Makai & NELHA: A History of Ocean Energy Excellence

Makai has a long and illustrious history with NELHA since its inception in 1974 when it was founded for OTEC research. In 1979, Makai designed and oversaw the construction of the cold water pipe, mooring, and platform for a barge dubbed “Mini-OTEC”; the world’s first net-power producing OTEC plant (a State of Hawaii, Lockheed, and Dillingham project). Since that time, Makai has designed 4 deep water pipelines for NELHA, including the largest and deepest seawater intake in the world, pictured below (right), as well as the massive subterranean pump station pictured below, center. These seawater pumping systems supply water to over 30 tenants, including for deep ocean water bottling which is currently the #1 export from Hawaii.

NELHA Pipeline	Date	Seawater Flow	Depth
12 inch	1980	1,200 gpm	500’
18 inch	1987	3,000 gpm	2,100’
40 inch	1987	13,400 gpm	2,200’
55 inch	2001	27,000 gpm	3,000’

Makai will continue to pioneer OTEC research at NELHA, moving Hawaii further ahead in providing critically needed firm, renewable energy, and reducing our dependence on imported oil.

Makai Ocean Engineering

OTEC

Test Facility

The world’s only fully operational Ocean Thermal Energy Conversion (OTEC) ammonia cycle

Designed & Operated by:
Makai Ocean Engineering, Inc.
www.makai.com

Natural Energy Laboratory of Hawaii Authority
Keahole Point, Kailua-Kona, Hawaii

OTEC in Hawaii

Welcome to the Natural Energy Laboratory of Hawaii Authority. This location has long been the world's premier site for research, development and demonstration of electrical power generation using the temperature differences in the ocean using a process is called OTEC: Ocean Thermal Energy Conversion. NELHA has the largest and deepest intake pipelines in the world providing a "delta-T" exceeding 20 deg C; these large flows of natural thermal energy have supported OTEC R&D for over 20 years.

OTEC is an exciting "game-changing" alternative energy for Hawaii and the world. Our ocean captures and stores solar thermal energy for continuous conversion to electricity - 24/7. As with the ocean, this resource is immense and far exceeds our energy needs. OTEC power is firm, clean, and does not use other resources such as land, food, and potable water. For a world and an island concerned with energy security, clean renewables, and global warming, OTEC is a very attractive solution.

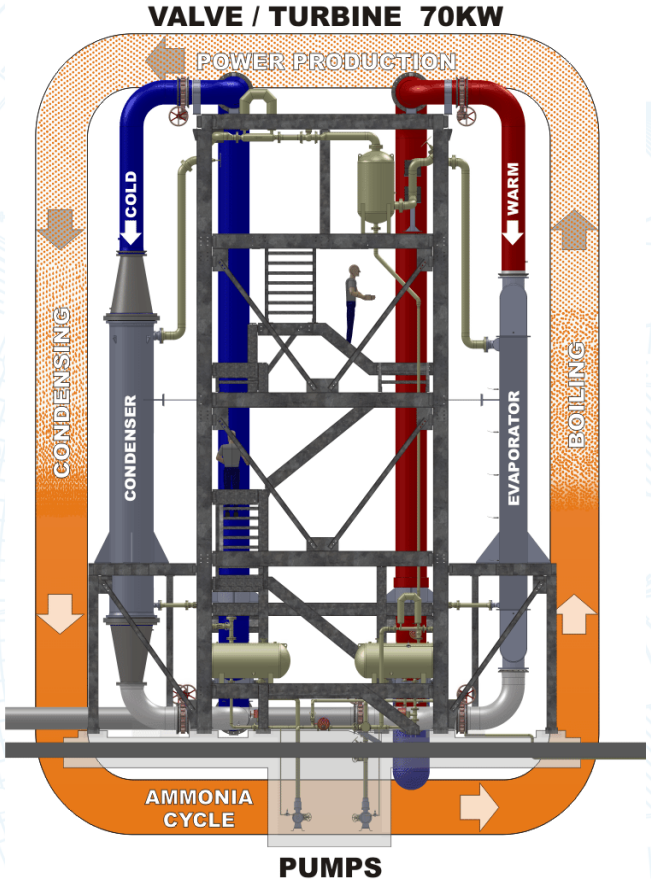
Dreams, plans and even commercial attempts at OTEC go back nearly a hundred years. Magnificent but elusive, this resource is not easily harvested. While the concept is simple and the engineering principals are fundamental, the implementation of these large systems has been an engineering and financial challenge. Today those challenges are now being solved and a practical and cost-effective OTEC plant is but a few development steps away.

The OTEC Test Facility at NELHA is an essential tool for the development and testing of candidate OTEC heat exchangers. Heat Exchangers are the single most expensive component of an OTEC plant and thus their cost, longevity and performance are critical for OTEC's economic success. Testing of the performance of both condenser and evaporator heat exchangers using both cold deep seawater and warm surface seawater is performed at this facility. Ammonia circulates between the two heat exchangers; liquid ammonia boils in the evaporator, expands in a valve or a power generating turbine, and returns to liquid in the condenser before being pumped through the cycle again. This facility has been designed for expansion; Makai plans to add a turbine and generator, providing electrical power to the grid and allowing operations and controls to be perfected.

In addition to evaluating heat exchanger performance, Makai is testing heat exchanger materials for corrosion resistance. In Makai's laboratory are thousands of aluminum heat exchanger samples being exposed for long periods (since 2009) to warm and cold seawater flows. A variety of materials, fabrication methods, and operational procedures are being evaluated.

This facility provides a critical test bed for OTEC technology as the industry matures and as OTEC's economic attractiveness increases with global energy prices. Knowledge gained from these tests will inform the final design and development of a future commercial-scale offshore OTEC plant.

OTEC Test Facility



More information can be found at: www.makai.com/e-otec.htm

Project Mission

To demonstrate and improve the technologies for Ocean Thermal Energy Conversion (OTEC), generating clean, firm power using the ocean's vast thermal resources