

Hawaii Okinawa Clean Energy Cooperation

Overview of Previous Ocean Energy Workshops

The mission of the Ocean Thermal Energy Conversion (OTEC) Working Group of the Hawai`i – Okinawa Clean Energy Cooperation is to facilitate the implementation and advancement of effective OTEC systems

September 17, 2016
Ikegami, Saga University

Islands and Ocean Energy Characteristics

- ▶ Island energy networks and transportation areas are relatively small scale, therefore, it is possible to quickly implement smart grids and systems that utilize the benefits of all kinds of renewable energies by mixing with conventional energy sources.



Photovoltaic



Wind



Geothermal



Solar Thermal



Small Hydro/
Non-Conventional



Ocean Energy



Biomass

- ▶ In addition to wind and solar energy, it is relatively easy to access ocean energies.

Islands and Ocean Energy

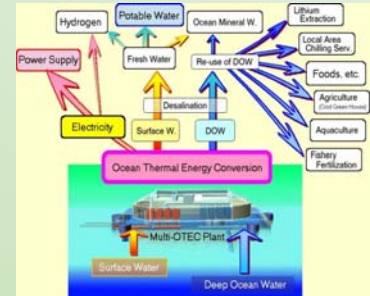
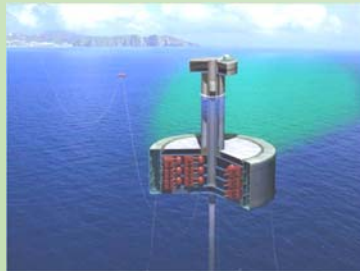
Potential of Ocean Energy

- ▶ It has been recognized that the potential of ocean energy is very large worldwide.

FORM OF OCEAN ENERGY	ESTIMATED GLOBAL RESOURCES* (TWH/YEAR)	PRESENT GLOBAL ELECTRICITY PRODUCTION (TWH/YEAR)+
Tides	300+	17 400
Waves	80 000	
Tidal (Marine) Current	800+	
Thermal Gradient	10 000	
Salinity Gradient	2 000	

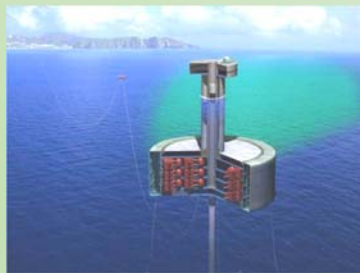
Islands and Ocean Energy Suitability

- ▶ Ocean Thermal Energy Conversion (OTEC) can utilize ocean thermal gradient (by IEA energy category) and provide stable energy **as base-load power**.
- ▶ Ability to scale up the capacity of individual plants.
- ▶ Large deployment is possible even in islands with **little onshore space available**



Islands and Ocean Energy Suitability

- ▶ With integration of other intermittent renewable energy sources, it can complement and complete island energy systems via smart grids.
- ▶ Utilization of cold energy in deep seawater **lowers air-conditioning load and day-time** energy consumption, resulting in energy saving (in fact, renewable energy).
- ▶ Multi-purpose utilization of deep seawater contributes to diversifying **island economy and job creation**.



A History of Cooperation

Ocean Energy Workshop under Hawaii-Okinawa Clean Energy Cooperation

(DOE, METI, Hawaii, Okinawa signed June 2010 renewed 2015)



Kona and Kumejima became Sister Cities in Sept. 2011.

- 7 years of annual conferences
 - Sister City Relationship
- Two unique, yet closely related projects
- Growing international interest
- Data and experience from TWO 100kW facilities

Okinawa Hawaii Cooperation

OTEC and U.S./Japan

- ▶ Historically, OTEC R&D has been conducted and **led by both countries.**
- ▶ Both countries are the only countries with actual net power generation experiences in 1980s.
- ▶ Post-1980s R&D toward commercialization is led mainly by the countries here today

OTEC and Hawaii/Okinawa

- ▶ The temperature of **seawater in both regions is suitable for OTEC implementation.**
- ▶ The both regions own large-diameter deep seawater intake systems and have fledging deep seawater industries.

Okinawa Hawaii Cooperation

Proposal to discuss OTEC within this framework

- ▶ U.S. DOE proposed to discuss the possibility of implementing OTEC **within this cooperation framework.**
- ▶ Ocean energy workshops have been held to share information of the potential of ocean energy such as OTEC and its status/stage of technologies, and **to discuss the contribution of its implementation to building and promoting an “island model”.**



News, History, and Workshops

June 2010 : METI, DOE, Okinawa Prefecture, and Hawai'i sign an MOU on Clean Energy Cooperation between Okinawa and Hawai'i

Aug. 2010 : Toward clean energy cooperation in Okinawa and Hawai'i, Japan an US experts make mutual visits to both locations. With OTEC's potential, the "Ocean Energy Working Group" was formed based on the suggestion from the US DOE.

First Ocean Energy Workshop

November 11, 2010 at Kumejima



News, History, and Workshops

Mar. 2011 : Great East Japan Earthquake

Mar. 2011 : Kumejima Advanced Deep Ocean Water Use Feasibility Study (Ministry of Internal Affairs and Communications) completed. "Kumejima Model" proposed for cascade use of deep ocean water.

Mar. 2011 : NEDO "Work relating to the understanding of Ocean Energy Potential" **completed**.

July 2011 : NEDO "Ocean Energy Technology Research and Development (demonstration/ next-generation development)" project **start**. OTEC entrusted to Kobe Steel and Saga University.

Second Ocean Energy Workshop

September 11-12, 2011 at Kona



At this time in Hawai'i, large scale OTEC Heat Exchanger study was started.

During this WS, Kumejima Town and Hawai'i County (Kona) became sister cities.

Oct. 2011 : NELHA began RFI (Request for Interest) towards 1MW OTEC. OTEC International was selected as first candidate (afterwards negotiations were interrupted)

Aug. 2012 : Okinawa Prefecture begins “Power Generation Utilization Demonstration Project for Sophisticated Use of Deep Ocean Water.” OTEC Demonstration Facility Construction of 100kW class on Kumejima determined.

Third Ocean Energy Workshop

September 11-12, 2012
at Kumejima



Nov. 2012 : Visit of Emperor and Empress to ODRC

Nov. 2012 : Okinawa OTEC Demonstration Facility
Groundbreaking

Nov. 2012 : Passing of **Guy Toyama**

Mar. 2013 : **Start of Okinawa OTEC Demonstration Facility
Power Generation**



Apr. 2013 : Lockheed Martin signs MOU with China's Reignwood Group for 10MW OTEC Plant

Jun. 2013 : Okinawa OTEC Demonstration Facility Opening Ceremony. Aired on TBS's July "Door to Dreams+" TV Program

Fourth Ocean Energy Workshop

September 13, 2013 at Kona
Jointly with the 1st International
OTEC Symposium Sept. 9-11



At the 1st International OTEC Symposium, French and Korean Companies announced roadmap for development.

July 2014 : Announcement that France's DCNS and Akuo Energy will receive funding from the EU NER300 of 72,000,000 Euro for a 10MW OTEC project in Martinique.

Sep. 2014 : NEDO Ocean Energy Technology Research and Development OTEC Demonstration Phase **Start** (JMU, Saga University).

Oct. 2014 : Installation of Saga University Satellite next to the Okinawa OTEC facility containing seawater desalination and hydrogen production equipment.

Oct. 2014 : 2nd International OTEC Symposium held in South Korea



Fifth Ocean Energy Workshop

October 30-31, 2014 at Kumejima



This year NEDO was the Organizer (Co-hosted by Okinawa):
Expanded theme held as “Renewable Energy Workshop”

Dec. 2014 : France’s DCNS and Akuo Energy announce plans to build a 5MW onshore OTEC plant in Martinique. Signed MOU with Indonesia’s Pertamina and the Philippines National Oil company.

Sixth Ocean Energy Workshop

August 19-20, 2015 at Kona

Jointly with: Makai's 105kW OTEC Plant Energization Ceremony
(Aug. 21 at Kona)



A large number of DSW use companies in Okinawa participated.



A cooperation agreement on the deployment of OTEC was entered into by related companies and Universities (From the left: NELHA, JMU, Makai Ocean Engineering, Xenesys, Saga University, Yokogawa Electric, and Kobe Steel)

Oct. 2015 : 3rd International OTEC Symposium held at Kuala Lumpur

Mar. 2016 : Groundbreaking of GO
Farm Oyster Hatchery
and Research Center

Jul. 2016 : Determination of Post-
OTEC Seawater Use
Demonstration on
Kumejima



Sep. 2016 : Conversion of Okinawa OTEC Facility to Double
Rankine Cycle (Installation of 2nd Turbine)

Sep. 2016 : Construction of Post-OTEC Seawater Use Piping for
Demonstration Project

Towards the Next Step

// I will be traveling to Okinawa and Japan later on this year to renew our sister state relationship as communities and more importantly in the renewable energies space because I believe that our countries working together really will accelerate the development of OTEC as a viable firm energy, renewable energy source for the world.

//
-Hawaii Governor David Ige
8/21/2015



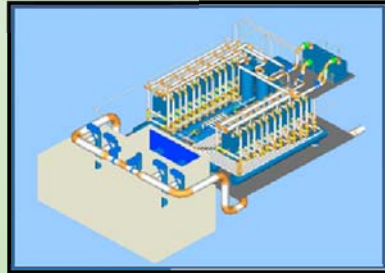
Japan OTEC Roadmap



We are here!



On shore



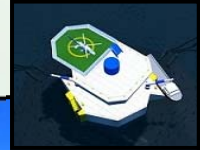
Drawing by IHI Construction Co.



Offshore



Japan Marine United Corp.



100kW
Demonstration/
Experimentation

1MW Class
Pilot/Semi-Commercial

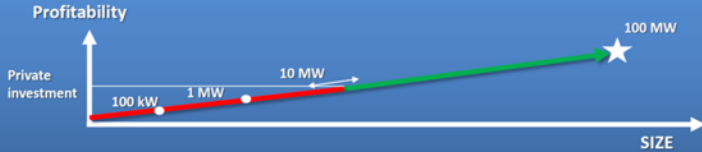
10MW Class



100MW+ Commercial Plants

1MW Scale Pre-Commercial Facility

What's Next for OTEC?



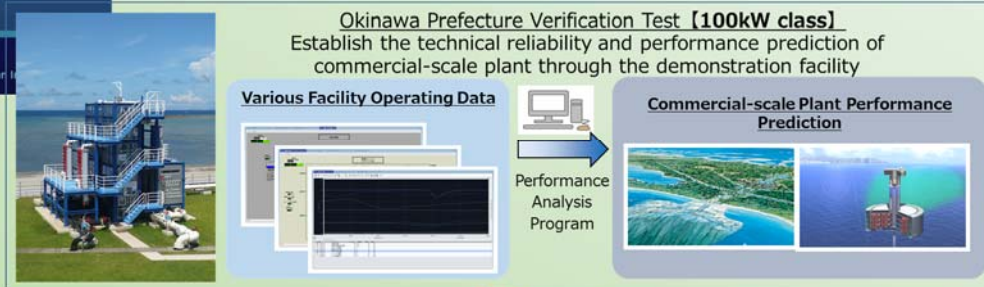
- NO TECHNICAL HURDLES
- Intermediate steps are capital-intensive for private industry alone
- To get to commercial OTEC, must reduce cost of intermediate stages
- Research focused on cost-reduction: heat exchangers & cold water pipes.

International consensus on the need for pre-commercial 1MW scale OTEC demonstration facility to bridge capital-intensive intermediate development steps.



The Future of Ocean Energy

Slide courtesy of Makai Ocean Engineering



"Kumejima Model" [1MW-class Power] + [Deep Seawater Use]

Industrial Development and Sustainability of Domestic Island

Change in Economic, Social, and Political Climate



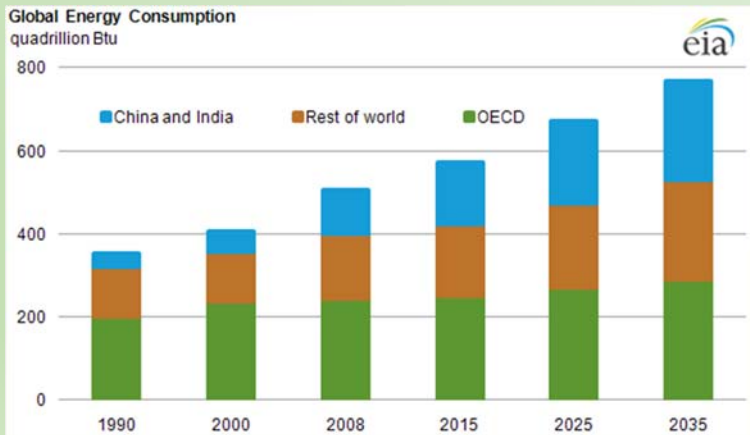
Climate Change

“In 2015 **COP21**, also known as the **2015 Paris Climate Conference**, will, for the first time in over 20 years of UN negotiations, aim to achieve a legally binding and universal agreement on climate, with the aim of keeping global warming below 2°C.”

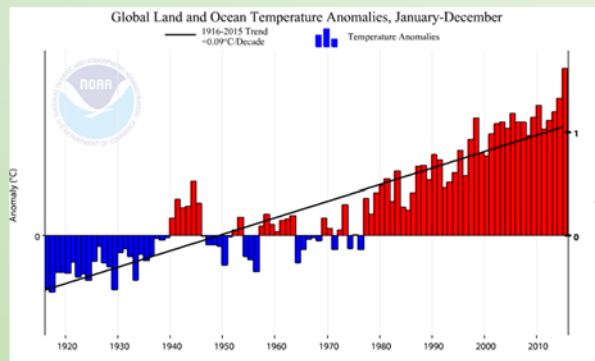
International recognition of the need to combat climate change in order to prevent global warming

Change in Economic, Social, and Political Climate

Environmental/Economic Costs

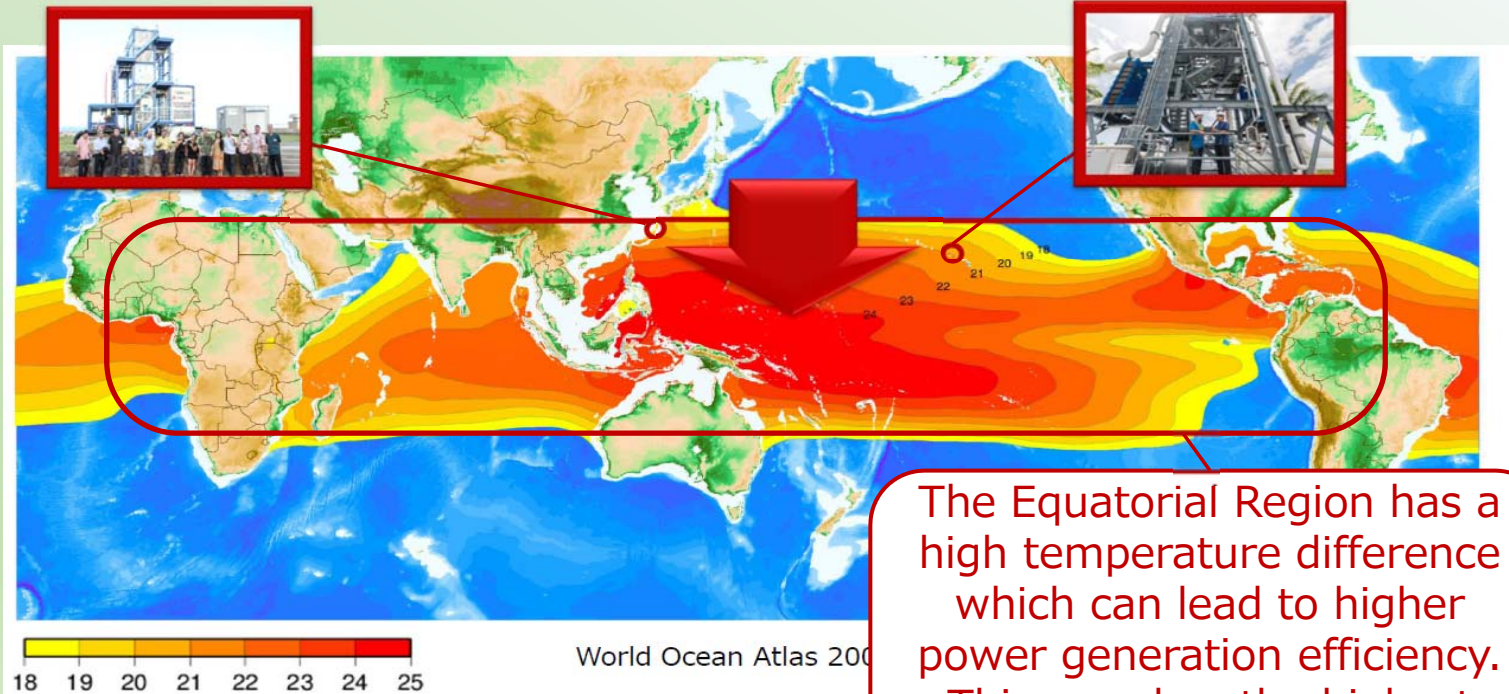


Temperatures are rising as global energy consumption increases. OTEC is a good option for increasing power supply in a clean/renewable manner.



Sources : http://www.ncdc.noaa.gov/cag/time-series/global/globe/land_ocean/ytd/12/1916-2016?trend=true&trend_base=10&firsttrendyear=1916&lasttrendyear=2016,
<https://www.eia.gov/todayinenergy/detail.cfm?id=3130>

Positioned to Lead and Test Deployment



The Equatorial Region has a high temperature difference which can lead to higher power generation efficiency. This area has the highest potential for OTEC.

Hawaii's 100kW Class Facility



+

Japan's 100kW Class Facility



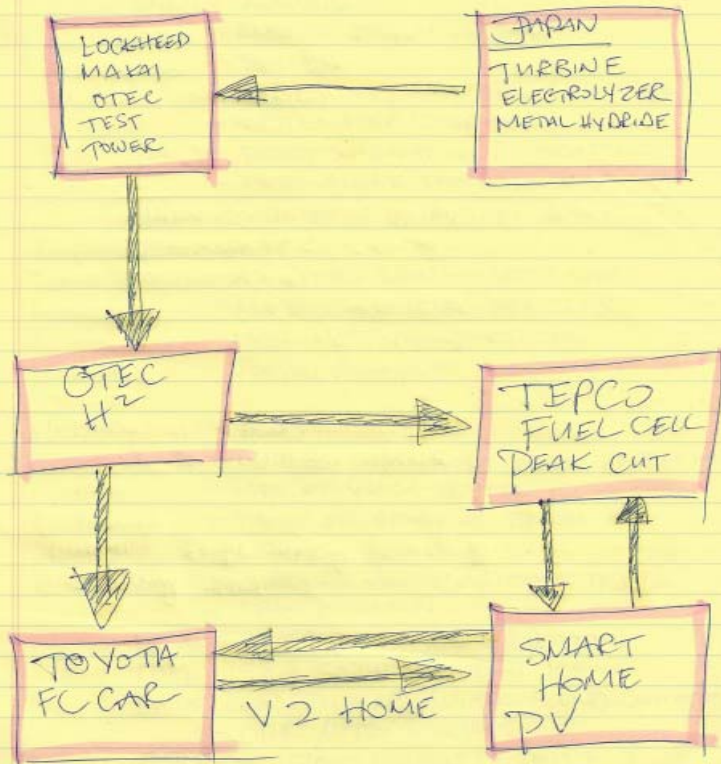
MW Class

Technical and Commercial Validation

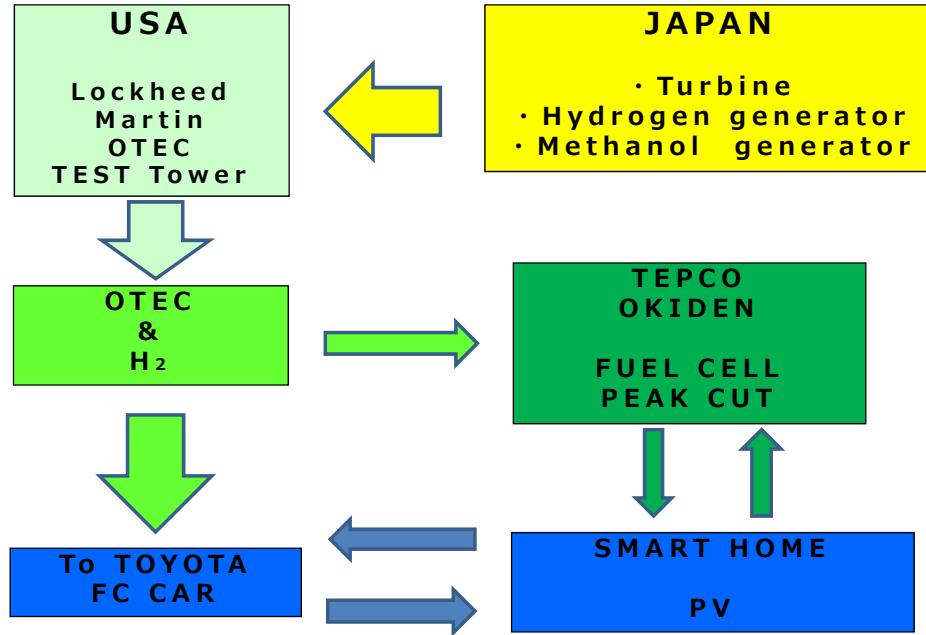
Together, we can lead the world in an ocean renewable energy that provides power 24/7



US - JAPAN HAWAII - OKINAWA
OTEC HYDROGEN TEST PROJECT



1. OTEC and Hydrogen Project as "Island model"



From Vision To Action

Thank you for your
attention



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SAGA UNIVERSITY JAPAN