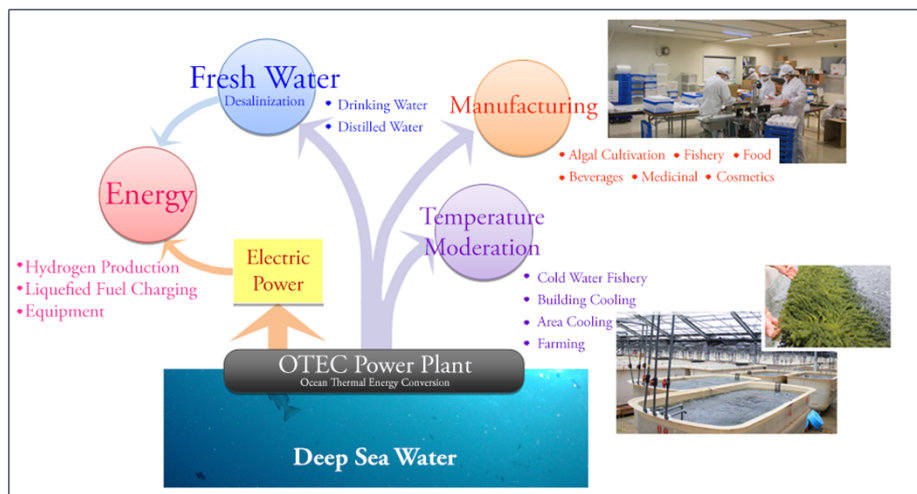


Deep Ocean Water Uses

Since deep ocean water maintains its low temperature (10-12 degrees Celsius) and unique mineral properties after use in OTEC power generation, the resource can be used in agriculture, industry, cooling, and other fields. Research continues into the uses of deep ocean water, opening new ways to harness the power of the sea.



Graphic: Xenesis Inc.

OTEC Q&A

Q: What are the characteristics of OTEC power generation?

A: Since seawater temperature does not change rapidly, power output is stable and prediction of potential power generation is simple. The ability to use seawater after OTEC for many different applications is unique.

Q: What is the history of OTEC?

A: In the 1870 novel "20,000 Leagues Under the Sea," the submarine Nautilus was powered by the temperature difference in seawaters. On the theoretical side, physicist Jacques-Arsène d'Arsonval of France proposed the idea in 1881. Afterward, development was intermittent, but in response to the recent growth in interest in renewable energy, in addition to Japan development has increased in countries such as the United States, France, the Netherlands, South Korea, China, etc.

Q: Where is OTEC possible?

A: With current technology, a difference of 20°C or more in annual temperature is needed. This is found in sub-tropical and tropical regions such as the Okinawa, Kuroshio, and Ogasawara areas in Japan.

Q: What is the potential of OTEC?

A: The potential power generation in Japan is 5,952MW within 30km, with no offshore distance limitation the potential is 173,569MW (Both in areas where the seawater temperature difference is 20 °C or more. The impact on marine environment is negligible due comparatively small water intake).

In Okinawa, the potential for power generation is 2,797MW within 30km and 79,992MW without offshore distance limitation. Since the current power generation in Okinawa is 2,000MW, the potential could cover all Okinawan demand. (Source: NEDO report "A Business Understanding of Ocean Energy Potential" March, 2011)

Q: What is the cost of commercial power generation at this time?

A: According to OEA-J the cost is 20 yen per kWh at 10,000kW class output and 10 yen per kWh with 100,000kW class output. (Source: NEDO "White Paper on Renewable Energy Technology 2nd Edition," February 2014). In Okinawan Waters, the estimate is 31-44.5 yen/kWh for 1,000kW-class and 20.7-26.3 yen/kWh for 10,000kW-class. (Source: NEDO "Proceedings of New Energy Achievement Report Meeting Of FY2018," October, 2018).

Improving the Efficiency of Deep Ocean Water Use Through OTEC Power Generation Experimentation

Ocean Thermal Energy Conversion Demonstration Facility



<http://otecokinawa.com/en/>
Location: Kumejima Town, Okinawa





Project Overview

Power Generation Demonstration Project for the use of Deep Ocean Water

Project Goal
 In order to realize a low-carbon island society, part of the basic plan for realizing the 21st Century Vision of Okinawa, we promote the research and development of ocean energy, striving to reduce the environmental impact of local production of energy and promote the regional characteristics of Okinawa.

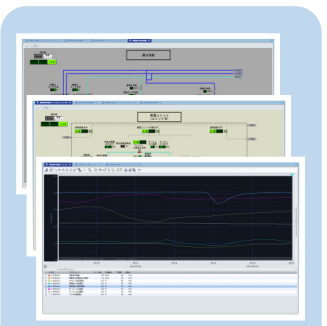
Project Fundamentals

- Measure the amount of power generation as influenced by changes in weather and sea temperatures.
- Empirical studies on techniques for obtaining a stable output.
- Study advanced composite utilization of surface and deep ocean water.
- Study the possibility of the establishment of offshore-type OTEC facilities in Okinawa, Etc.

Implementation
 Implementation of the project has been outsourced to a consortium of three (*1) companies: IHI Plant Construction Co., Yokogawa Solution Services Co., and Xenesys Inc.
 *1 Operation from FY20115 was entrusted to Xenesys Inc.

Demonstration | Study | Research

- (1) Power Generation Demonstration Test**
 In addition to measuring the amount of power generation during weather changes, temperature changes, and other criteria, we perform verification tests on OTEC technology and ensure stable output.
- (2) Establishment of OTEC System**
 In order to develop practical uses of ocean thermal power generation facilities in the future, and reduce the cost of power generation, we are considering the installation of offshore type OTEC plants.
- (3) Establishment of Combined Use System with Deep Ocean Water**
 We investigate and examine the potential use of deep ocean water after use in ocean thermal power generation.



Variety of demonstration facility performance data

Performance Analysis Program



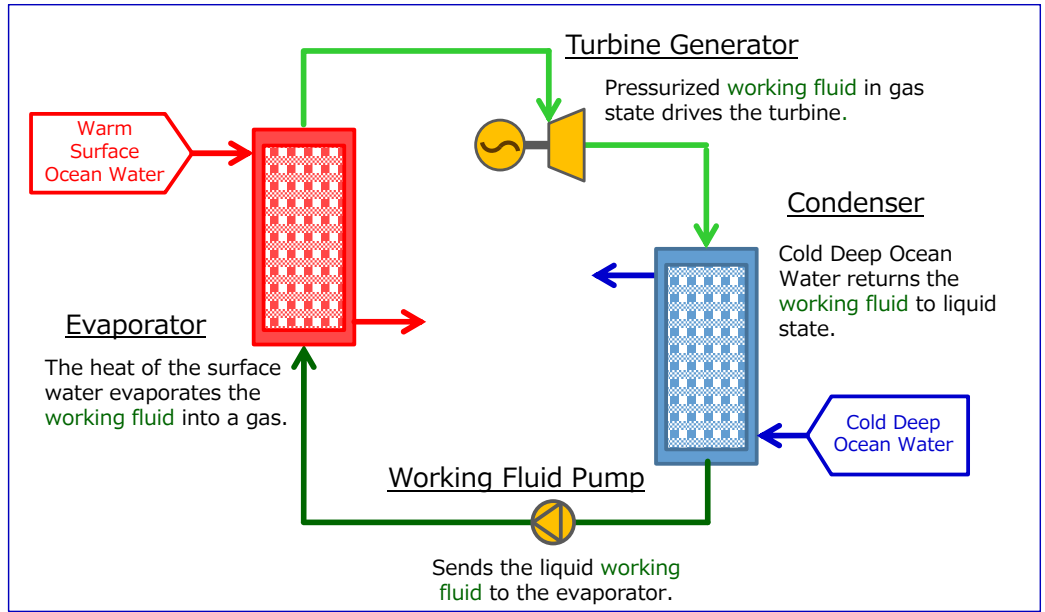
Possible future large-scale production plants

Average world seawater depth: About 3,800m

Source: Japan Oceanographic Data Center Water Temperature Statistics

Principles of OTEC

Ocean Thermal Energy Conversion technology uses a turbine generator to create renewable energy from the temperature difference between cold, deep ocean water circulating in the ocean and surface water warmed by the sun. In order to use the low temperature range, a working fluid (refrigerant or Ammonia), is used due to its low boiling point.



The Demonstration Facility

