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.
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.

In addition to wind and solar energy, it is relatively easy to access ocean energies. 
It has been recognized that the potential of ocean energy is very large worldwide.

<table>
<thead>
<tr>
<th>Form of Ocean Energy</th>
<th>Estimated Global Resources* (TWh/Year)</th>
<th>Present Global Electricity Production (TWh/Year)+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tides</td>
<td>300+</td>
<td></td>
</tr>
<tr>
<td>Waves</td>
<td>80,000</td>
<td></td>
</tr>
<tr>
<td>Tidal (Marine) Current</td>
<td>800+</td>
<td></td>
</tr>
<tr>
<td>Thermal Gradient</td>
<td>10,000</td>
<td></td>
</tr>
<tr>
<td>Salinity Gradient</td>
<td>2,000</td>
<td></td>
</tr>
</tbody>
</table>

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.
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)

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

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.

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.
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”.

Okinawa Hawaii Cooperation
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
Mar. 2011 : Great East Japan Earthquake


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


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: 2nd International OTEC Symposium held in South Korea.
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 2\textsuperscript{nd} 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

100kW
Demonstration/Experimentation

1MW Class
Pilot/Semi-Commercial

On shore

10MW Class

Offshore

We are here!

Drawing by IHI Construction Co.

Japan Marine United Corp.

100MW+ Commercial Plants
International consensus on the need for pre-commercial 1MW scale OTEC demonstration facility to bridge capital-intensive intermediate development steps.
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.”
Temperatures are rising as global energy consumption increases. OTEC is a good option for increasing power supply in a clean/renewable manner.

The Equatorial Region has a high temperature difference which can lead to higher power generation efficiency. This area has the highest potential for OTEC.
Together, we can lead the world in an ocean renewable energy that provides power 24/7

Hawaii’s 100kW Class Facility + Japan’s 100kW Class Facility

MW Class
Technical and Commercial Validation

Photo courtesy of Makai Ocean Engineering
US-JAPAN

HAWAII-OKINAWA

OTEC HYDROGEN TEST PROJECT

LOCKHEED MARIN
OTEC TEST TOWER

JAPAN
TURBINE
ELECTROLYZER
METAL HYDRIDE

OTEC H2

TEPCO
FUEL CELL
PEAK CUT

TOYOTA
FC CAR

SMART HOME
PV

V2 HOME
1. OTEC and Hydrogen Project as “Island model”

USA

- Lockheed Martin
- OTEC TEST Tower

OTEC & H₂

To TOYOTA FC CAR

JAPAN

- Turbine
- Hydrogen generator
- Methanol generator

TEPCO OKIDEN

FUEL CELL PEAK CUT

SMART HOME

PV
From Vision To Action
Thank you for your attention