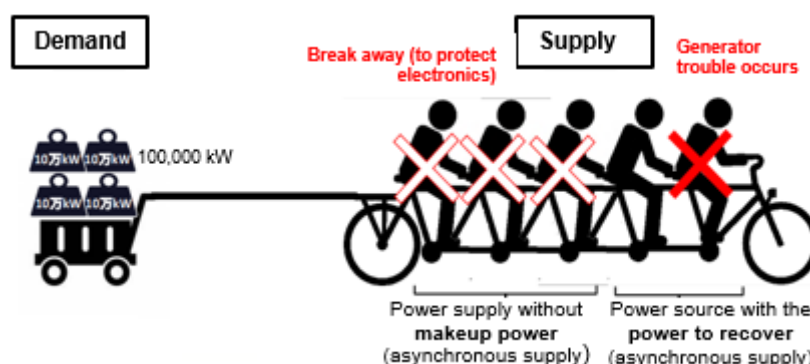
It will be necessary to reduce the output of diesel generators due to supply and demand when the output of renewable energy increases. However, there are mechanical restrictions on the lower limit of operation by diesel generators. Therefore, it will be necessary to curb output of the surplus of renewable energy. (That means restrictions on renewable energy generation opportunities.)



**Figure 20: Restrictions on Renewable Energy Output due to Combined Use with Diesel Generators**

- Risk of Wide-area Power Outages due to a Reduction in the Inertial Force  
The number of diesel generators operating will decrease with the spread of renewable energy. If a grid incident occurs while the inertial force is decreasing, the generators

will not be able to keep up with the target frequency. Consequently, there is a risk that may lead to wide-area power outages. (It will not be possible to secure inertia with storage batteries.)



**Figure 21: Synchronous Power Sources (with Inertial Force) and Asynchronous Power Sources**

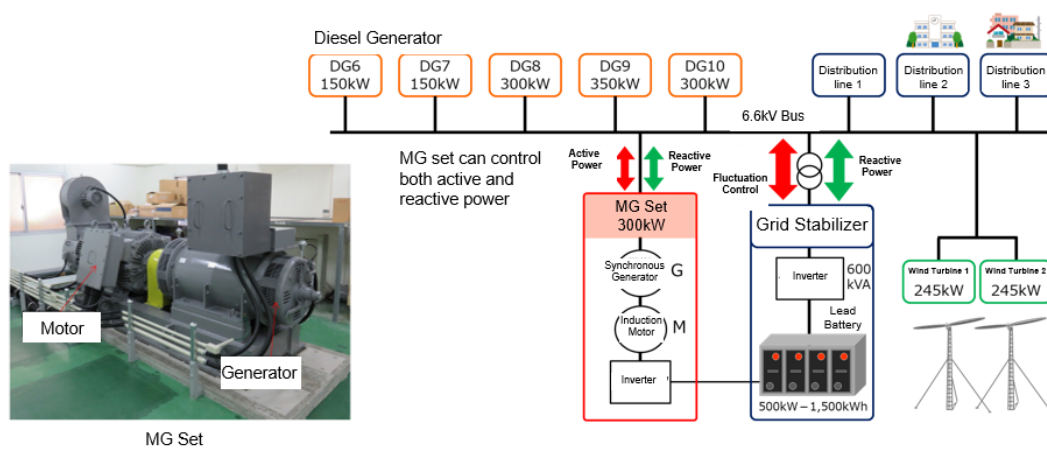
Source: Agency for Natural Resources and Energy: Study on Achieving Carbon Neutrality in 2050 (December 21, 2020)

- Failure of the Function to Protect against Incidents  
If the number of generators operating decreases and the short-circuit capacity reduces, the protection function (relay) may not activate when there is an incident. That means it will not be possible to detect the incident.

An effective solution to these issues is to introduce grid stabilizers which can maintain the inertial force of the grid while maximizing the utilization rate of renewable energy.

Okinawa Electric Power is operating existing power generation equipment (diesel generator, wind power generator and storage batteries) together with demonstration equipment (MG set) on the island of Hateruma. It has experience of conducting demonstration experiments for practical operation such as in terms of confirming effectiveness and identifying issues.

Specifically, utilizing the surplus of renewable energy to charge storage batteries will alleviate restrictions on the output of renewable energy. At the same time, combining motors and generators will provide pseudo inertia to enable operation as an alternative to diesel generators. That is a mechanism which will prevent a decrease in the inertial force and short-circuit capacity. There is track record of achieving 10 days of 100% renewable energy operation combined with a tiltable wind turbine in the demonstration experiment on Hateruma.



**Figure 22: Grid Stabilization with an MG Set Demonstrated on Hateruma**

There is a need for technical consideration such as for Palau's weather conditions, electric power demand forecasts, electric power grid analysis, transmission/distribution facility plans and environmental and social concerns. Against this background, we will consider support based on a track record over many years relating to integrated control in the islands of Okinawa Prefecture.

Specifically, we will consider the grid stabilization measures which will be necessary when introducing tiltable wind power with the cooperation of the Palau Public Utilities Corporation (PPUC). In addition, we will consider the introduction of an area aggregation system for controllable loads on the consumer side such as PV-TPO and energy services. We will then consider the effectiveness of the mechanism to stabilize the grid in the form of contributing to grid stabilization on the consumer side.

These technologies and services based on knowledge in Okinawa Prefecture have a high degree of superiority in Palau which is also an island region. That means they can be expected to have a high degree of potential for utilization locally.

We met with the PPUC which manages the electric power system in the field survey in January 2023. We discussed the feasibility of this initiative.

The PPUC told us they are aware that grid management will become an issue as renewable energy increases with assistance from various countries and international organizations. The company plans to set up a National Control Centre as a measure against that.

It is not possible to monitor supply and demand and to issue orders to power plants to make adjustments in the control center. Nevertheless, if the system as a whole lacks the ability to make adjustments, there will be limits to the measures which can be taken. There

is a possibility it may be necessary to take measures to prevent the maximization of renewable energy use.

In particular, there are plans to construct a 12.5 MW storage battery with regards to the 15 MW mega solar plant being constructed with the support of Australia. This will have a massive impact on the grid at maximum power generation. The PPUC also expressed concerns about its operation.

Under these circumstances, we were able to obtain a high level of interest in the grid stabilization effect with the introduction of the MG set.



**Figure 23: Interview with the PPUC**

At the same time, we were able to receive materials relating to electric power supply and demand data that will be necessary for the consideration. Therefore, we plan to propose concrete measures based on these materials in the future.

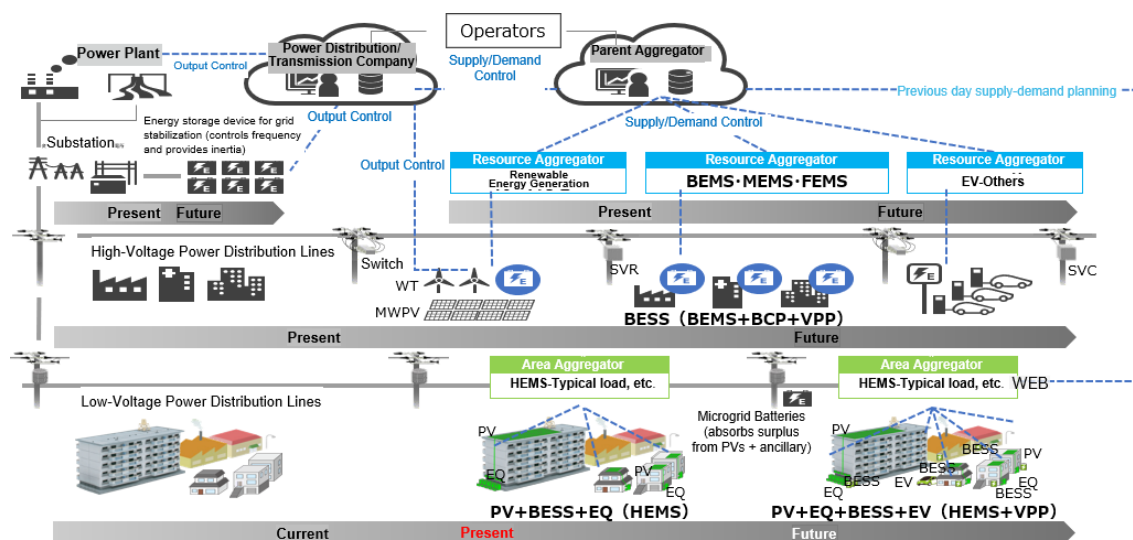
Palau plans to start a low-interest financing program for solar power kits for households in the future with the support of the ADB. That means grid management will become even more complicated.

After the spread and expansion to a certain level of renewable energy equipment with solar power, wind power and PV-TPO, power generation operators, transmission/transformation operators and consumers will need to work together to adjust supply and demand. We will also consider an aggregation model at this stage.

NEXTEMS in Urasoe City sells solar power generation systems, storage batteries and EcoCute equipment. At the same time, it has conducted demonstration experiments for the remote monitoring and control of distributed power sources and controllable loads. The company will aim to demonstrate and establish area aggregation that allows for flexible demand formation by adjusting the supply and demand balance in the electric power grid while making renewable energy the main power source.



It is possible to expect that the business model of this company will function effectively in Palau where renewable energy is expected to expand in the future at the same time at the power generation operator and consumer levels. Therefore, we agreed with the PPUC to continue considering the construction of a Palau-style aggregation model based on the outlook for introducing renewable energy facilities and trends in demand.



**Figure 24: Aggregation Model**

### 2.3.5. Policy Recommendations

The development of measures to promote the achievement of the clear target set by Palau of increasing the renewable energy ratio to 45% by 2025 is an urgent issue in the country. There is the Palau Energy Roadmap compiled by the International Renewable Energy Association (IRENA) as a policy for these measures focused on the aforementioned target. In addition, there is the Electrical Power System Prioritization Plan by the PPUC as a document which summarizes the specific priority order of measures. However, plans addressing climate change at the state level have yet to be formulated.

Airai State has a development master plan and land use plan as part of its regional development plan. These indicate the following policies in Airai State.

1. Protection and conservation of natural resources
2. Protection and conservation of historic buildings
3. Perpetuation of Palau's cultural heritage
4. Vibrant city with a mix of residential, commercial and recreational facilities
5. Provision of pleasant, healthy and conveniently located residential areas

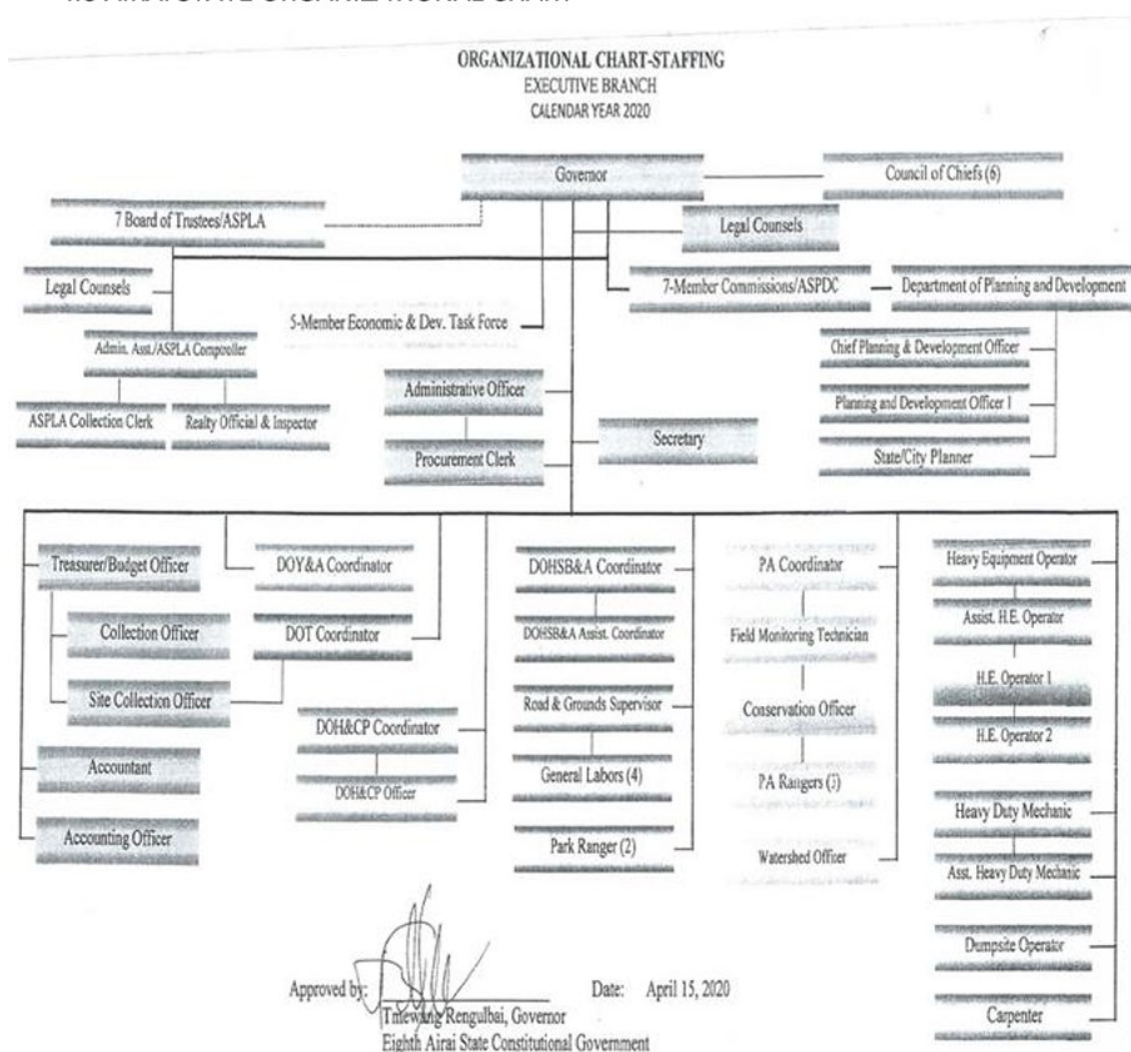
6. Agricultural promotion and support: balance of self-sufficient gardens and large-scale farms
7. Provision of optimal infrastructure and land to achieve sustainable economic growth

There are plans to formulate a new development plan as of 2023. We have decided to provide cooperation as there is leeway to consider decarbonization targets based on cooperation with Urasoe City in this project.

We visited Airai State in the field survey in January 2023. We had the opportunity to hold discussions with the Governor of the Airai State at that time.

The organizational chart of the Airai State Government is as below. There are 50 employees. That includes 48 accountants and janitorial staff members with two staff members who deal with the state parliament.

#### 4.0 AIRAI STATE ORGANIZATIONAL CHART

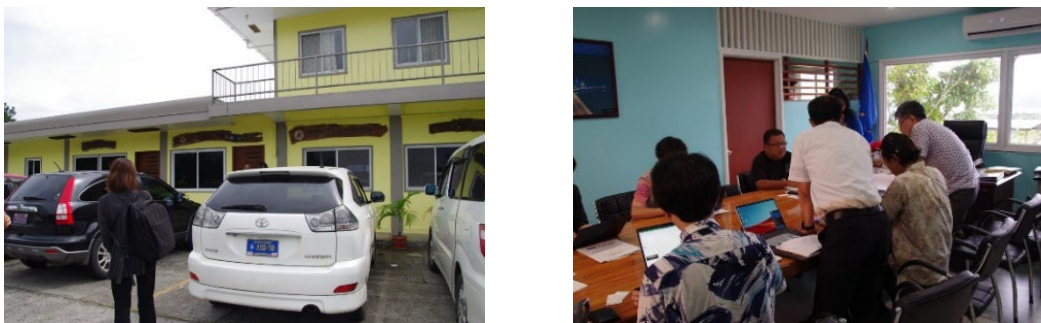




**Figure 25: Airai State Organizational Chart**

There is a development bureau responsible for development planning as a department of the state. We were able to meet with the director of the bureau. The state has a development plan (5- and 10-year targets). However, it does not currently have its own energy policy. Policy is still under consideration at the national level. The PPUC is also responsible for achieving the target to increase the national renewable energy ratio to 45%. The involvement of the state is currently such that it enters into discussions with business operators about matters related to land when they are introducing solar power generation equipment. The director says they are proactively cooperating with the provision of public land in line with the central government's target to increase the renewable energy ratio.

The introduction of solar power generation is also increasing in private homes. Nevertheless, there is still almost no solar power generation equipment installed in state facilities. There is leeway to consider introduction if the price is lower than the electric power price of the PPUC. That means we were able to obtain some interest.



**Figure 26: Visit to the Governor of Airai State**

We introduced the purpose of the intercity collaboration project and an overview of Urasoe City to Airai State. That included sharing materials in advance with them. At the same time, we introduced the importance of formulating a policy on decarbonization at the municipal level.

The state expressed its understanding of initiatives toward decarbonization at the municipal level. At the same time, it welcomed feasible development proposals for the introduction of renewable energy.

## 2.4. Intercity Collaboration Activities

We conducted a field survey and met with the stakeholders in January 2023 as part of the intercity collaboration activities in this fiscal year.

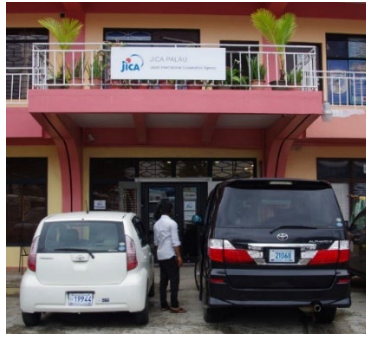
We give the schedule of the field survey below.

**Table 7: Field Survey Schedule**

Date	Day of the week	Activities
January 12	Thu	Arrive in Palau at 24:50
January 13	Fri	JICA Office (Japanese Embassy in attendance), Government of the State of Irai
January 14	Sat	MALAKAL POWER STATION, Site Inspection (Roofing Material Survey, etc.)
January 15	Sun	Site inspection (roofing material survey, etc.)
January 16	Mon	Koror State Recycling Center, PPUC (Palau Power Utilities Corporation)
January 17	Tue	Reception hosted by Okinawa Prefecture • Site survey of a candidate site for installation of a retractable wind turbine
January 18	Wed	Departure from Palau at 03:25

### (1) Embassy of Japan in Palau and the JICA Palau Office

We obtained the opportunity to exchange opinions with the Embassy of Japan in Palau and the JICA Palau Office during the course of this survey. We got hints about the importance of ensuring the people are aware of results in an easy-to-understand manner due to the characteristics of Palau in relation to this intercity collaboration project. Moreover, the number of foreign companies entering the market in Palau has been increasing in recent years. Accordingly, it is also assumed there will be competition over resources such as land. We obtained the comment that we will be able to receive advice about the local situation by sharing information with the embassy. In addition, we obtained the comment that the key to sustainable business is training maintenance and operator personnel for the equipment after introducing it in Palau. The promotion of renewable energy and the grid management accompanying that are fields of interest to both the embassy and the JICA. Therefore, we agreed with them to continue exchanging information.



**Figure 27: Appearance of JICA and Meeting**

## (2) Airai State

Discussions with Airai State, which is the partner city in this intercity collaboration project, led to an interview with the Governor and Director of the Development Bureau.

As mentioned above, Airai State does not currently have its own state-level energy plan. It is contributing to the realization of the energy plan in terms of land use which is under the jurisdiction of the state based on the national and PPUC policy. There is interest in promoting renewable energy in response to the issues of power outages and high electricity bills. However, that has not yet led to the introduction of renewable energy in state facilities. We were able to obtain interest in considering the introduction of equipment assuming assistance from the JCM equipment subsidy through the intercity collaboration project and consideration of decarbonization policy. We also received a request for consideration with respect to the leeway to introduce small hydropower in water intake sites possessed by the state. Moreover, there was a comment that the state had expectations for an early transition to the execution phase.



**Figure 28: Interview with Airai State**

## (3) Malakal Power Plant

The current core power source for Palau is diesel power plants. Malakal Power Plant (15 MW) and Aimeliik Power Plant (10 MW) are responsible for the majority of that. We visited and surveyed Malakal Power Plant with its larger equipment capacity in this

survey.

Three engines are constantly in operation in the Malakal Power Plant we visited. Two spare engines were introduced with free funding from Japan several decades ago. The control devices, generators, engines and other major devices were made in Japan.

It is possible to monitor the operating status of the Aimeliik Power Plant at Malakal Power Plant. In addition, it is also possible to monitor the supply and demand situation over the whole of the country including the power generation situation on remote islands.

There are not many ups and down in both the amount of annual and daytime demand. That means there is no major adjustment of the amount of power generated. The supply is constant. This point is different from Japan. It was thought that it would, on the contrary, lead to the introduction of renewable energy making grid control more complicated. We were able to obtain trends and data for the balance of the supply and demand of electric power in this survey. Therefore, we will proceed with a proposal relating to grid stabilization in the future based on this information.



**Figure 29: Visit to the Malakal Power Plant and Received Electric Power Supply and Demand Data**

#### (4) PPUC

We interviewed those in charge of electric power at the Palau Public Corporation (PPUC) which is responsible for public works such as power generation. We introduced an overview of the intercity collaboration project. After that, we exchanged opinions on the current state of promoting renewable energy and the schemes scheduled to be considered in this project.

With renewable energy spreading, the issue of grid control is a big one. The Electrical Power System Prioritization Plan compiled by the PPUC also prioritizes measures against that. As mentioned above, a specific measure is the scheduled establishment of the new National Control Centre in May 2023.

The electric power consumption in regular homes in Palau is about 40 to 45 kWh. Accordingly, in relation to the spread of renewable energy, we expect that it will be covered to a certain extent with solar and wind power looking at the number of households. It was thought that a service which allows consumers to more affordably introduce solar power generation systems would lead to an acceleration in the pace of promotion through PV-TPO and other schemes from this point.

There are multiple local solar power construction operators in Palau. However, the scale at which they can install equipment differs depending on the company. We received a list of construction operators.

There has already been a survey on wind power. We selected three candidate sites from those results. It is expected that it will take time to realize them due to respective land and cost issues. The response to the candidate sites identified in this project will differ depending on whether they are private land or public land. Accordingly, we were recommended to confirm the land classification through the Airai State Government.

The PPUC has currently introduced two types of system for renewable energy. The contents of the introduction are conventional power purchase and offset. The offset system is one that is similar to net metering. However, it is a system in which the electric power generated by each home and operator is converted to credits with electricity bills then being discounted by the amount of those credits from the month following power generation under an upper limit of 50% of the amount of surplus power generation. The term of validity of credits is one year.

In addition, two types of tender or limited tender contract are permitted in the system with regards to the setting of the electricity sale price by IPP operators. Nevertheless, it is recommended that a decision is made through discussions with the IPP operator and the PPUC instead of a tender according to the guidance of the national PWA agency (the organization above the PPUC). It is necessary for the operator to show evidence it is the



least expensive at that time. It appears the PPUC recognizes 13 IPP operators. Considering the possibility of that number increasing in the future, it seems there is an awareness that deciding this by tender would be a simpler means.

It is necessary to consider a competitive system which meets the needs of consumers while achieving harmony with such existing systems when implementing PV-TPO services.

The PPUC and Okinawa Electric Power have built a cooperative relationship. Consequently, we confirmed that they will continue to work together while exchanging information when promoting this project.

#### (5) Okinawa Prefecture Friendship Reception

This survey was scheduled to coincide with the ceremony for the signing of the memorandum of understanding relating to the strengthening of friendly relations between Okinawa Prefecture and Palau. This ceremony was held to introduce the technologies of companies in the prefecture to Palau and to hold exchanges between stakeholders toward smooth collaborative efforts in the future. This intercity collaboration project was also introduced to stakeholders as an activity linked with the efforts of Okinawa Prefecture.

The main participants included Governor of Okinawa Prefecture, the Minister of Infrastructure for Palau, the Special Advisor to the President, Japanese Ambassador to Palau, JICA Director, the Okinawa Prefectural Government (Director of Agriculture, Forestry and Fisheries, the Governor's Office and General Manager of the Fisheries Division, etc.), Professor of International Regional Studies at the University of Ryukyus, Managing Director of the Okinawa Prefectural Fisheries Cooperative Association, and Director, Comptroller of the Yaeyama Fisheries Cooperative.





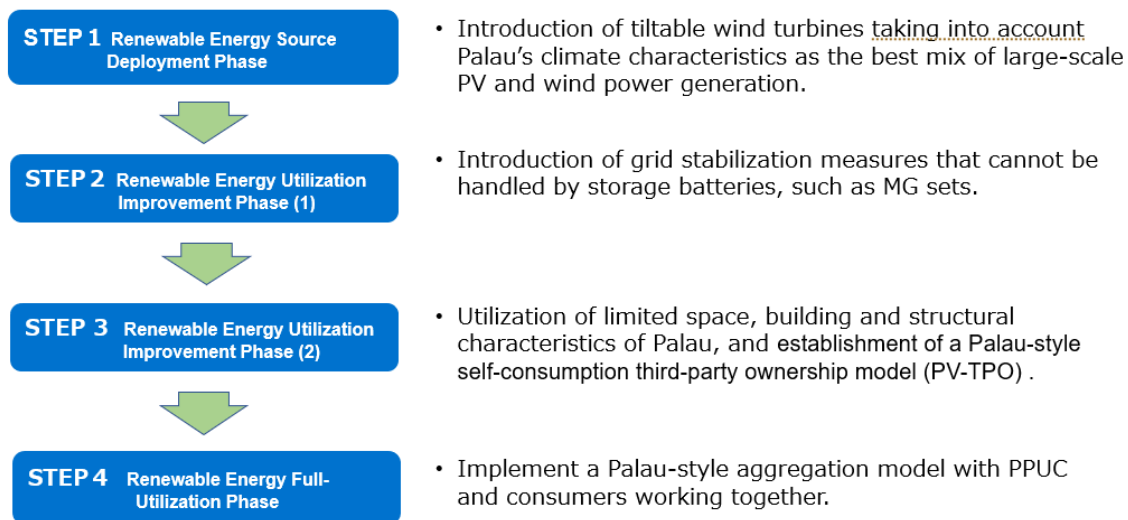
**Figure 30: Ceremony**

## **2.5. Future Activity Policy**

We will consider more concrete commercialization plans from the survey results including literature in addition to being able to travel locally and to build relationships with local counterparts through the survey in this fiscal year. At the same time, we will continue to support the formation and promulgation of the vision as a municipality pertaining to decarbonization through collaboration with the Airai State Government.

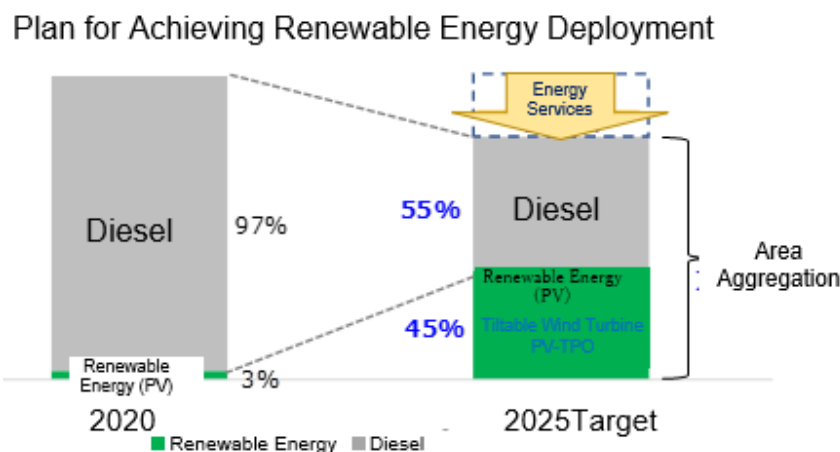
It is necessary to go through four stages when considering the promotion of renewable energy toward decarbonization. In other words, the first step is the introduction of high-potential renewable energy. The second step is to take grid stabilization measures to improve the utilization rate of renewable energy. The third step is to introduce renewable energy for limited spaces and self-consumption. The fourth step is for the smarter and maximum utilization of renewable energy.

The introduction of mega solar plants with overseas support is being planned in Palau. Accordingly, there are prospects for the first phase to promote renewable energy. Meanwhile the establishment of a central power control center and a grid enhancement program with the support of JICA are in progress to stabilize the grid in the second stage. Nevertheless, the possibility remains it will not be possible to fully take measures depending on the amount of renewable energy connected to the grid. In addition to the plan that is the policy of Palau to raise the renewable energy ratio to 45% by 2025, it is necessary to promote efforts from now with an eye on the third stage and fourth stage.



**Figure 31: Stage of the Promotion of Renewable Energy**

We will consider the realization of this project in a form in which there is harmony with other related projects in Palau with an awareness of the above stages to promote renewable energy based on the current situation that has been revealed by this survey. The image of the plan toward achievement is shown in the figure below. Accordingly, it is important to grasp the overall situation concerning the promotion of renewable energy including the other projects.



**Figure 32: Image of the Plan for Achieving the Renewable Energy Introduction Target**

We will continue to introduce to Airai State the significance and necessity of efforts toward decarbonization in municipal facilities based on the plans of Urasoe City and the partnership agreement with Okinawa Electric Power as policy support to boost these efforts. We plan to continue promoting support in the form of integration between



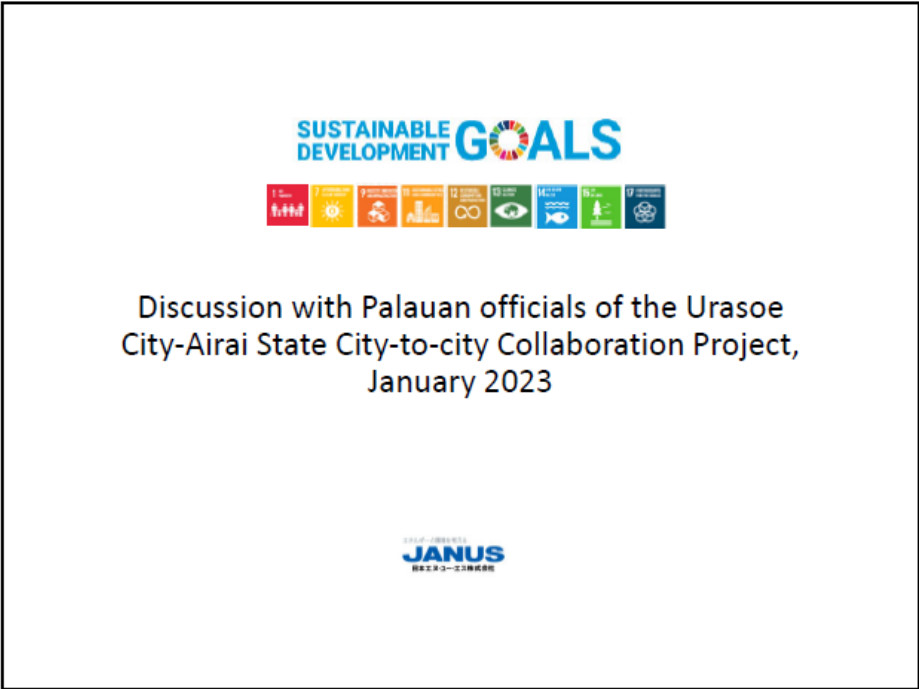
technologies and measures.

We assume we will proceed with the plan for efforts in this project over the next three years with the following schedule serving as a guideline. We would like to conduct a smooth survey through cooperation with those locally on each scheme. We hope to be at the stage where we can verify the effect in anticipation of the execution phase in the next FY2023.

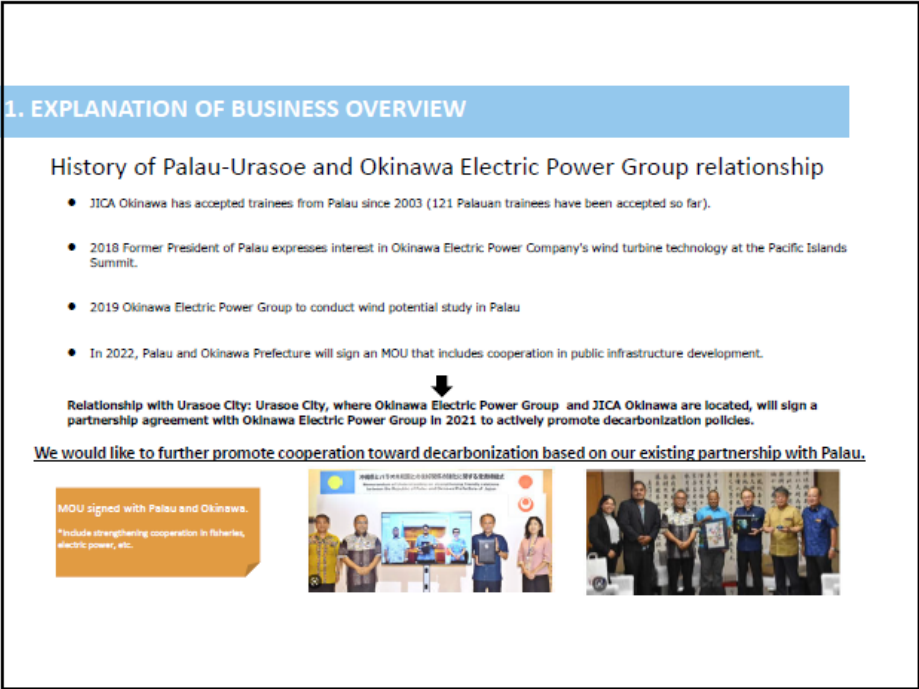
Items	FY2022				FY2023				FY2024			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>1 party owned solar panel and storage battery installation service (PV-TPO)</b>												
① Target site selection												
Conformity site survey												
Site information collection												
Construct a project framework												
② Effect verification												
CO2 emission reduction effect												
Cost estimation												
Economic efficiency, return on investment analysis												
<b>2 Study on introduction of collapsible wind turbines</b>												
① Target site selection												
Conformity site survey												
Site information collection												
Construct a project framework												
② Effect verification												
CO2 emission reduction effect												
Cost estimation												
Economic efficiency, return on investment analysis												
<b>3 commercial and public facilities to install high efficiency air conditioning and hot water supply equipment P18:P20and hydrogen production</b>												
① Feasibility study												
Survey of energy types to be integrated												
Study of integration and control methods												
Construct a project framework												
② Effect verification												
CO2 emission reduction effect												
Cost estimation												
Economic efficiency, return on investment analysis												
<b>4 Grid stabilization with a view to introducing the above 3 technologies/services</b>												
① Feasibility study												
Survey of energy types to be integrated												
Study of integration and control methods												
Construct a project framework												
② Effect verification												
CO3 emission reduction effect												
Cost estimation												
Economic efficiency, return on investment analysis												

**Figure 33: Plan for Future Efforts by Business Item**

Reference material 1 Materials for local consultations related C2C projects



1

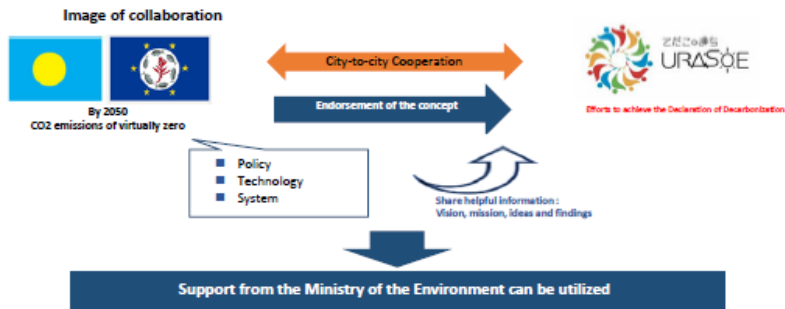


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## Municipalities, decarbonization and international cooperation

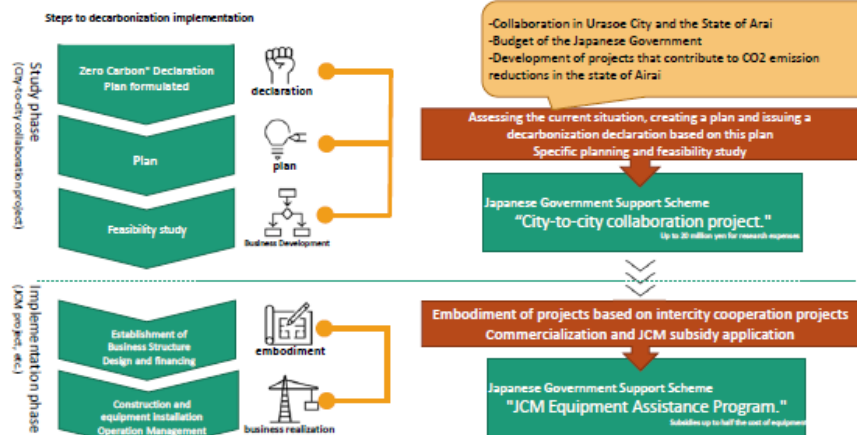
The Ministry of the Environment's idea of a decarbonization initiative through municipal collaboration

- ✓ Paris Agreement Accelerates Global Decarbonization Efforts
- ✓ The Agreement and the United Nations Framework Convention on Climate Change (UNFCCC) clearly state the importance of non-state stakeholders, such as local governments, in promoting decarbonization.
- ✓ The Ministry of the Environment aims to use the Declaration of Decarbonization as a starting point to spread decarbonization efforts to related parties like dominoes (decarbonization dominoes)



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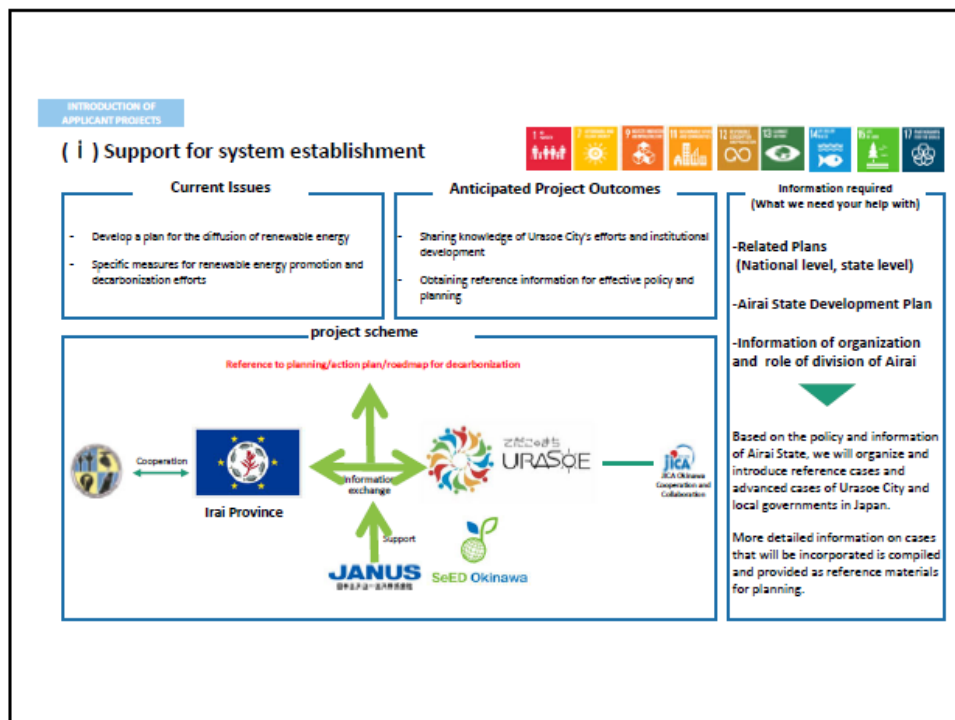
## Japanese Government Support Scheme for Decarbonization



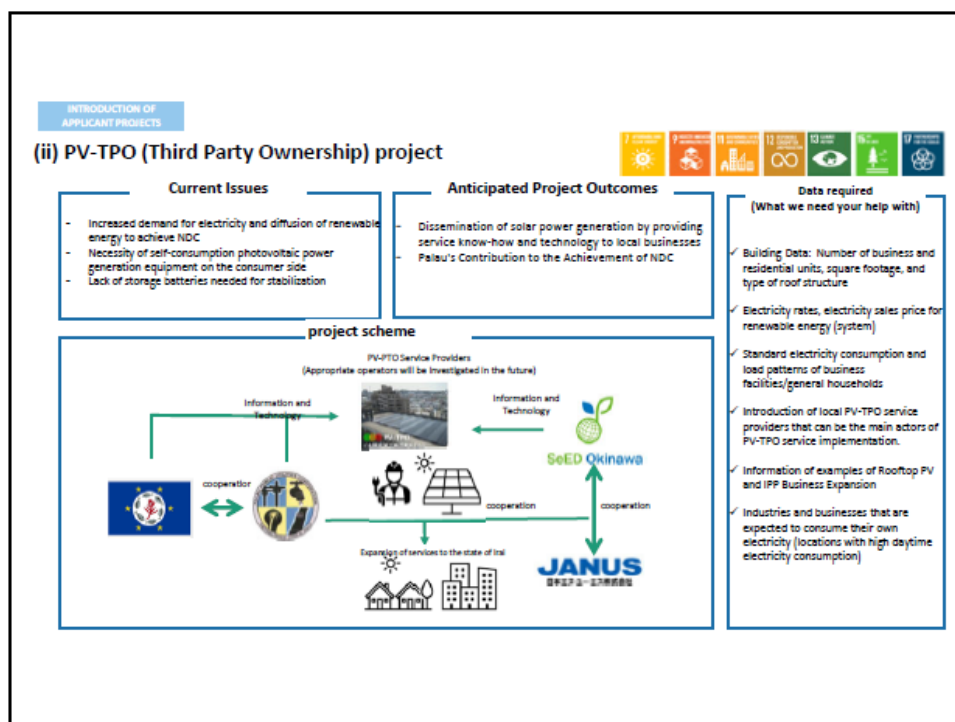
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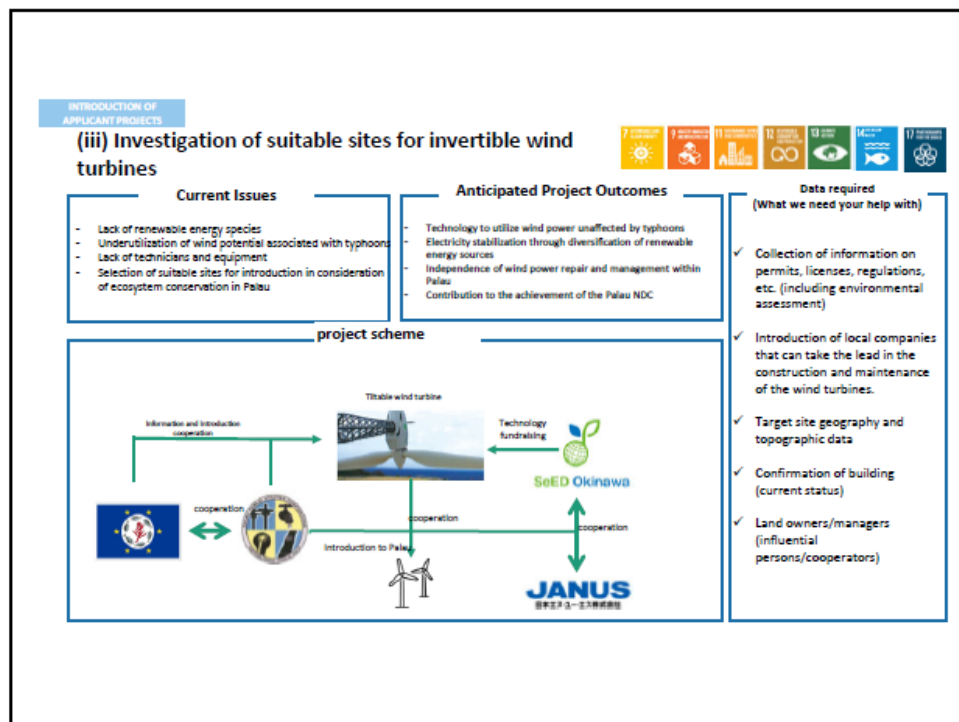




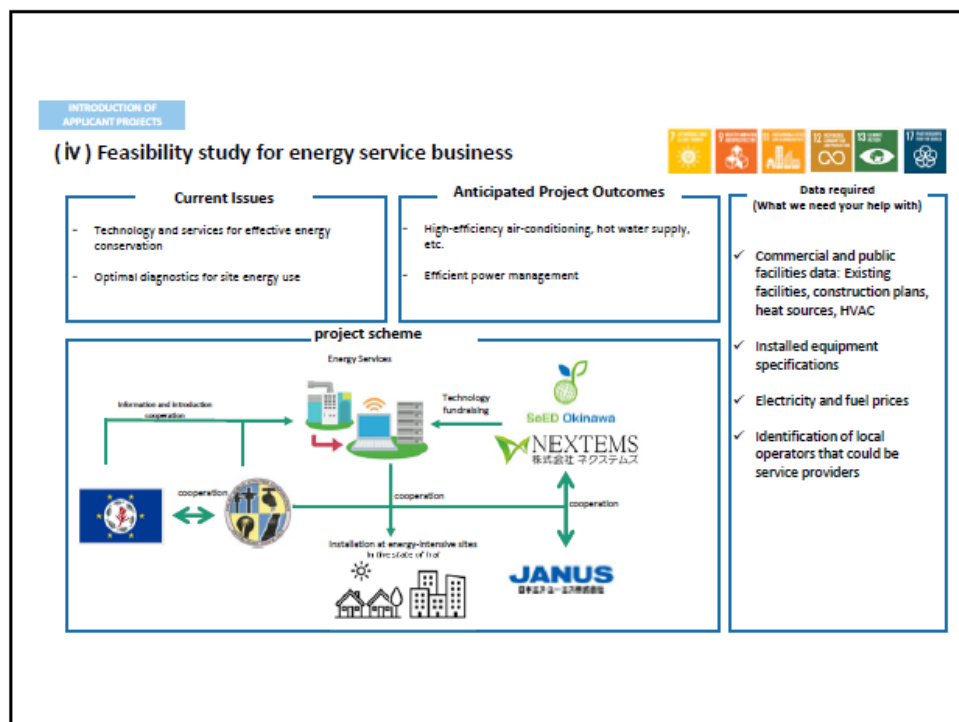
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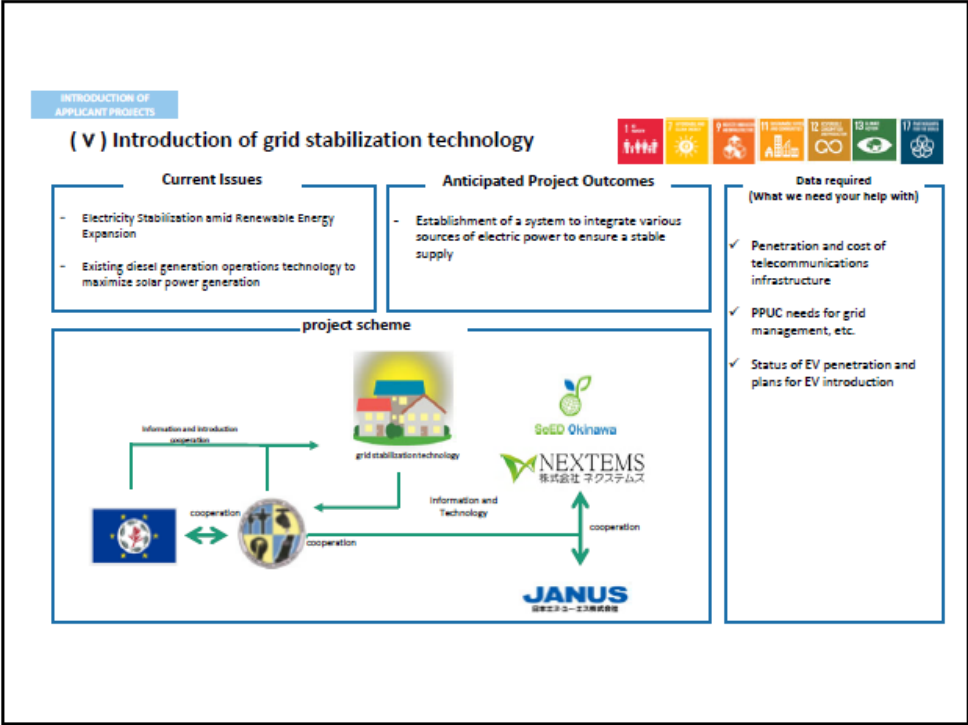
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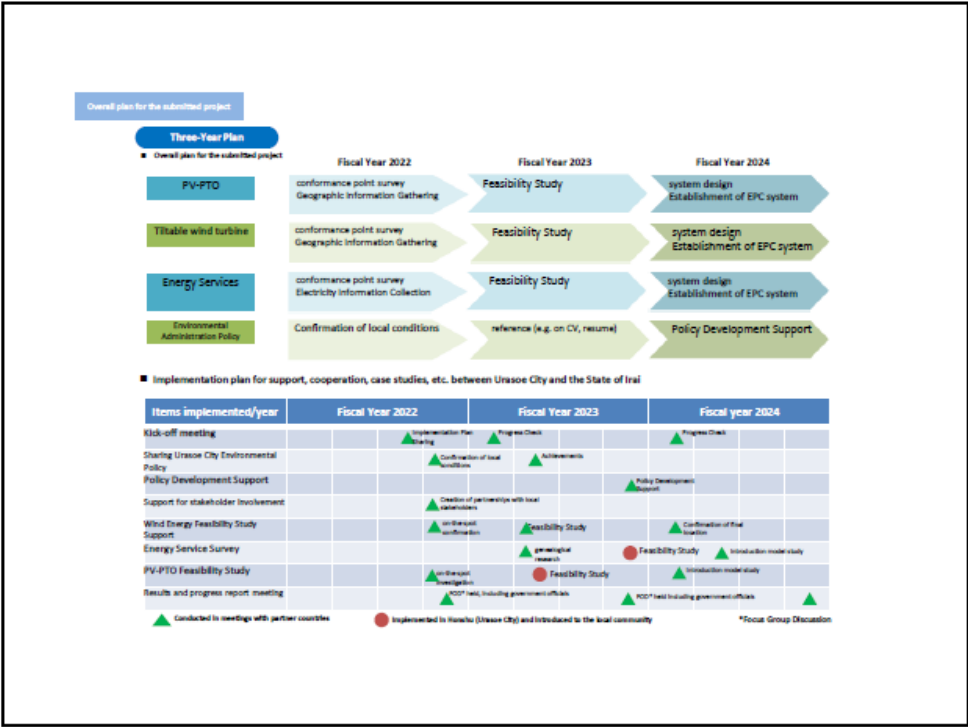
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12

Data required

☐ In considering commercialization and introduction, we would like to fully understand and optimize the situation of Palau before materializing the projects.

☐ Therefore, we would like to obtain information and/or idea regarding the items listed on the right that are relevant to our projects.

☐ If you have information and/or idea, we would like to receive it to the extent possible.

☐ We would be grateful if you could refer us to the parties with whom we should have a hearing on the content for which you do not have information and/or idea.

☐ Please let us know of any other points to keep in mind regarding the collection of information.

• **Support for System Establishment**

Plans related to NDC in Palau  
Airlai State Development Plan  
Information of organization and role of division of Airlai

• **PV-TPO**

Building data: Number of business facilities (including public) and residential units, area, and type of roof structure  
Electricity rates, electricity sales price for renewable energy (system)  
Standard electricity consumption and load patterns of business facilities (including public) / general households  
Introduction of local PV-TPO service providers that can be the main actors of PV-TPO service implementation.  
Examples of roof-mounted PV and IPP projects  
Industries and businesses that are expected to consume their own electricity (locations with high daytime electricity consumption)

• **Tilttable wind turbine**

Collection of information on permits, licenses, regulations, etc. (including environmental assessment)  
Introduction of local companies that can take the lead in the construction and maintenance of the wind turbines.  
Geographic and topographic data  
Confirmation of building at potential sites (current status)  
Land owners/managers (influential persons/cooperators)

• **Energy Services**

Commercial and public facilities data: existing facilities, construction plans, heat sources, HVAC equipment  
Installed energy equipment specifications  
Electricity and fuel prices  
Identification of local operators that could be service providers

• **Grid stabilization**

Availability and cost of widespread telecommunications  
PPUC needs, etc.  
EV penetration status/introduction plan

13



Reference material 2 About city-to-city collaboration between Urasoe City and Airai

JGC

Proposal for City-to-City Collaboration Project  
between The State of Airai and Urasoe City

Enhancing planetary health

December 2022

Urasoe City

The Okinawa Electric Power Co., Inc.

JAPAN NUS CO., LTD.



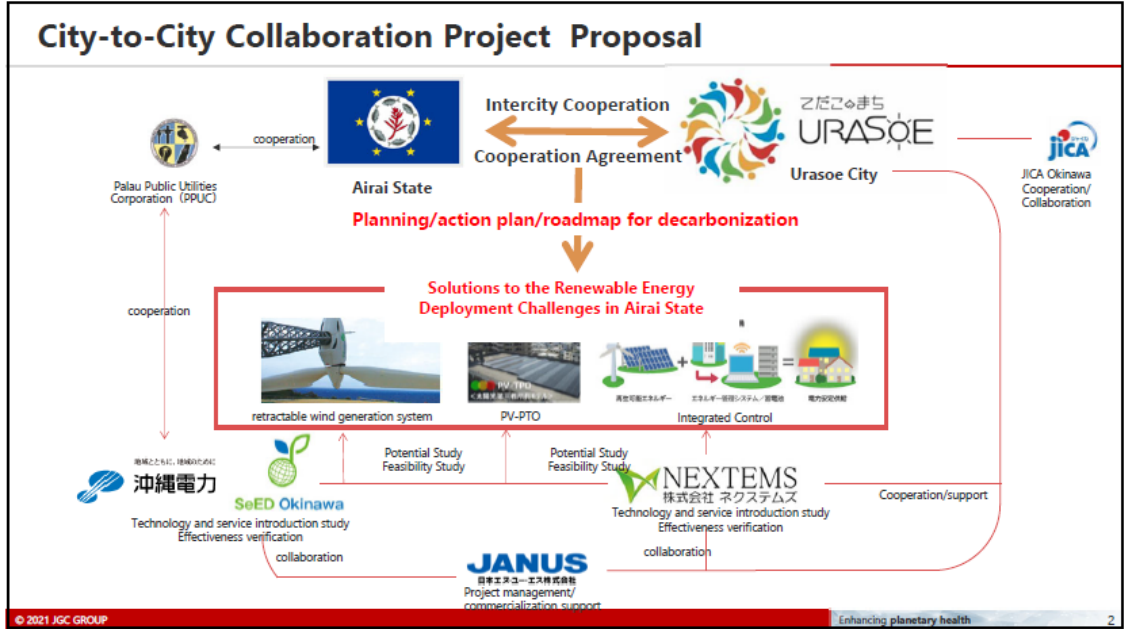
沖縄電力

SeED Okinawa

NEXTEMS

JANUS

1



2

## Summary of the Proposal

Research activities aimed at developing a decarbonized society together with Urasoe City, Okinawa Prefecture, by applying its advanced decarbonization initiatives to Palau, an island nation with similarities and cultural characteristics.

### 【 Actions of Urasoe City : Institution Building Support 】

#### • Assessing the current situation and setting goals

—Deployment of policy formulation and implementation know-how for identifying actual conditions and target setting implemented in the formulation of the action plan for global warming countermeasures

Introduction to Palau of the model of PV-TPO initiatives being promoted based on the partnership agreement of The Okinawa Electric Power Co., Inc.

### 【Actions of SeED Okinawa LLC, NEXTEMS : Project identification /formulation survey 】

#### • Feasibility study on PV-TPO business by local companies as a decarbonization measure in cooperation with local communities

—In Urasoe City, a PV-TPO project is being deployed in a junior high school. It is also a designated evacuation center and functions as a disaster prevention measure.

Realized by cooperation with local governments, with a local company as the business entity. Horizontal deployment to Palau is possible, and its diffusion, including disaster prevention functions, will be promoted.

#### • Investigation of suitable sites for Retractable wind generation system

—Although there is potential for wind power, it is necessary to consider the impact of typhoons, investigate the possibility of introducing Okinawa Electric Power's retractable wind power technology, identify issues, and formulate a dissemination plan.

#### • Investigate the feasibility of energy service projects by local companies as energy conservation measures for municipalities and companies.

—Calculation of the effects of energy conservation targeting energy intensive facilities, investigation of applicable technologies, identification of issues, and formulation of a dissemination plan.

#### • Introduction of the above 3 technologies and services and grid stabilization technologies at the time of expansion of renewable energy introduction

—Calculation of the decarbonization effects of the above decarbonization initiative measures, introduction of grid stabilization technologies during the expansion of renewable energy, research, and identification of issues.

## Background of the Project Proposal and Issues in Palau

### Background

- Palau and Okinawa have deep geographical, cultural and historical ties.
- Obtaining support requests from Palau Electric Power Corporation and the government through Okinawa Electric Power Co., Inc.
- Urasoe City, the municipality where Okinawa Electric Power Company is located, promotes cooperation with the power company in implementing its comprehensive plan and global warming plan
- Deploy Urasoe City-Okinawa Electric Power Cooperation Model in Palau
  - ✓ Urasoe City's knowledge and ability to understand the actual situation, implement policies and goals, and Okinawa Electric Power's technology are highly needed.
  - ✓ Urasoe City's Fifth Comprehensive Plan positions international exchange as Measure 2-8, which includes the promotion of international cooperation projects in collaboration with JICA Okinawa, which is located in the city. Many Palauans have training experience at JICA Okinawa in Urasoe City, and Urasoe City will consider collaboration as a bridge to Okinawa.


### Issues in Palau



- Global warming (e.g., La Niña phenomenon) is expected to cause geographic crises such as rising winds, air temperature, sea temperature, sea level, and precipitation, as well as impacts on tourism such as coral die-off.
- The country relies on fossil fuel generation for approximately 98% of its electricity (as of 2020) and has set a goal (NDC) to increase the share of renewable energy in its electricity generation to 45% by 2025.
- On the other hand, electricity demand is expected to increase from 79,311 MWh in 2016 to 109,121 MWh (37.6%) in 2025.
- The amount of electricity generated is expected to be approximately 115 GWh, and in order to achieve NDC, more than 52 GWh must be covered by renewable energy, which must be achieved by power generation that makes the most of local resources.
- In order to expand renewable energy, it is necessary to utilize a variety of renewable energy resources rather than relying solely on PV.
- While Palau has potential for wind power generation, it has suffered extensive damage from typhoons in the past, and typhoon countermeasures are essential.
- As a decarbonization measure, energy-saving measures on the consumer side using energy services will also be an important measure.

Source : JICA2019 (<https://www.mofa.go.jp/mofai/gaiko/osda/files/000072638.pdf>)

## Target area: The State of Airai, Republic of Palau



### The State of Airai

#### Basic information

- ✓ Southern Province of Babeldaob Island, Palau
- ✓ Population 2,455.  
( About 14% of the domestic population. Palau's second most populous state )
- ✓ Area 44 km<sup>2</sup> (about 9.6% of the entire country)

#### Reference information

- ✓ It is a commuter town, with the only international airport in the country, a Japan-Palau Friendship Bridge (funded by Japanese ODA) between the state of Koror, which has the largest population in the country.
- ✓ While it is an agricultural area, commerce and industry are developing with the transfer of urban functions to Koror.
- ✓ There are five major residential development project sites in the state, including Airai Elementary School and new residential subdivisions owned by many young dual-income families.
- ✓ Due to its proximity to the capital Melekeok and the international airport, residential and commercial/industrial development is underway.
- ✓ The headquarters and satellite facilities of Palau National Communications (PNCC), which provides telephone, internet and television services, are located here.
- ✓ In the future, Koror's public facilities (hospitals, schools, ports, etc.) will be transferred to Airai state. Population and investment projects are increasing.
- ✓ There is a resort development plan in the peninsular part of Airai state. A prison will be built along the border road between Airai and Ngchesar provinces.

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## Natural Resources in the State of Airai, Disaster Risk Management, Regional Development Planning

### 【Natural Resources in the State of Airai】

- Two-thirds of Airai's land remains untouched with natural vegetation. About a third is occupied by houses, roads, ports, offices, airports and farms.
- Natural resources are often destroyed by sudden fires during the dry seasons of December, January, February and March. This burning has destroyed crops and habitats, exacerbated soil erosion and lost income.
- Invasive species threatening habitats and the environment are a major problem in the country, and some of these invasive species are common in Airai State.


### 【 Disaster Risk Management 】

- Palau has long been hit by typhoons. In April 2021, Typhoon No. 2, which passed through northern Palau, caused property damage such as the collapse of houses, as well as blackouts and water outages, and JICA has provided emergency relief supplies to Palau. Preparations against the impacts of these natural disasters are not sufficient.
- Palau is expected to be severely affected by climate change due to global warming, and it is urgent to prepare measures to reduce the risk of future natural disasters. At the national level, the National Disaster Risk Management Framework (NDRMF) 2016-2030 provides guidance for Palau's strategies and actions at each level, but Airai State currently lacks disaster risk management (DRM).

### 【 Regional Development Planning 】

Among the regional development plans of Airai State, important guidelines for climate change and disaster countermeasures are development master plans and land use plans. The future vision of Airai State stipulated in these is as follows.

- 1. Protection and conservation of natural resources
- 2. Protection and Conservation of Historic Buildings
- 3. Perpetuation of Palau's cultural heritage
- 4. A vibrant town center with a mix of residential, commercial and recreational facilities
- 5. Providing comfortable, healthy, and conveniently located residential areas
- 6. Agricultural promotion and support - Balancing self-sufficient gardens and large-scale farms
- 7. Provision of optimal infrastructure and land to achieve sustainable economic growth



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## Power demand in Airai state

- Airai State has the second largest population after Koror State and has a central function in the country. There is a plan to formulate a new development plan in the future, and there is a need to refer to the efforts of Urasoe City.



Power transmission and distribution system on Koror Island and Babeldaob Island

	2016	2017	2018	2019	2020	2025	2030	2035
Aimeliik	3,026	3,056	3,127	3,201	3,277	3,438	3,519	3,603
Airai	16,932	17,222	17,840	18,481	19,365	23,149	24,929	26,830
Koror	53,341	54,103	56,222	58,417	62,558	72,145	76,648	81,425
Melekeok	2,928	2,964	3,053	3,145	3,242	5,016	6,623	7,007
Ngaraard	587	595	617	640	665	2,253	3,131	3,186
Ngardmau	247	250	258	266	275	296	313	331
Ngaremlengui	671	678	697	717	737	784	817	851
Ngatpang	408	413	423	434	446	471	489	507
Ngchesar	306	309	317	325	334	355	374	395
Ngarchelong	529	535	548	562	577	829	1,218	1,390
Ngihwal	331	334	343	353	363	385	401	419
Koror+Babeldaob	79,311	80,459	83,447	86,541	91,839	109,121	118,461	125,944

Power demand forecast by state

- While focusing on Airai State, the supply potential of renewable energy is not within the territory of a single municipality, so collaboration with multiple municipalities with potential is also being considered.

Reference : JICA2017 ([chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www2.jica.go.jp/ja/evaluation/pdf/2017\\_1260190\\_4\\_f.pdf](https://chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www2.jica.go.jp/ja/evaluation/pdf/2017_1260190_4_f.pdf))  
JICA2019 (<https://www.mofa.go.jp/mofai/qaiko/oda/files/000072638.pdf>)

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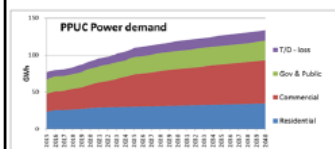
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## Power Supply Situation, Demand Forecast, Energy Saving Policy in Airai State, Republic of Palau



### Power supply situation

- Two major domestic diesel power plants (Aimeliik power plant 12MW, Malakal power plant 24.45MW) are installed.
- Photovoltaic power generation and wind power generation are regarded as important as renewable energy, and wind power generation has not been introduced.
- As of 2017, there are about 80 PV systems connected to the grid, with a total power generation capacity of 2,356 kW. Most are located in Koror and Airai states.



### — Demand composition ratio by sector

Demand is on the rise overall, especially in the commercial sector.

Demand for new power is expected to continue to increase in the future in Airai State.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Power demand (kW)	0	78	245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gov & Public	0	77	234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	175	381	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	171	696	123	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T/G - loss	0	221	288	149	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	283	735	286	297	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power demand (kW)	0	288	735	235	216	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gov & Public	0	299	720	290	258	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	304	735	368	267	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	313	735	382	300	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
T/G - loss	0	321	735	396	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	330	735	400	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Power demand (kW)	0	338	735	404	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gov & Public	0	343	735	406	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commercial	0	354	735	412	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential	0	360	735	416	319	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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## Urasoe City, Okinawa Prefecture



### Overview of Urasoe City

- Adjacent to Naha City, population growth is remarkable, and commerce and industry are active.
- The fourth largest city in the prefecture, with a population of about 116,000.
- More than 14% of the 19,480 ha area is occupied by US military bases.



### Urasoe City's Greenhouse Gas Emission Reduction Target

- Xmtw 2jw yfwljy: 7576. ; Wjizhj 9% tkhtr ufwi yt K^7568
- R jizw 2jw yfwljy (2026) ; Wjizhj =% tkhtr ufwi yt K^7568
- Qtsl 2jw yfwljy (2050) Wjizhj <5% tkhtr ufwi yt K^7568

### Urasoe City Environmental Basic Plan (2020~2026)

In cooperation with the 4th Urasoe City Comprehensive Plan, etc., establish a promotion system and set forth concrete measures for citizens, citizen groups, businesses, and the city (administration) to realize "Urasoe, a city of environmental symbiosis that nurtures rich nature and culture and connects to the next generation".

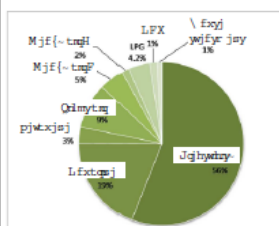
### Urasoe City Action Plan for Global Warming Countermeasures (2017)

Set reduction targets, and work together with citizens, businesses, and tourists on energy conservation, energy-saving behavior, eco-driving, 4Rs, etc.

## Efforts related to decarbonization in Urasoe City

- Incorporated promotion of effective use of energy into the 5th Urasoe City Comprehensive Plan and announced promotion of introduction of renewable energy to public facilities, etc.

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▲ Identification of emission sources and future projections

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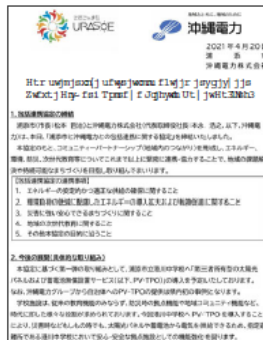
Understand the current situation in Urasoe City, analyze policies, introduce technologies, formulate plans, etc., and promote them in cooperation with citizens, companies, the city, and tourists based on various plans in order to achieve the goal of realizing a low-carbon society.



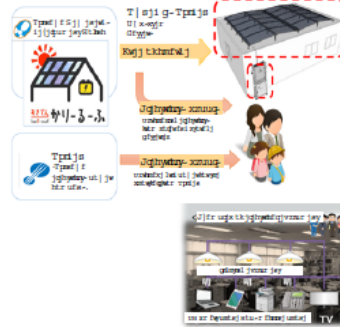
## Urasoe City, Okinawa Electric Power

### Power supply service through free installation of PV equipment and storage batteries (PV-TPO business)

Concluded a comprehensive partnership agreement with The Okinawa Electric Power Co., Inc. to solve regional issues and develop sustainable communities



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Installed photovoltaic power generation equipment and storage batteries free of charge to Urasoe Municipal Minatogawa Junior High School, and introduced a service to supply electricity (PV-TPO business).

The school facility, which functions as a base in times of disaster and as a local community, can be supplied with electricity from solar panels and storage batteries even in times of disaster, thereby contributing to strengthening its functions as a safe and secure base facility.

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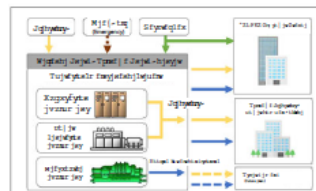
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## Urasoe City Energy supply service and management business

Reliance Energy Okinawa (REO), a member of the Okinawa Electric Power Group, develops energy service business in Urasoe City



REO  
Reliance Energy Okinawa

● Example: Sanei Urasoe Nishikaigan PARCO CITY

REO owns energy service facilities and supplies secondary energy such as "electricity, cold and heat", and operation management.

- High supply reliability is improved by securing a backup power line with extra high voltage power receiving.
- High temperature difference heat source air conditioning ST enables high CO2 reduction effect and comfort under Okinawa's hot and humid conditions
- Adoption of a desiccant ventilation system that uses waste heat water from solar heat and micro cogeneration
- Introduction of cutting-edge CO2 reduction technology that utilizes Okinawa's solar power, geothermal heat, etc.



The energy center, which supplies electricity and cooling/heating for air conditioning over an area, enables energy generation by high-efficiency heat source equipment and power generation and waste heat utilization by gas cogeneration.

Reduces energy costs and environmental impact, and supports building business continuity planning (BCP) in the event of a disaster.

● Example: Makiminato Area Energy Center

Cold water for air conditioning and regular/emergency power are produced from heat source facilities and power facilities that are constructed, owned, maintained, and operated within the energy center, and supplied to actual users through cold water pipes and power lines.

<Best mix of electricity and natural gas>

- Stable supply of chilled water for air conditioning by high-efficiency inverter centrifugal chiller and air-cooled heat pump
- Introduction of cogeneration, normal power generation using natural gas, and production of chilled water with exhaust heat input type gas-fired water chiller-heaters using waste hot water from power generation

<Preparation for emergencies and BCP measures>

- In addition to receiving extra high voltage power by placing all wires underground, power is received from the main line and backup power line to cope with blackouts.
- Equipped with a cogeneration system fueled by natural gas and an emergency power generator fueled by heavy oil
- 24-hour remote monitoring at multiple locations and emergency assistance



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## Okinawa Electric Power Co., Inc. Company Profile, Efforts to Expand the Introduction of Renewable Energy in Small Power Systems on Remote Islands

Company Name	Okinawa Electric Power Co., Inc.
Date of Establishment	May 15, 1972
Head Office	Urasoe City, Okinawa
Capital stock	7,586 million yen
No. of employees	1,536

- The Okinawa Electric Power Group is promoting the introduction of solar and wind power generation from the perspective of global warming countermeasures and cost reductions on remote islands.

Category	No. of power plants	Authorized maximum output(kW)
steam power	5	1,629,000
gas turbine	5	326,000
internal combustion power	13	189,780
alternative energy	5	2,315
<b>Total</b>	<b>28</b>	<b>2,147,095</b>

Number of substations	134
Substation Capacity	7,186MVA
Length of transmission line	1,234km
Length of distribution line	11,135km

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## Strengths of the Okinawa Electric Power Group

The Okinawa Electric Power Group has gained the following strengths primarily through its experience with solar and wind power installations on remote islands.

Htaxyhyts tkm-gwL x-xyjr tkirxjgut | jwljaCyta fai wja | fgg jsejw-

- We built a hybrid system that combines wind power generation, storage batteries, and diesel power generation on five isolated islands in Okinawa Prefecture.
- On four remote islands, we operate Retractable wind turbines in cooperation with diesel generators.

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- Achievements in technological development aimed at suppressing fluctuations in wind power and solar power that fluctuate in output
- Various storage system introduction and operation results such as NaS battery, lead storage battery, lithium ion battery, nickel metal hydride battery, lithium ion capacitor, flywheel, etc.

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- Extensive experience and achievements in diesel generators, renewable energy, and equipment maintenance for power systems
- We have knowledge of equipment management that takes into consideration typhoon and salt damage measures, which are issues unique to tropical island regions.



Hybrid system in Yonaguni-island



Retractable wind turbines in Awaguni-island



PV system in Tarama-island



NaS battery in Miyako-island



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## SeED Okinawa LLC, Company Profile



Company name	SeED Okinawa LLC
Year of establishment	30 April 2021
Location	Urasoe city, Okinawa, Japan
Capital	27 million JPY
Manager	Kiyohito Shimabukuro (Representative Director and Executive Vice President of Okinawa electricity power company)
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● Jointly established by five group companies for the purpose of leveraging the strengths of the Okinawa Electric Power Group to develop overseas business.

● Realization of a low-carbon and sustainable society in overseas countries, particularly in the islands of Asia and the Pacific, by using the knowledge and technologies it has accumulated in the operation of renewable energy and grid stabilization equipment to face global climate change risks.



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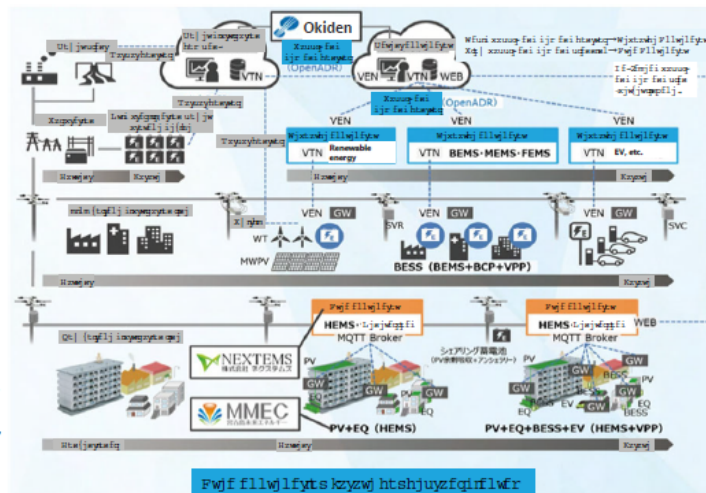
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## NEXTEMS Company profile, initiatives with Okinawa Electric Power Co., Inc. and affiliated companies



- A company based in Urasoe City that sells photovoltaic power generation systems, storage batteries, eco-cutes, and other equipment, and is involved in the demonstration of remote monitoring and control of distributed power sources and controllable loads.
- The company aims to demonstrate and establish an area aggregation system that uses renewable energy as its main source of power while balancing supply and demand on a grid-wide basis and allowing for flexible demand formation.
- The company's complex energy services, which include the installation of solar power generation and Eco-Cute in homes owned by third parties, the sale of electricity for private consumption and hot water heat, and the trading of PV surplus power to Okinawa Electric Power Company, won the Minister of Economy, Trade and Industry Award (Advanced Business Model Category) in FY2019.



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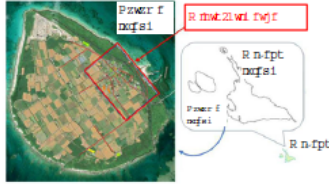
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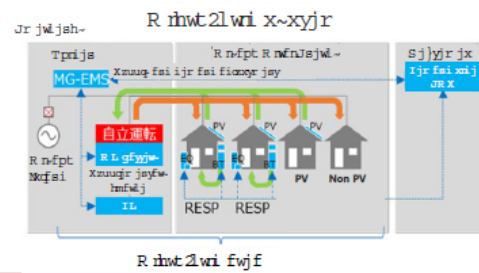
### Efforts to expand the introduction of renewable energy in small-scale power systems on remote islands

### Regional Microgrid Construction Project in Kurima Island, Miyakojima City



- A consortium consisting of NEXTEMS, Okinawa Electric Power Co., Inc., Miyakojima Mirai Energy Co., Ltd., and Miyakojima City has started a “microgrid (MG)” project since 2020, aiming for local production and local consumption of renewable energy on Kurima Island (Miyakojima City).
- Install solar panels and storage batteries in each household on the island. When the amount of electricity generated exceeds demand, the storage batteries are charged, and when the amount falls below demand, the storage batteries are discharged.

- Achieved 100% power supply using only solar power and storage batteries. For the first time in Japan, it was confirmed that the system can be operated on an actual power system connected to ordinary homes.



## Okinawa Electric Power Group's Efforts to Introduce Renewable Energy Outside the Region

**Introduced a retractable wind power plant to the Kingdom of Tonga**



Retractable wind turbines



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Introduced five retractable wind turbines to the Kingdom of Tonga in 2019 and contributes to saving 1.5 million TOP per year (equivalent to about 75 million yen in Tonga pa'anga) in fuel costs for existing diesel power plants



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- Supporting appropriate operation and maintenance of diesel generators in Fiji, Tuvalu, and Kiribati based on the status of renewable energy introduction. In addition, we will support the introduction and operation of renewable energy for grid stabilization, and promote the introduction of hybrid power generation systems.

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- Conducting surveys to assess the potential for introduction of renewable energy and to identify technical issues for the purpose of decarbonization and strengthening resilience on remote islands with isolated environments.

## JICA Okinawa Organization Profile, Training Achievements at Okinawa Electric Power Co., Inc.



- JICA Okinawa was established in Urasoe City in 1985 and is engaged in international cooperation projects utilizing Okinawa's technology and experience.
- JICA Okinawa accepts approximately 400 government officials, engineers, and others annually, and offers a variety of courses that take advantage of Okinawa's characteristics (island characteristics, subtropical climate, and uniqueness).
- In 2013, Okinawa Prefecture and JICA Okinawa concluded a partnership agreement, the first of its kind in Japan at the prefectural level.
- Since FY1982, JICA has accepted 13122 trainees from 164 countries, including 121 from Palau. (As of July 2022, two Palauans are currently undergoing training)



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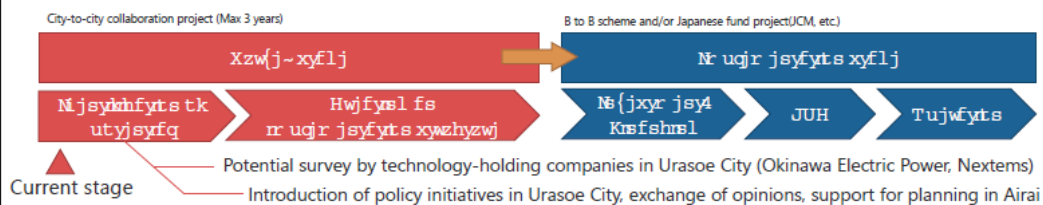
### JICA Subject-Specific Training "Power Distribution Network Development (A)" Course

Since FY2003, Okinawa Electric Power Company has accepted this training as part of this JICA program every year, introducing power distribution technology and power distribution facilities through lectures and practical training, aiming to reduce power distribution loss, improve power quality, and promote rural electrification in developing countries, to improve the skills of engineers who play a leading role in each country.

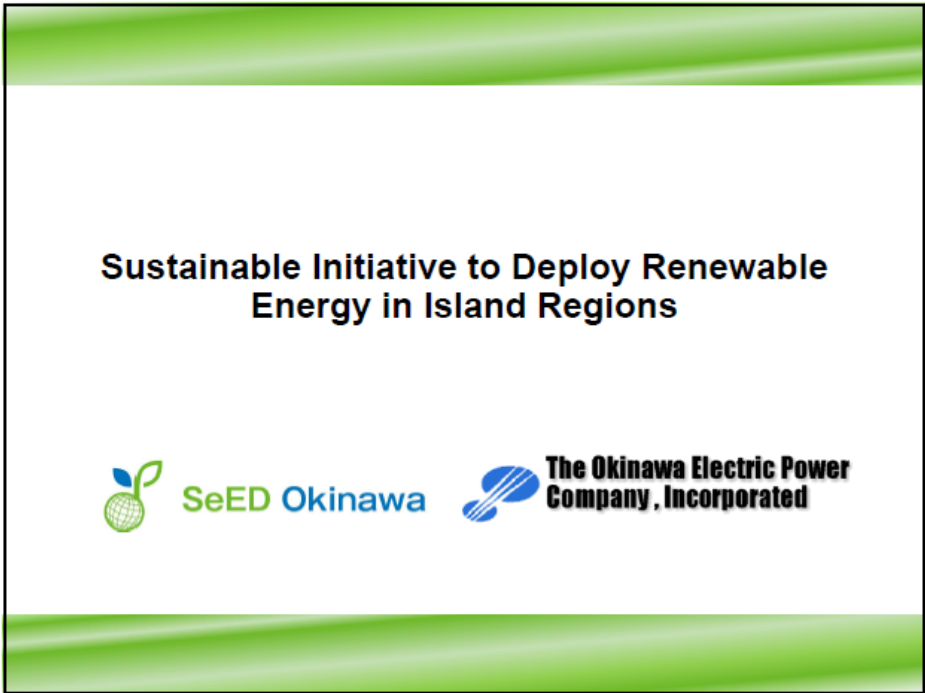
Until 2022, the 19th time, 181 people from a total of 51 countries have been accepted, of which 6 people from Palau have received training at Okinawa Electric Power Company.

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- Accelerating decarbonization measures such as the introduction of renewable energy through planning by local governments.
- Through collaboration, we will increase opportunities to provide technology, knowledge, investment, etc. of companies located in Japanese municipalities (Urasoe City).
- We will maximize the feasibility by obtaining Japanese subsidies and support funds.
- During the research period of up to three years, we will identify specific projects and create an implementation plan.



Reference material 3 Regarding measures to spread renewable energy



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Overview of Okinawa Prefecture and OEPC

1

- 160 islands scattered over a sea area spanning about 1,000 km east-west and about 400 km north-south.
- OEPC supplies electricity to 37 inhabited islands including Okinawa main island.

Okinawa Prefecture	
Population	1,451,676
No. of Households	608,753
Area	2,281 km <sup>2</sup>
Climate	Subtropical

Renewable Energy installed capacity in Okinawa	
PV	430,000kW
Wind power	14,000kW

As of September 2022

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## Main Point of Today's Presentation

2

### Palau's High Renewable Energy Targets

- Palau has set a challenging goal of 45% renewable energy deployment by 2025.
- However, the current deployment rate is only about 3% as of 2020.

Generation in 2019	GWh	%
Non-renewable	83	97
Renewable	2	3
Hydro and marine	0	0
Solar	2	3
Wind	0	0
Bioenergy	0	0
Geothermal	0	0
Total	85	100

Source: [Palau Energy Profile IRENA, 2021](#)

### Okinawa Electric Power Company (OEP) Group Initiatives

- For the past 30 years, OEP has worked on the deployment of renewable energy in isolated grids in island regions with environmental conditions similar to those of Palau.
- OEP Group can contribute to achieving Palau's goals through its experience, know-how, and execution capabilities.

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## Step-by-step advancement to achieve renewable energy deployment targets

3

### STEP 1 Renewable Energy Source Deployment Phase

(Initiatives by power producers)  
Select renewable energy sources suited for the site considering current use of land, natural environment, and other factors



### STEP 2 Renewable Energy Utilization Improvement Phase (1)

(Initiatives by power producers as well as transmission and distribution system operators)  
-Work on initiatives to increase the utilization rate of renewable energy sources deployed by power producers

### STEP 3 Renewable Energy Utilization Improvement Phase (2)

(Initiatives by consumers)  
-Work on initiatives to expand the utilization of distributed renewable energy by consumers as efforts to deploy and further utilize renewable energy while reducing the impact on grids



### STEP 4 Renewable Energy Full-Utilization Phase

(Collaborative effort between power producers, transmission and distribution system operators, and consumers.)  
-Efficiently operate grids where diesel power generation, renewable energy power source, and consumer facilities are integrated

Aim to achieve renewable energy deployment targets through a Palau-style model, which is tailored to local conditions

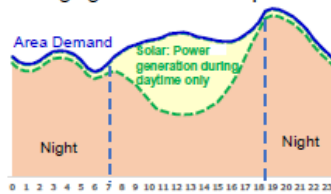


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## STEP1 Renewable Energy Source Deployment Phase (Initiatives by power producers)

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- Large-scale PV is expected to increase its output during the daytime only. (The power output decreases in winter.)  
The ideal method is the best mix with wind power generation, which is expected to generate power stably even at night and in winter.
- Palau is blessed with abundant wind resources, but like Okinawa, damage by typhoons and others may cause conventional wind turbines to suffer low operation rates and high repair costs.
- Island regions face challenges including the difficulty in securing large cranes necessary for the construction and maintenance of conventional wind turbines and in maintaining and managing them with local personnel.



Tower buckled due to typhoon



Blade broken by typhoon

**Tilttable wind turbines that can cope with typhoons and can be maintained in island regions are an effective solution.**

4

## STEP1 Renewable Energy Source Deployment Phase (Initiatives by power producers)

5

### Use of Tilttable Wind Turbines



- The power generation with tiltable wind turbines deployed by OPEC is an innovative method that solves the challenges island regions face.  
⇒ Can be tilted nearly 90 degrees to avoid typhoon winds  
⇒ No large cranes required for construction; can be installed on hilly terrain  
⇒ Maintenance can be performed at ground level by tilting the wind turbine  
⇒ Reduction in typhoon damage leads to lower repair costs and higher operation rates
- OEPC has installed seven units on outlying islands in Okinawa Prefecture (totaling 1,715 kW); in 2019, it installed five units in the Kingdom of Tonga (totaling 1,375 kW).
- Past wind surveys indicate that wind conditions are relatively good in the northern part of Babeldaob Island; however, the capability of the grids is an issue.
- Since there is a plan to increase grid capacity on the island, the deployment of tiltable wind turbines is worthy of a feasibility study.



Tilted wind turbine



Tongatapu Island  
275kW×5

Installed Units				
Island	Tilttable WT	Area	Population	Max Demand
Aguni	245kW×1	7.6km <sup>2</sup>	689	800kW
Minamidaito	245kW×2	30.5km <sup>2</sup>	1,257	1,900kW
Tarama	245kW×2	19.8km <sup>2</sup>	1,099	1,200kW
Hateruma	245kW×2	12.7km <sup>2</sup>	496	800kW
Tongatapu	275kW×5	260.4km <sup>2</sup>	74,611	

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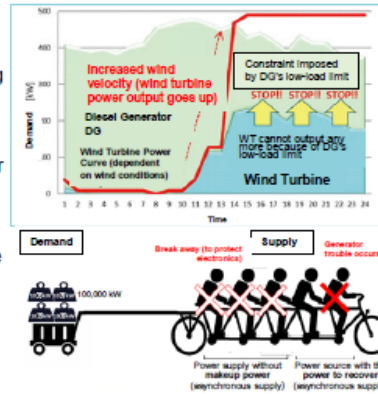


## STEP2 Renewable Energy Utilization Improvement Phase (1) (Initiatives by power producers, transmission and distribution operators)

6

➤ Renewable energy penetration gives rise to the following challenges in grid operation:

- **Restrictions to renewable energy output due to the low-load limits of diesel generators (DG)**  
When renewable energy output increases, DG output must be reduced to balance the supply and demand. DGs cannot operate below the low-load limit for mechanical reasons, forcing constraints on surplus renewable energy output.
- **Risk of widespread power outages due to reduced inertia**  
Renewable energy penetration leads to reduction in the number of operating DGs, which lowers the inertia in the power grid. If a grid accident occurs under low-inertia conditions, generators may not be able to attain the target frequency, resulting in a wide-area power outage. (Batteries do not provide inertia.)
- **Failure of protection mechanisms during accidents**  
Less generators in operation means less short-circuit capacity. This can cause protection mechanisms (relays) to fail and accidents to go undetected.



Source: Agency for Natural Resources and Energy: Study on Achieving Carbon Neutrality in 2050 (December 21, 2020)

**An effective solution is to introduce a grid stabilizer that can maintain grid inertia while maximizing renewable energy utilization rate.**

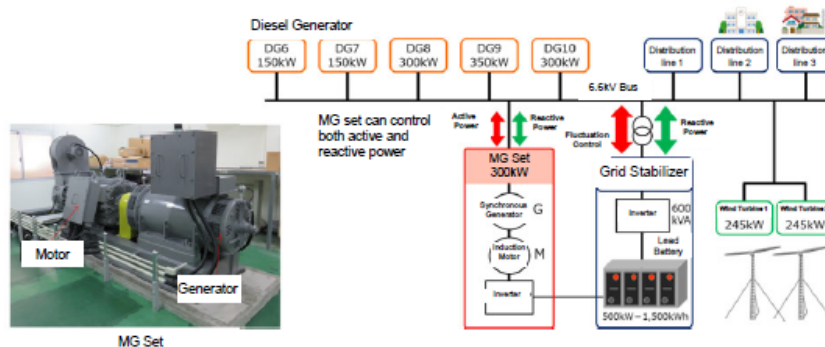
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## STEP2 Renewable Energy Utilization Improvement Phase (2) (Initiatives by power producers, operators of transmission system and substations)

7

### Maximizing energy efficiency with Motor-Generator Sets (MG Sets)

- The surplus renewable energy is used to charge batteries, alleviating restrictions on renewable energy output.
- Can be used as an alternative to diesel generators and is capable of preventing reduction in inertia and short-circuit capacity.
- On Okinawa's Hateruma Island, the combination of MG set and tilttable wind turbines achieved 100% renewable energy operation for 10 days.



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### STEP3 Renewable Energy Utilization Improvement Phase (2) (Initiatives by consumers)

8

➤ Challenges to the deployment of large-scale PVs for increased renewable energy penetration:

- **Limited sites/environmental protection**  
Securing land in island regions is difficult. Alteration of land in areas with a rich natural environment should be minimized.
- **Reinforcement of power transmission and distribution facilities**  
Augmentation of transmission and distribution facilities requires expensive capital investment.
- **Impact on power system**  
The larger the renewable energy power plant, the greater the impact on the grid, causing power shortages in the event of accidents.



Deployment of self-consumption renewable energy facilities is an effective solution in the phase where the promotion of initiatives by consumers is required, which will lead to reduced investment in grids.

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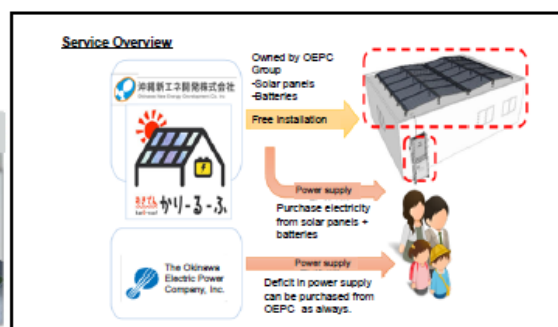
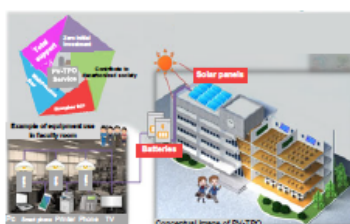
### STEP3 Renewable Energy Utilization Improvement Phase (2) (Initiatives by consumers)

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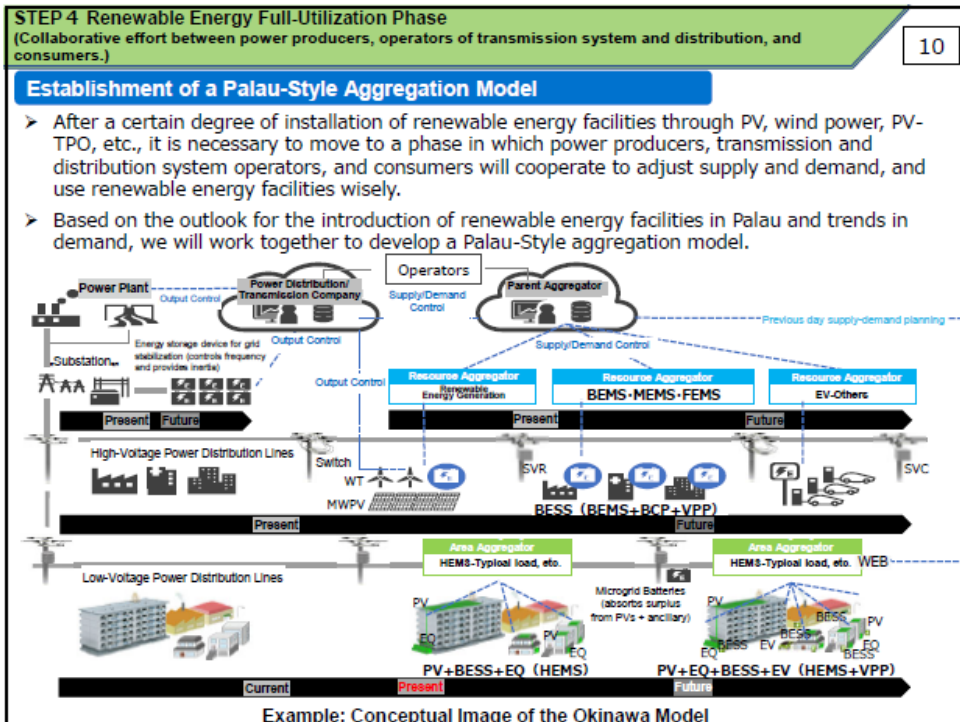
#### Establishment of Palau-Style Third-Party Ownership Model (PV-TPO)



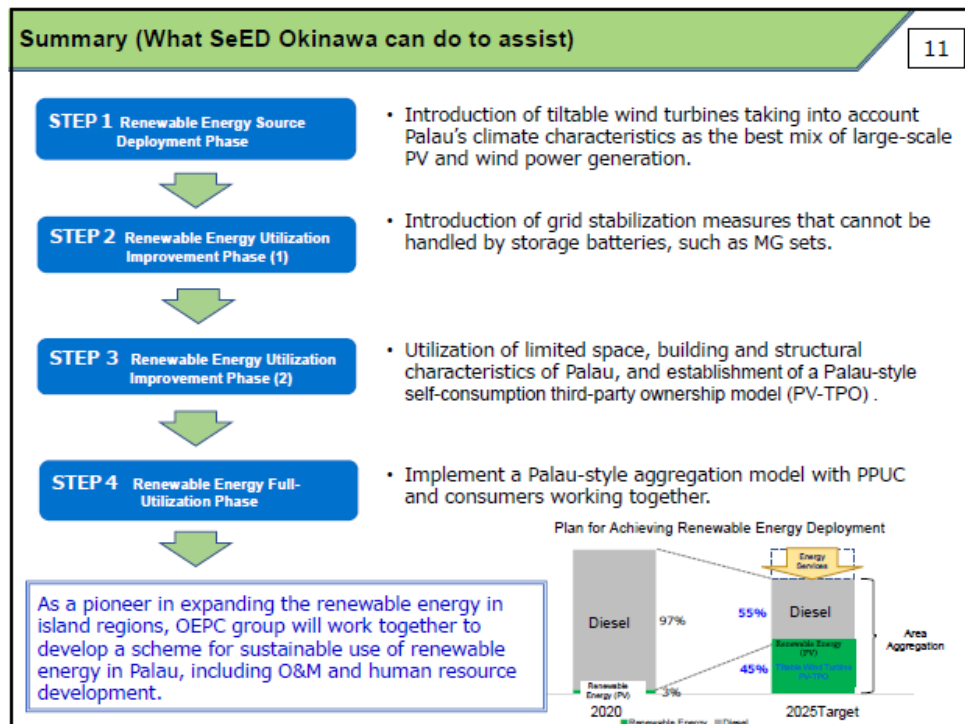
- Establish a Palau-style self-consumption third-party ownership model (PV-TPO) in which roof-mounted PVs are installed on homes and commercial facilities and operated by a local operator in Palau.
- Users do not bear the cost of equipment installation
- For facilities requiring high energy security, batteries can be installed to supply power during outages caused by typhoons or other disasters. (Ensures resilience.)
- In Okinawa, this service is currently being provided to private companies, residences, and public facilities (schools) with the cooperation of the local government.



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