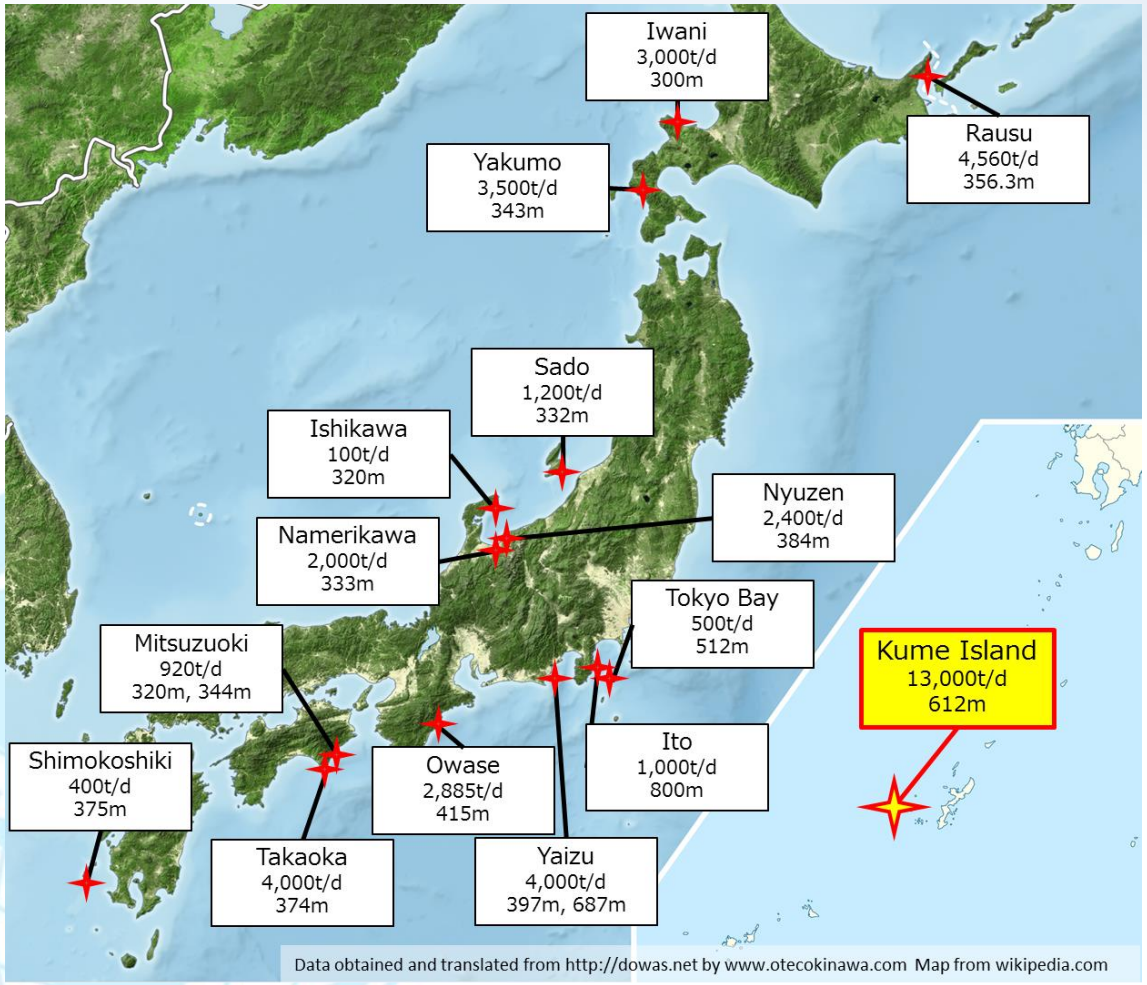
Applications and Benefits of OTEC

The Kumejima Model:
a Catalyst for Sustainable Island Development using OTEC

Yasuyuki Ikegami
Institute of Ocean Energy Saga University

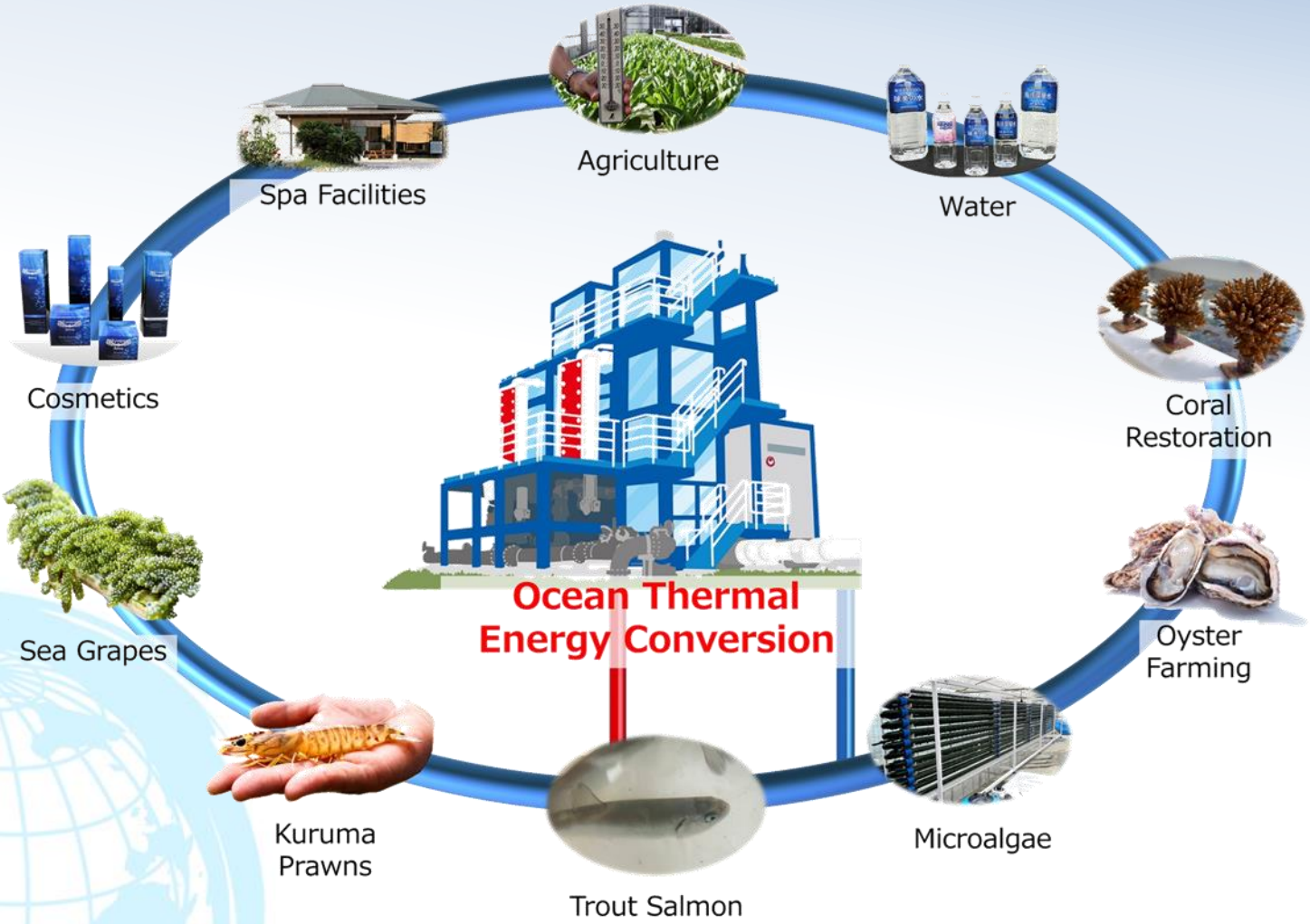
Japan DOW Intake Pipes

With 15 Deep Ocean Water (DOW) intake sites, Japan has the largest number in the world. Kumejima in southern Japan, has the largest intake capacity in Japan



As a small island community, Kumejima has been working towards increasing capacity as a key resource for development of self-sufficient water, energy, and food.

The Kumejima Model



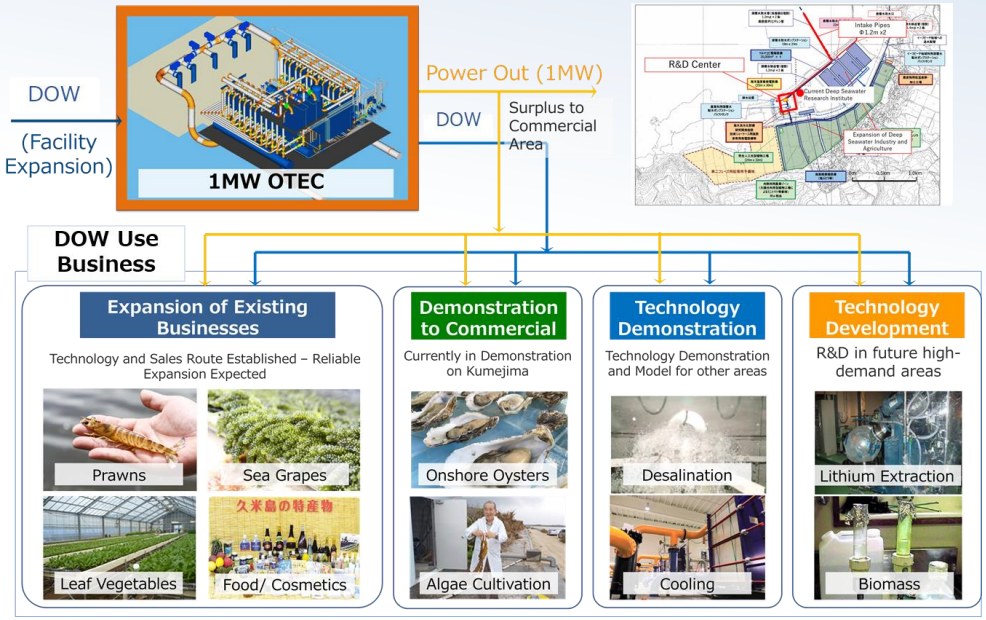
Kumejima's concept is use of DOW resources for energy (via ocean thermal energy conversion), food (aquaculture and agriculture), and water (desalination).

From Concept to Reality

Okinawa Prefecture
100kW
Demonstration

Established in 2013

Kumejima Model
1MW Onshore OTEC + DOW Industries
enabled by 10x current intake pipeline



A detailed planning survey for expanded intake capacity installation is currently underway, funded by the Japanese national government.

Photo Source: Okinawa Prefecture Industrial Policy Division

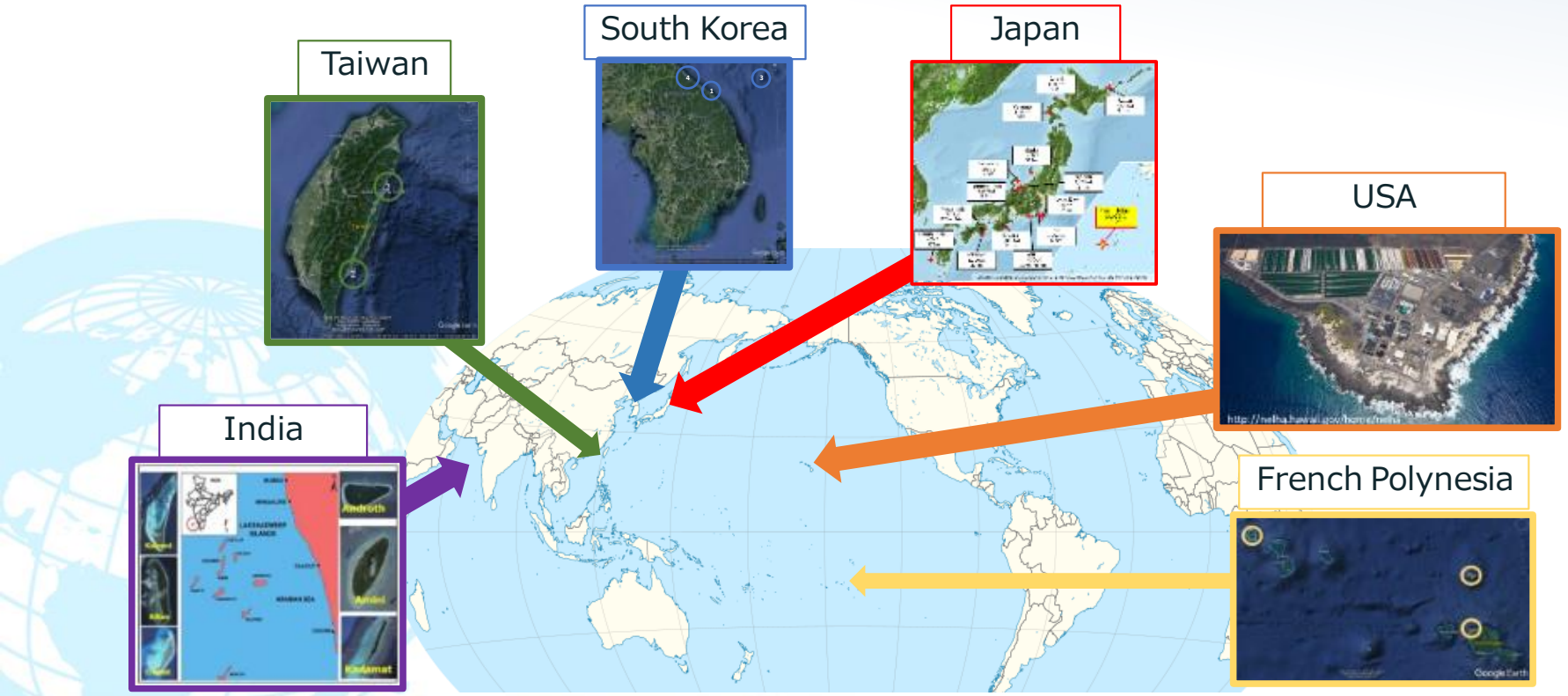
Demonstration Catalyzing Development

More than 11,000 visitors including press, government, academia, and visitors from 68 countries have visited the existing OTEC demonstration and Deep Ocean Water use industries on Kumejima

DOW around the World

The first intake was established at the Natural Energy Laboratory of Hawaii Authority (NELHA) in Hawaii, USA in 1980 for development of OTEC. Since then, intakes have been established around the world, but for a variety of purposes including desalination, industry development, and energy research.

DOW Intakes have become an important INFRASTRUCTURE enabling access to a critical resource for island and costal communities, operated as a UTILITY.



Basemap Source: https://commons.wikimedia.org/wiki/File:World_location_map_(W3_Western_Pacific).svg,

Resilient Economic Development

Power
- Clean/Renewable
- Stable/High Availability
- Possible H2 Economy Integration

→ **Energy Security**

Desalination
- Feed power/water for Existing SWRO
- Replace SWRO w/ distillation

→ **Water Security**

SWAC
- Central Cooling (Air-conditioning)

→ **Energy Saving**

Industrial DOW Use
- Fishery Processing
- Aquaculture
- Agriculture
- New Businesses

→ **Food and Economic Security**

Environment
- CO_2 reduction
- Endemic Species Nursery
- Ocean Monitoring
- Etc.

→ **Environmental Security**

DOW intake infrastructure, installed as a utility can provide economic development, climate and disaster resilient food, water, and jobs – catalyzing a paradigm shift towards sustainability.

TOPIC of OTEC Project

1. Program of International Platform on Ocean Energy for Young Researcher

2. JST/JICA SATREPS Project of OTEC in Malaysia

3. The 3rd Japan-Pacific Island Countries Economic Forum

4. UNIDO/CTCN FS on OTEC in Nauru

6th Program of International Platform on Ocean Energy for Young Researcher
(Nov 11-Nov 15, 2019)

19 Country
25 Young Researchers

6th Program will be held on Nov.11th
~Nov. 17th in 2019

Project Details

▼ Environment/Energy (Low carbon society/energy)

"Development of Advanced Hybrid Ocean Thermal Energy Conversion (OTEC) Technology for Low Carbon Society and Sustainable Energy System: First Experimental OTEC Plant of Malaysia"

Achieve sustainable power supplies using temperature differences in the ocean

Principal Investigator (Affiliation)	 Prof. IKEGAMI Yasuyuki (Institute of Ocean Energy, Saga University) researchmap	 Prof. Dato' Ir Dr. A. Bakar Jaafar (Director, Ocean Thermal Energy Centre, University of Technology Malaysia (UTM))
Research Institutions in Japan	Saga University / The University of Tokyo / AIST	
Research Institutions in Malaysia	University of Technology, Malaysia(UTM) / University Putra Malaysia(UPM) / University of Malaya / University Kebangsaan Malaysia / University Malaysia Terengganu	
Adoption fiscal year	FY 2018	

Key Information

FY2021 SATREPS
Invitation for Research Proposals is currently under preparation.
Click here for the previous Invitation (Closed).

Quick access

SATREPS SUSTAINABLE DEVELOPMENT GOALS

Download Brochure PDF 8.4MB

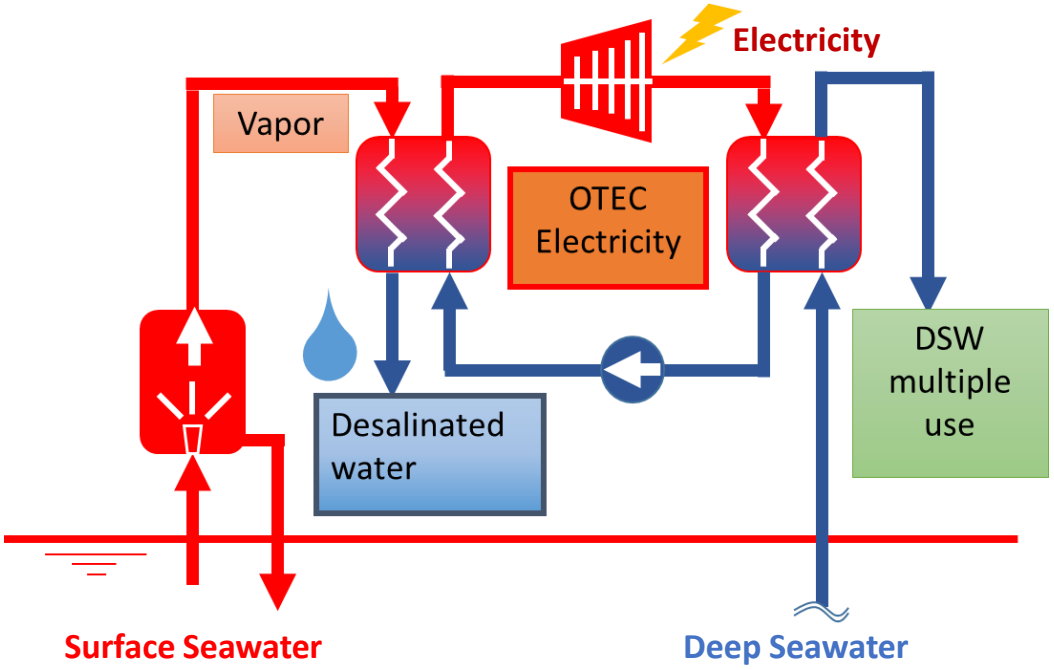
Projects Click!! >

SNS

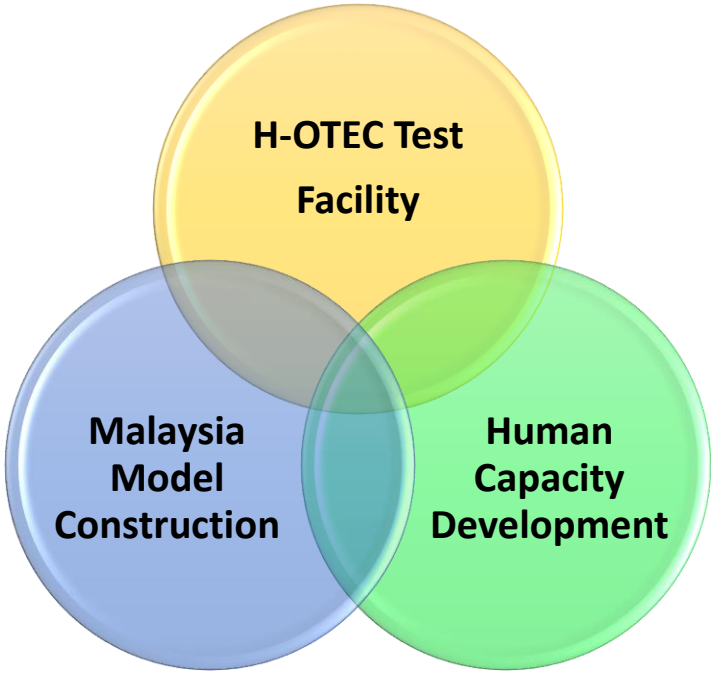
<Overall goal>
The implementation of combination of Hybrid OTEC (H-OTEC) and deep seawater application, so called ”Malaysia Model”, is commenced in Malaysia

<Project purpose>
Malaysia Model is established

<Project term>
25 March 2019 – 24 March 2024

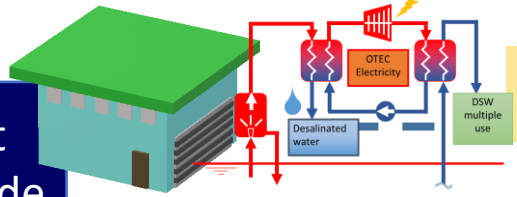


Hybrid OTEC (H-OTEC) system



Malaysia Model

H-OTEC pilot plant supplied by Japan side



Pilot Plant (UPM,2021)

- Technology verification
- Commercial conceptual design

Surface Seawater (SSW)

Deep Seawater (DSW)

H-OTEC system
- Power
- Desalination

Power (electricity)

Water

DSW multiple use
- Aquaculture
- Agriculture
- Drinking water
- Cosmetics
- Spa … etc

Suitable combination in Malaysia

Variety of Products

SSW+DSW

Economical Evolution

Target to Malaysia Moldel

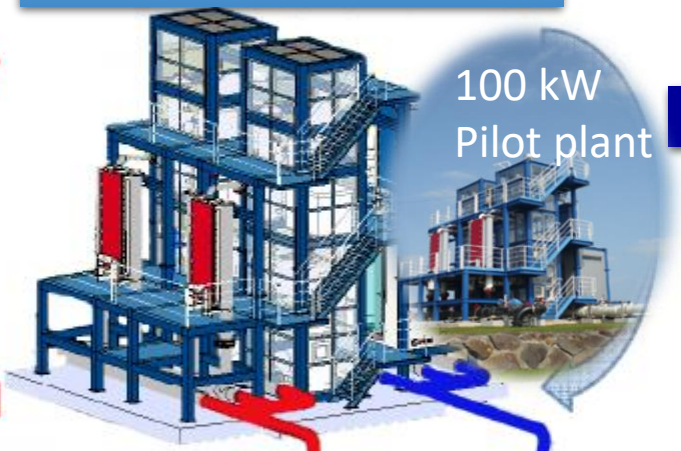
Sustainable Local community of < Energy +Water + Food >

Vegetables (Agriculture)

Desalination (Water)

Hot bath (Tourism)

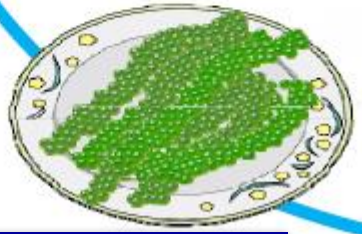
OTEC



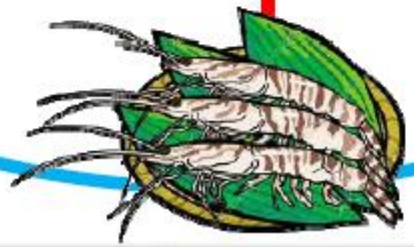
Seaweed (Aquaculture)

Cosmetics (Industry)

Coral nursery (Environment)



Sea Grapes (Aquaculture)



Kuruma shrimps (Aquaculture)

Oyster farming (Aquaculture)

Source: http://www.ogb.go.jp/-/media/Files/OGB/Keisan/move/OSHIRASE/oshirase/201710/171010houkokusho.pdf (in Japanese), Translated by the presenter

The human capital on the OTEC technologies and the DSW multiple use for business is developed

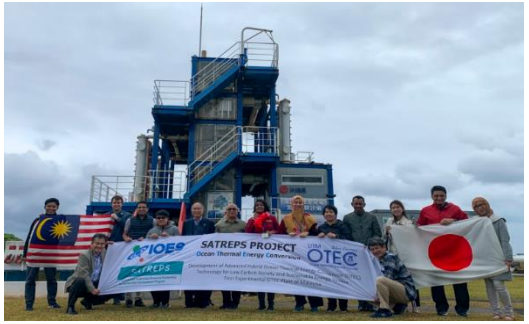
Objectively Verifiable Indicators

1 Over 30 researchers completed the training programs related to OTEC in Japan

2 Over 5 joint papers published in international journals

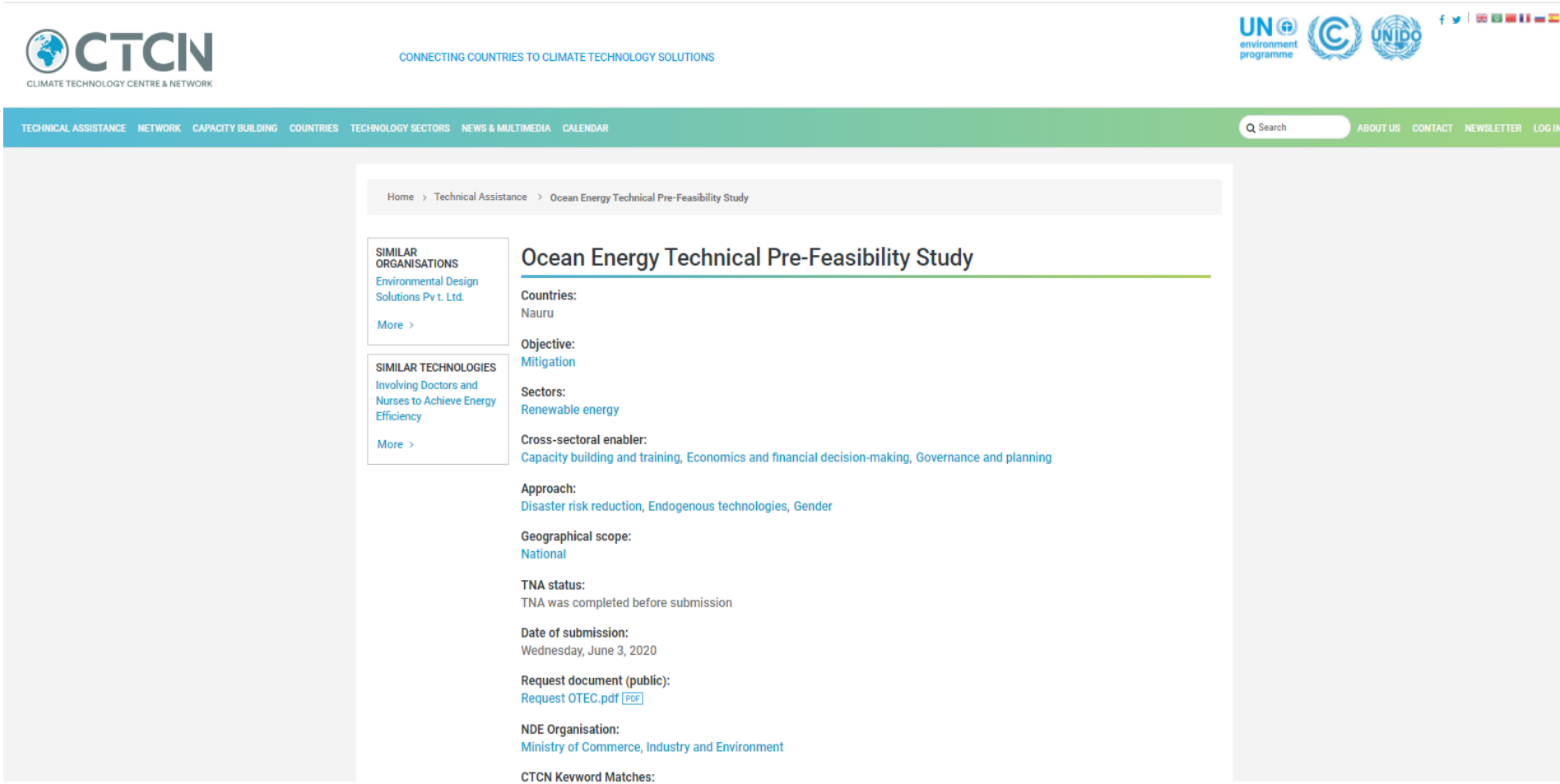
Progress and Achievement

- 10 researchers attended the 1st on the site training of OTEC and DSW applications
- Issued the training completion report
- Selected PhD candidate for the JICA Long Term Training
- 2 researchers participated 6th International Platform on OE for Young Researcher



Training in IOES & Kumejima satellites and Deep Seawater Research Center

Climate Technology Centre & Network：CTCN
OTEC Pre-Feasibiliy Study in Republic of Nauru



Japanese team is adopted by International recruitment

CONNECTING COUNTRIES TO CLIMATE TECHNOLOGY SOLUTIONS

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Home › Technical Assistance › Ocean Energy Technical Pre-Feasibility Study

Ocean Energy Technical Pre-Feasibility Study

Context

Ocean Thermal Energy Conversion (OTEC) are found to be competitive in various markets in coastal and island countries, globally. Amongst the various markets worldwide, the Pacific Island countries are expected to be most promising pertaining to the cost of oil-fired power, the demand for desalinated water, potential of aquaculture and the social benefits of this clean energy technology. Furthermore, the enormous potential of ocean energy in Nauru is long known as the world's first OTEC pilot plant was set up in Nauru by the Japanese Tokyo Electric Power company in 1981. It was the highest power OTEC plant ever operational and the first and last to feed power to an operating commercial grid. Due to extreme weather events, this OTEC plant is not operational anymore because of the damage made to the plant pipes.

Since the installation of the OTEC pilot plant in 1981, there have been significant improvements in OTEC technology and design, with side benefits such as the production of large amounts of fresh water. With the very rapid drop-off beyond the reef in Nauru, there is an opportunity for OTEC energy development in the country. Construction techniques have now also improved to become climate-proof. However, the Republic of Nauru lacks technical and financial resources as well as in-country expertise to conduct a pre-feasibility study and assess the potential of OTEC in comparison to other ocean energy possible solutions.

The main contribution of the Republic of Nauru to climate change mitigation is the implementation of its Energy Road Map (NERM) 2014-2020 in order to reduce greenhouse gas emissions and achieve energy security by reducing reliance on imported fuel.

The specific targets of the NERM by 2020 are:

- 50% of grid electricity supplied from renewable energy sources;
- a 30% improvement in energy efficiency in the residential, commercial and government sectors

Ref. CTCN, IRENA

ELECTRICITY CAPACITY AND GENERATION

Capacity in 2019	MW	%
Non-renewable	**17**	**95**
Renewable	**1**	**5**
Hydro/marine	0	0
Solar	1	5
Wind	0	0
Bioenergy	0	0
Geothermal	0	0
Total	**18**	**100**

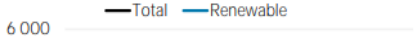
Capacity change (%)	2014-19	2018-19
Non-renewable	**+ 44**	**0.0**
Renewable	**+ 291**	**0.0**
Hydro/marine	0	0.0
Solar	+ 291	0.0
Wind	0	0.0
Bioenergy	0	0.0
Geothermal	0	0.0
Total	**+ 48**	**0.0**

Net capacity change in 2019 (MW)

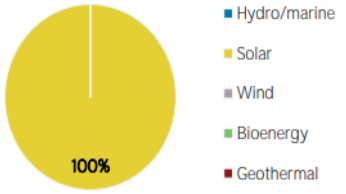
Non-renewable 0	Hydro and marine 0
Solar 0	Wind 0
Bioenergy 0	Geothermal 0

Generation in 2018	GWh	%
Non-renewable	**50**	**98**
Renewable	**1**	**2**
Hydro and marine	0	0
Solar	1	2
Wind	0	0
Bioenergy	0	0
Geothermal	0	0
Total	**51**	**100**

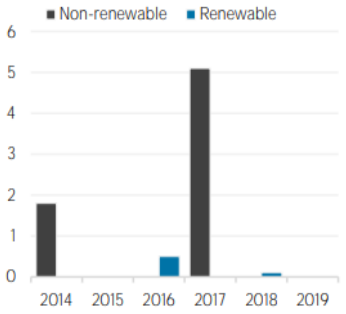
Per capita electricity generation (kWh)



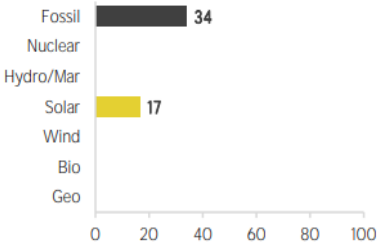
Renewable capacity in 2019



Net capacity change (MW)



Capacity utilisation in 2018 (%)



Renewable generation (GWh)

1981

Ongoing Projects and Proposals related to Japan

Nauru Ocean Energy Technical Pre-Feasibility Study

United Nations Industrial Development Organization

TERMS OF REFERENCE (TOR)

Title: Ocean Energy Technical Pre-Feasibility Study

CTCN request reference number 2020000016

Countries: Nauru

27 July 2020

GCF has some support projects for Paradigm shift

- ●Micro：10M US$～
- ●Small：10MUS$～50MUS$
- ●Medium：50MUS＄～250MUS＄
- ●Large 250MUS$～

UNIDO (United Nations Industrial Development Organization)

CTCN※1 (Climate Technology Centre & Network)
As an executing agency to promote technology transfer related to climate change, it was decided to establish it at COP16 (2010) and started operation and service provision in 2013.

※1： Government of Japan contributes $4.6 million

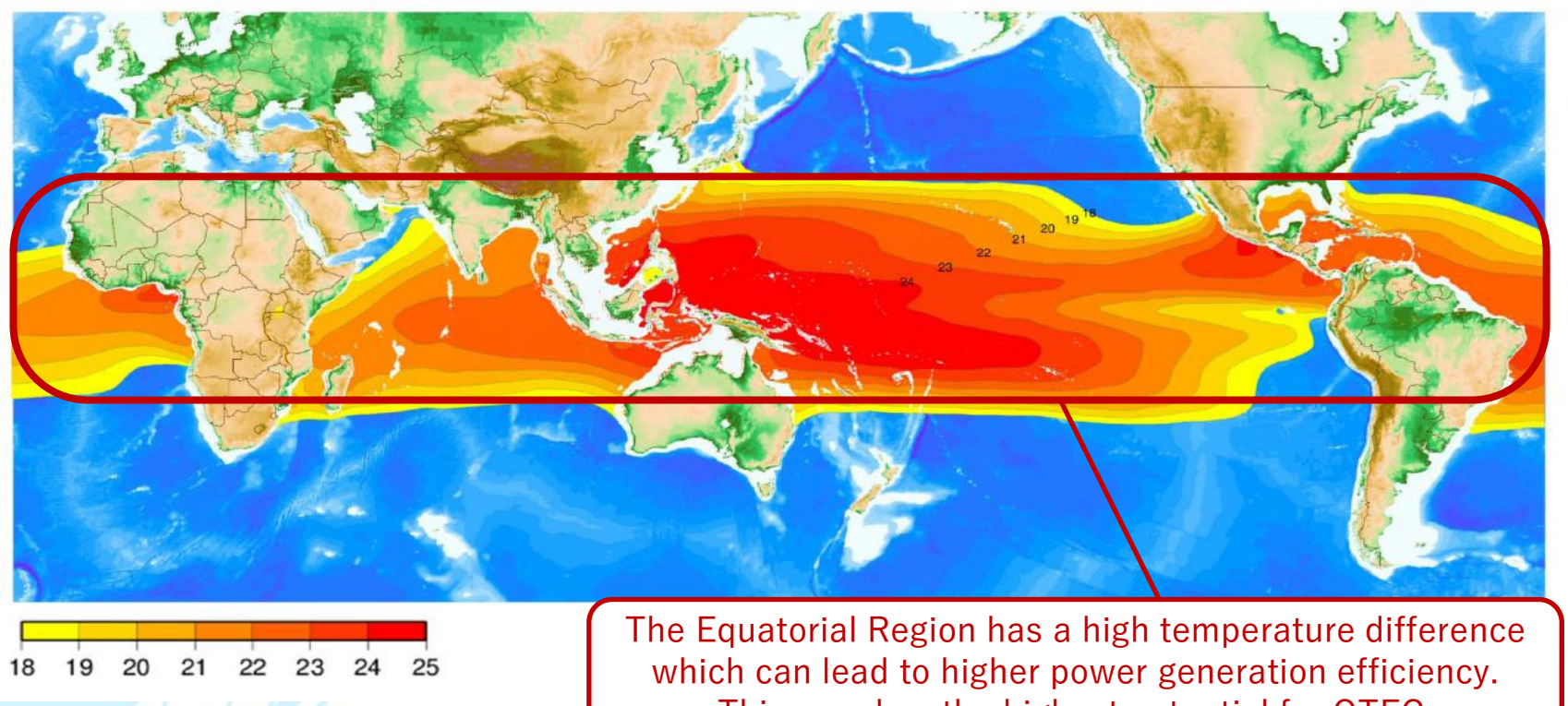
The Japan Team (OECC, IOES, University of Tokyo cooperating) is the first in Japan to adopt for renewable energy

CTCN and the Nauru government aim to put OTEC into practical use with support of the GCF※2(Green Climate Fund)

※2： Government of Japan contributes $1.5 billion

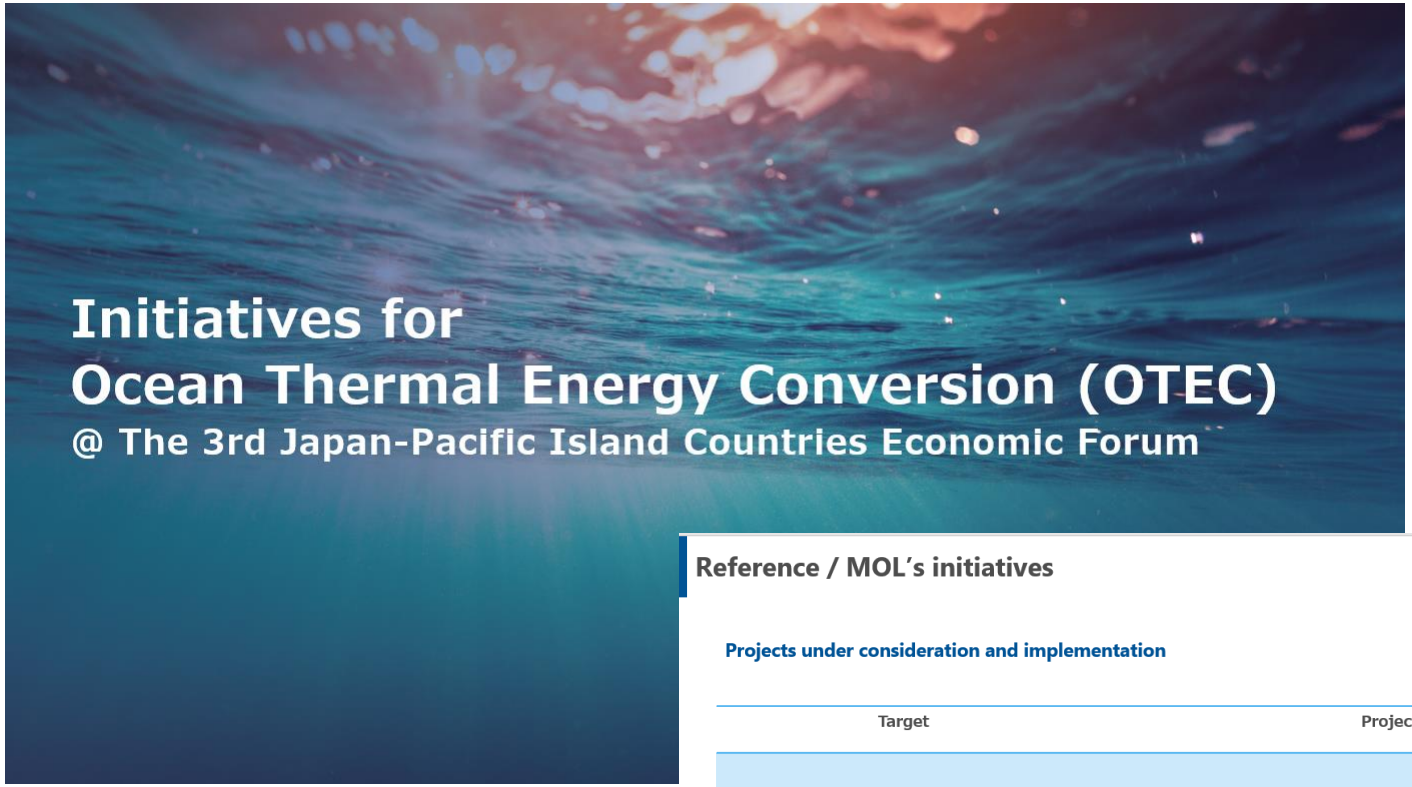
Vast Potential

The area of potential DOW and OTEC use is vast, but in locations most in need of expedited support. Adapting the Kumejima Model to SIDS can address many global challenges and provide an opportunity to shift communities from net-energy importers to self-sufficiency. In the future, a hydrogen society may further shift this balance, enabling SIDS to lead as resource-rich Large-Ocean States.



Source: Created from World Ocean Atlas 2009 (WOA2009) Data

The 3rd Japan-Pacific Island Countries Economic Forum



Reference / MOL's initiatives

Projects under consideration and implementation

Target	Project Overview
1. Kumejima 1MW Land OTEC	A demonstration project is under consideration to realize 1 MW onshore OTEC in Kume Island. The seawater after power generation will be used for various industries such as fisheries and agriculture, and will also contribute to the promotion of the local economy.
2. Experimental Study on OTEC off Mauritius	In Mauritius, which is working on the introduction of renewable energy, we will conduct a demonstration experiment of OTEC and research for the utilization of deep sea water, and consider introducing Kumejima Model.
3. Floating 100 MW FS	The idea is being tested by relevant parties (including certification bodies) with a view to conducting a demonstration experiment in Indonesia. It aims at the proposal to NEDO.

MOL × SAGA UNIVERSITY 国立大学法人 佐賀大学

Thank you for your Attention

Comparative Study for Selection of Renewable Energy Introduction (Focused on Installation for Pacific Islands and Small Islans)

	Solar	Onshore Wind	Offshore Wind	Wave	Tide /Current	OTEC	Notes
Footprint/Power Generation	× (Large Land Use)	△	△	×(Large Ocean Area Use)	×	○	
Power Generation Cost ($/kWh)	◎	○	△	×	×	×: Small (500 k W or less) ○: Medium (1+ MW) ◎: Large (10MW+)	
Initial Cost ($/kW)	◎	◎	△	△	△	×: Intake ○: Power Plant	
Running Cost ($/kW)	◎	○	○	○	△(Difficult to Maintain)	◎	
Power Stability	×	×	×	×	○(Predictable)	◎(Stable 24hrs)	
No Need for Storage Batteries for Stability and Emergency	×	×	×	×	△(Predictable)	◎(Stable 24hrs)	
Capacity Factor	△ (~20%)	△ (~20%*)	△ (35%*)	○ (*)	× (*)	◎ (80-90%+)	*Survey Required. Currently Japanese Data
Necessity of Internal Power	◎	◎	◎	◎	◎	△ (internal power use of 20-40%)	Internal power for pumps, etc. required for power generation
Resilience to Weather (Typhoons, Earthquakes, etc)	○	△	△	△	○	◎: Onshore △: Offshore*	*Few Practical Installations/ However, in the "Takumi" project (floating body and intake pipe) there is a long term (5yr) track record.
Seawater Desalination	△	△	△	△	△	◎	For OTEC, continuous flash-type is possible if power provided from OTEC. Other RE can supply RO such as Demand Response.
Employment Creation	×	×	△ (Fisheries)	△ (Fisheries)	△ (Fisheries)	◎ (Multi/ Combined Use)	In this case, Fisheries includes the installation of artificial reefs, artificial sea plant beds, cages, etc.
Industry Development	× (Power Only)	× (Power Only)	△ (Fisheries)	△ (Fisheries)	△ (Fisheries)	◎ (Multi/ Combined Use)	In this case, Fisheries includes the installation of artificial reefs, artificial sea plant beds, cages, etc.
Hydrogen Production	△	△	△	△	△	◎	For OTEC, continuous flash-type is possible if power provided from OTEC. Other RE can supply RO such as Demand Response.
Compatibility with South Pacific Island Nations (typhoons, climate, etc.)	○ (High Insolation)	△ (Typhoon, etc.)	△ (Typhoon, etc.)	△ (Typhoon, etc.)	△ (Typhoon, etc.)	◎ (Particularly High Potential, Typhoon Resistant)	

Note: The above is an initial analysis and not final

Comprehensive Evaluation of Introduction in Pacific Islands & Small Islands (tentative)

	Rating	Reasoning
Solar	○	There are advantages in terms of cost and operating costs, however, there are issues such as required area (land) use, intermittency, etc.
Onshore Wind	△	Issues with Low Potential, required area (land) use, intermittency, etc.
Offshore Wind	△	Issues with Low Potential, area (ocean) use, intermittency, etc.
Wave	×	A detailed survey is required for a final decision
Tide / Current	×	A detailed survey is required for a final decision
OTEC	◎	MW+ Onshore OTEC provides advantages in most categories

Note: The above is an initial analysis and not final.

When aiming for 100% renewable energy, strategic combination of OTEC and Solar Power Generation is effective for SDGs in Pacific Islands & Small Islands