

2015-16
Annual
Report



**NATURAL ENERGY
LABORATORY of HAWAII
AUTHORITY**



**MISSION
STATEMENT**

“To develop and diversify Hawaii’s economy by providing resources and facilities for energy and ocean related research, education, and commercial activities in an environmentally sound and culturally sensitive manner.”

www.nelha.org

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NELHA FY 2015-2016 ANNUAL REPORT

- **Introduction**

FY 2015 and FY 2016 saw continued strong growth for the Natural Energy Laboratory of Hawaii Authority (NELHA). Our efforts over the past 5 years continue to yield strong results. We are poised to grow and fulfill our potential as a site to advance research, stimulate scale-up models and nurture market acceptance of sustainable technologies in global aquaculture and advanced energy.

NELHA is a master-permitted ocean science and technology park whose mission is to bring economic development and diversification to the State of Hawaii and specifically West Hawaii. HOST Park is comprised of 870 acres of at Keahole Point, Kailua-Kona, on the Island of Hawaii. NELHA was created to host and support research, development, pre-commercial and commercial enterprises that make use of the unique resources at the laboratory's site at Keahole Point, particularly the clean, cold, deep ocean water accessible near to the shore as well as high solar irradiation. Its assets include a unique complement of support facilities, infrastructure, pristine natural resources and leasable land for a wide range of business research, commercial and educational applications.

As its name implies, NELHA was formed to operate and further develop the State's geothermal experimental project in Puna and ocean thermal energy conversion (OTEC) experiments and re-use of the seawater for other projects in Kona. Over time, as geothermal matured and became commercially viable and the federal governments interest in OTEC waned, due to lower oil prices, NELHA has de-emphasized its initial involvement in geothermal development and looked to other secondary uses for its ocean science facilities and expansive seawater system in Kona.



Today, other uses for the seawater system have included projects needing to take advantage of the sites other main resource: high solar insulation. This includes aquaculture, mainly as algae production for nutraceuticals and fish/seafood hatcheries, water desalination, clean energy research and development such as solar thermal energy production, algae growth for biofuels, and seawater air conditioning.

As a "first mover" into the economic development space of ocean science and energy the State, Federal and County of Hawaii investment of \$150M has

appreciated considerably in value over the past 40 years. It is imperative that NELHA move towards taking advantage of this comparative advantage of the most extensive land-based surface and deep seawater system in the world by focusing on maintaining the seawater system, providing the infrastructure to make development at Ocean Centerpiece possible and growing the existing microgrid by adding additional power generation and storage.

The main areas of focus are aquaculture and ocean science, ocean energy and storage, and ocean cooling. The strong ocean science and energy orientation of HOST Park is due to unparalleled comparative advantage that exists in the extensive seawater system developed over the past 40 years. There is no other seawater system in the world that can compare to the one found at HOST Park. NELHA provides many services, resources, and expertise to the 40 plus business clients in HOST Park.

SERVICES	RESOURCES	EXPERTISE
NELHA services are tailored to fit each business in HOST Park.	NELHA is uniquely suited as a test bed for clean energy and ocean science opportunities	NELHA provides a wide variety of support to business in HOST Park.
Research Campus: Located near the shoreline on Keahole Point the six-acre Research Campus consists of over 4,000 square feet of laboratory space, outdoor wet laboratory, conference rooms, restrooms and both covered and open industrial storage space.	Site Conditions: Planned master permitted subdivision includes a full range of infrastructure: access roads, potable water, underground telecommunication/electric lines, ocean water, intake and distribution pipes, pumping stations, disposal systems, and groundwater quality monitoring wells.	Water Quality Laboratory: The Lab is staffed with a professional chemist and provides a commitment to excellence combined with a wide array of analytical instruments to generate data of maximum quality. The lab has become a benchmark for environmental water quality analysis for ocean water.
Ocean Water Systems: NELHA is a seawater utility and is master-permitted to pump over 100,000 gallons per minute of pristine surface and deep ocean water within HOST Park.	Ocean Environment: The steep ocean bottom gradient makes possible the tapping of deep, cold waters at depths ranging from 50 to 3,000 feet. This ocean water is of significant purity and has a high nutrient content.	Scientific and Cultural Support is provided in the fields of biosecurity, ocean sciences and ocean energy applications. In addition, there are established cultural and business links to Asia and other Pacific countries.
Office Space: Several buildings within the Research Campus and the Hawaii Gateway Energy Center along Queen Kaahumanu Highway provide office space for businesses located in Host Park.	High Solar Insulation: In the lee of three major mountains, NELHA receives approximately 10 inches of rainfall annually and offers the highest solar insulation of any coastal site in the United States.	Technical Support is provided by engineers, electricians and mechanics. In addition, NELHA works closely with the Friends of NELHA to offer educational tours and information on clean energy projects.

This success has not happened on its own and NELHA acknowledges the strong support in the past that has helped it achieve success. The State administration, Legislature, small and large businesses, Hawaii residents and consumers and particularly NELHA's Board of Directors and excellent staff who have taken bold actions over the years to meet the demands and challenges of developing the world's premier ocean science and technology park.

ECONOMIC IMPACT

- According to The Economic Research Organization at the University of Hawaii (UHERO) the economic impact of HOST Park surged to \$123 million in 2013 an increase of 40 percent over 2010.
- Total expenditures from the businesses at NELHA were \$99 million dollars, of which about \$72 million were paid to Hawaii entities in 2013.
- The analysis also found that not only do NELHA businesses employ hundreds of people but also that their expenditures contribute to the total of 617 jobs in the larger Hawaii economy.
- The overall increase in the local (in-state) expenditures has led to the significant increase in the estimated impacts. This makes sense given recent reports of over \$60 million in new investments in the past two years.
- The growth surge is a good indication which shows that the private sector still sees a lot of potential and is willing to invest in HOST Park.

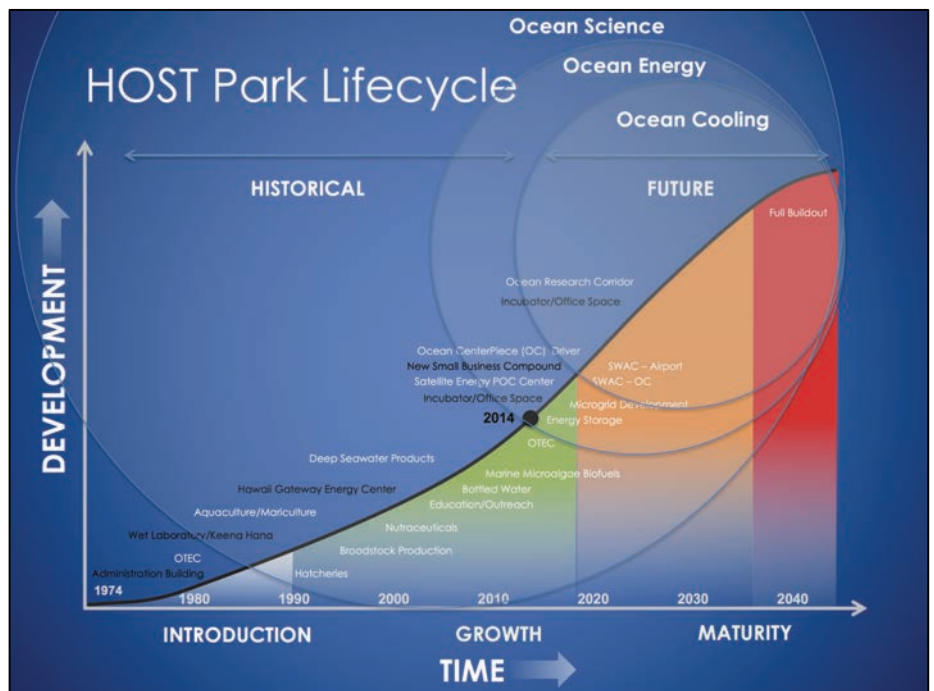


NELHA's humble beginnings in a garage in Kona's Old Industrial District in 1974.

NELHA's begins to take shape in this air photo of Keahole Point circa 1990.



NELHA's new Incubator and Office Building – Hale Iako in 2016



Development

- 65-year lease from State of Hawaii.
- Expires in 2066.
- 870 acres - Master Permitted.
- Outdoor demonstration site for marine science and advanced energy projects.
- World's largest seawater delivery system.

"We were very impressed with NELHA's development of facilities to support the growth of innovative energy and marine science companies. NELHA's achievements have undoubtedly contributed to national export expansion efforts that support the U.S. economy and create American jobs"

*U.S. Secretary of Commerce
Penny Pritzker
May 16, 2016*



NELHA's development of infrastructure and initiate programs to move from functioning as a landlord for an ocean science and technology park towards developing an environment or ecosystem where private sector businesses can grow and prosper. In this regard, we continued our priorities in FY 2015 and FY 2016 on efforts to "tee-up" the Ocean Centerpiece" or economic driver area for eventual development and ensure that there are no long-term constraints.

These efforts include design and construction of access roads, electric utilities, additional potable water well development, detailed archeological survey and site visits to model developments around the nation. Funds were secured for all projects and funds were encumbered with contractors to complete construction and development in FY 2015 and FY 2016.



NELHA's leasing and marketing efforts also showed strong growth and strength in FY 2015 and FY 2016. NELHA's limited marketing efforts support the facility with television interviews, magazine articles, newspaper articles and press releases.

HIGHLIGHTS

Road Construction

- Continued to coordinate the construction of main frontage road to insure completion in line with the Queen Kaahumanu road widening project.
- The roadway design has been completed. Reworked design to bring construction costs in line with \$9.6M budget. Also, the road now conforms to all County of Hawaii standards and will be dedicated to County upon completion resulting in no long-term maintenance costs for this roadway.
- Final construction bids and associated contracts came in a total of \$9.1M and it will be completed under budget. Executed all contracts for road construction; construction management; archeological monitoring; freshwater pipelines – including "tie-in" to the new 16" main along Queen Kaahumanu Highway; and, installation of all conductors and utility conduits to provide power along the entire approximately 1-mile stretch of new road.
- Construction is scheduled to begin late summer of 2017.

Potable Water

- NELHA requested funds for the exploratory phase of a new potable water well. With very strong support from DBEDT Director Richard Lim, Governor Abercrombie, the Legislature and businesses in HOST Park, we were successful in obtaining \$2.5 million for this project. These funds will be used to complete the exploration phase for a new well. This phase includes: well siting studies, such as hydrology and geophysical to locate a possible source; field investigations; environmental assessment; permitting; plans/specifications for the exploratory well; and, drilling, casing and testing of the exploratory well.
- Secured one of the few remaining sites in West Hawaii via the execution of a MOU with Hawaii Housing Finance and Development Corporation and Forest City.

- Executed a \$2.5M contract with Water Resources International to complete the exploratory phase of a new water well which will provide for an additional 333,000 gallons per day of potable water.

Detailed Archeological Surveys

- Completed an archeological survey of the entire upper campus in 2016 to identify any unknown sites.

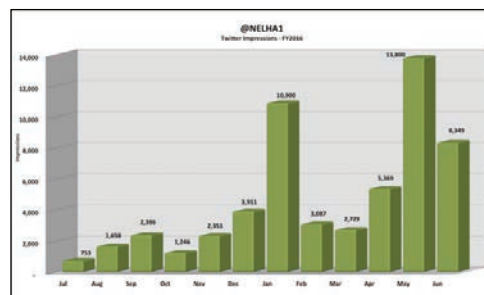
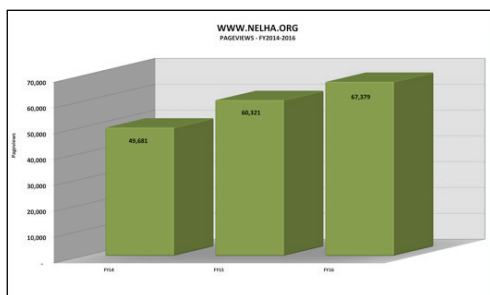
Leasing

- NELHA saw a significant amount of lease activity in FY 2015 and 2016. As shown in the table below, activity included renewing existing agreements, new leases, negotiation of existing leases during rent re-opening periods, merger of existing leases and review of a multitude of new projects.

Category	FY 2011	FY 2012	FY 2013	FY2014	FY2015	FY2016
Number new agreements including subleases	7	7	8	9	15	15
Number new tenants	4	3	1	4	6	5
Number new subleases	1	1	1	0	2	1
Potential projects (some NELHA staff time investment)	13	8	17	7	15	28
Potential projects (significant NELHA staff time investment)	6	12	11	7	12	4
Total potential projects	19	20	28	14	27	32
Number of promising long term projects	2	2	1	6	8	5

Marketing and Public Relations

- NELHA recently completed a “revamp” of its website and FY2014 was the first year it has been fully operational in the new format. The chart below shows steady growth in the number of page views since 2014 of approximately 36 percent.



- NELHA ramped up its efforts on Twitter in FY 2016 to gain name recognition and increase visits to the main website. The above chart shows steadily increase number of monthly impressions over the year.
- NELHA provided almost \$50,000 of in-kind support and works closely with the Friends of NELHA. Approximately 5,000 visitors were hosted at the Hawaii Gateway Energy Center in 2015 and 2016 and were given educational tours of the facility.
- NELHA continues to nurture connections with high schools, community organizations, colleges, universities and research institutions to promote a culture of fresh ideas and new thinking and offers “place-based” training internships.

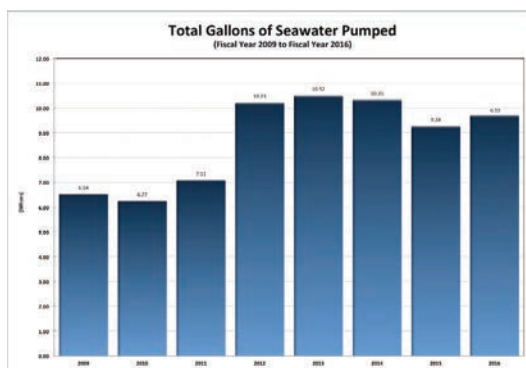
Seawater System

KEY FEATURES

- Largest seawater system in the world.
- Master permitted to pump over 130,000 gpm of seawater.
- Installed capacity is 90,000 gpm.
- Three deep seawater pipelines to depths of up to 3,000 ft.
- Three surface seawater pipelines at 80-foot depth.
- 99.999 percent uptime.

NELHA operates the world's largest seawater utility and provides both pristine surface and deep seawater throughout HOST Park. A listing of major pipelines is shown below. In addition, NELHA operates and maintains three major pump stations, four major backup generators and an extensive seawater pipeline distribution system throughout the park.

PIPELINE DESCRIPTION	DEPTH (ft)	SURFACE SEA WATER	DEEP SEA WATER
40-inch diameter	2,210		13,400 GPM
28-inch diameter	69	9,700 GPM	
18-inch diameter	2,060		3,000 GPM
24-inch diameter	33	5,400 GPM	
55-inch diameter	3,000		27,000 GPM
55-inch diameter	79	40,500 GPM	



The volume of seawater pumped increased by 50 percent since 2009. The volume has however, been relatively stable over the past five years at around 10 billion gallons annually. This equates to an average seawater volume of near 20,000 gallons per minute NELHA regularly achieves an uptime of 99.99 percent.

Highlights

Focus on increasing efficiency of the seawater system, including replacing the existing pumps. Significant improvements were made to the seawater system to increase efficiency. This includes working with large users to lower pressures; installing more accurate pressure transducers; recalibrating flow sensors; switching rate schedules; and, reprogramming variable speed drives to automate pump schedules.

NELHA completed seawater rates analyses in FY 2015 and FY 2016. 6 which validates efficiency improvements at the 55" pump station. It is an opportune time for this analysis as we are just beginning to see the results of the new SCADA system that is providing, on a real-time basis, weather, flow, temperature, dissolved oxygen, turbidity, pump status, energy generation and consumption.

A key part of the automation of the seawater system is the installation of new flow meters at all of the main pumping stations. The new meters will be much more accurate and allow us to optimize the seawater system.

One of the last remaining upgrades to the seawater system was a pipe to connect the north and south surface seawater systems. This is necessary for redundancy in the event of a major failure at either the north or south systems.



In FY 2014, design was completed and \$2.3M in CIP funds were obtained for construction. Construction the 28" surface seawater connector pipeline was completed in FY 2016. Bolton-Tinguely JV Construction was the general contract on the project and completed it ahead of schedule and approximately 50 percent under budget. It was determined that upgrades to the booster pump station would not be completed at this time.

A \$5.2M CIP appropriation in reimbursable government obligation bonds obtained in FY 2016 for additional seawater system upgrades, new pumps, and maintenance.

Aquaculture

“Hawaii has become the shrimp brood stock capital of the world. It is likely that Hawaii accounts for up to 60 percent of the total worldwide production. Two of the leading companies of this industry, Shrimp Improvement Systems and Moana Marine Biotech, are based at NELHA.”

Dr. Jim Wyban

Founder High Health Hawaii



Hawaii is a world center of aquaculture expertise in a wide variety of species and technologies and likewise, NELHA is home to a world-class aquaculture facility. Given Hawaii's year around growing climate, the biosecurity of its remote location and the easy access to pristine seawater at various temperatures, over 30 companies from around the world have located their aquaculture operations at NELHA.

At NELHA, public and private research organizations have pioneered the development of culture systems for a variety of aquatic species and regularly consult around the world. Local entities have extensive expertise in the spawning and rearing of marine shrimp, marine finfish, oysters, clams, abalone and algae. The level of cooperation between researchers, extension personnel and commercial producers in the local community is exceptional.



Companies located at HOST include CP Prima, a global aquaculture company that rears specific pathogen free brood shrimp and exports these animals to grow out facilities located around the world. Taylor Shellfish utilizes their facility at HOST as a nursery for their oyster crop that is then sent to over their 10,000 acres of farms in the Pacific Northwest to mature and harvest. Pacific Seafoods is based near Portland Oregon and has also has a nursery for clams at HOST Park that are planted in their farms offshore along the Pacific Northwest coastline. The first

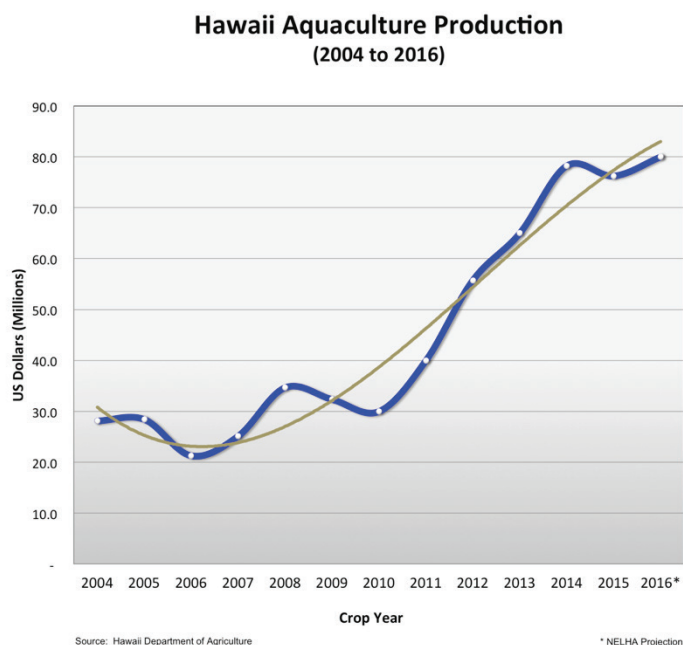


and only open ocean fish farming operation in the United States, Blue Ocean Mariculture, has an on-shore hatchery and off-shore farming operation that grows and exports Kona Kampachi, a high value species in the Amberjack family. Cyanotech is a NASDAQ listed nutraceutical company with a large algae growing operation that extracts Spirulina and Astaxanthin from the algae and sells their products worldwide.

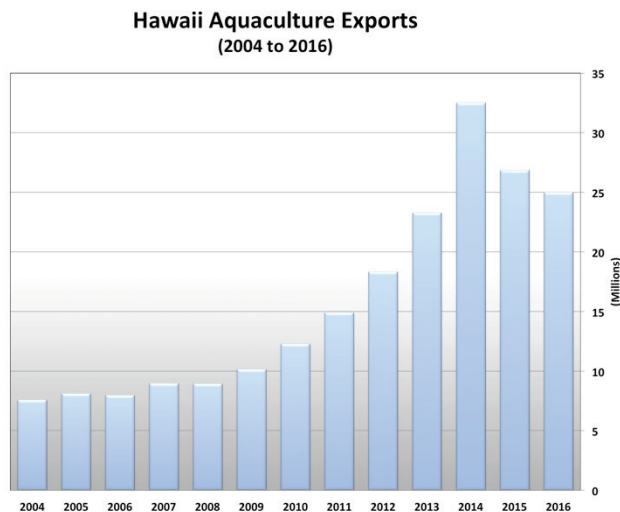
Hawaii's success in the global shrimp industry demonstrates Hawaii's proven track record in the aquaculture. By commercializing the groundbreaking research on specific pathogen free shrimp conducted by the Oceanic Institute, Hawaii has become the brood shrimp production capital of the world and now produces approximately 60 percent of the world's broodstock. Hawaii began exporting SPF Pacific white shrimp when worldwide production of farmed-shrimp production was 700,000 metric tons. It increased to 3.5 million metric tons in 2010 – a five-fold increase in 12 years.

Hawaii aquaculture production and sales have surged by over 150% in the past six years from \$30M to a projected \$80M. The majority of the increase is from businesses producing shellfish,

finfish and algae at NELHA. Exports are an important factor behind this growth and rose dramatically almost tripling between 2010 and 2014 to \$32M in 2014 before retreating in 2015 and 2016.



In late FY 2016, NELHA and the Hawaii Strategic Development Corporation (HSDC) began working on a concept for an aquaculture proof of concept (POC) center at NELHA. This effort will be focused on demonstrating the State's commitment to developing Hawaii's commercial aquaculture industry and to focus entrepreneur and investor interest in Hawaii as a location for globally relevant aquaculture companies. Developing technical expertise and intellectual property relevant to a global aquaculture industry will complement and benefit existing efforts of other State agencies currently involved in aquaculture with a focus on research and growing food for local consumption.



West Hawaii Today
WESTHAWAII.COM

Partnership looks to make open-ocean aquaculture commercially viable

By Chelsea Jensen West Hawaii Today cjensen@westhawaii.com

Thursday, March 26, 2015

The world's largest defense contractor, Lockheed Martin, is teaming up with NELHA-based Kampachi Farms on a venture to make open-ocean aquaculture commercially viable.

Forever Oceans, as the venture's termed, will take to the next level Kampachi Farms' mobile fish pen system, known as Vellela, which recently wrapped up research and development, by enhancing the means for monitoring and controlling the at-sea apparatus and creating a commercial demonstration project, Kampachi Farms co-CEO Neil Sims tells West Hawaii Today.

"We've gone and done the research. We've proven there is tremendous and phenomenal potential, and now it's time to move forward," Sims said. Kampachi Farms is a six-man outfit that uses open-ocean fish cages to raise fish reared at the company's headquarters at the Natural Energy Laboratory of Hawaii Authority in Kona.



And, moving forward means testing the company's technology on a commercial scale, which is where Lockheed Martin comes into play. "Some of the things that are being done at Kampachi are quite novel, but really taking advantage of technology robotics, satellite communications, command and control — things that are right in Lockheed Martin's wheelhouse — could enable what you think of essentially a farming operation in the sea,"

Lockheed Martin Chief Technology Officer Keoki Jackson, a native of Oahu's North Shore who oversees the corporation's advanced technology strategy and the maturation of future innovations, told West Hawaii Today.

The ability to monitor and control the pens remotely could increase their commercial viability as efficiency is increased and costs are reduced. For example, an employee would simply have to tend the pen once weekly, replenishing the feeding system and fuel generators, Sims said. "And, the rest of it is run by a research team wherever they are in the world," Sims said, adding that tasks such as releasing food for the fish could be done remotely via laptop or tablet. While the technology for such remote work was established during the last Vellela trial, it has not been tested on a commercial scale.

Ultimately, Sims said, the commercial demonstration, called the Vellela Delta Trial, would occur in waters off Keauhou, on the same mooring as the trials, however, a larger pen would be used. Plans also call for having a means for the public to view via the Internet details about water quality in the vicinity. He said the company is awaiting a permit from NOAA and does not have a time frame of when that might occur, but did note the permit for the last trial took 23 months to obtain.

"People always like to say fishing and aquaculture do not get along, but here we have powerful truth of fishing and aquaculture being able to work," Sims said, noting local fisherman "loved" the floating pens' ability to attract an array of fish, much like a "huge" fish-aggregating device. "Open ocean aquaculture, if you do it right it, has no measurable impact on the environment."

In recent times, Lockheed Martin has been working to expand its reach beyond global security by looking to renewable energy projects and those that deal with sustainability, like the partnership with Sims' operation to make commercially viable open-ocean aquaculture for food. Lockheed Martin also has an ongoing relationship with NELHA and Makai Engineering for the "demonstration and testing" of ocean thermal energy conversion, OTEC, technology at NELHA, Jackson said.



"Clearly, there is a growing demand for energy. If you look at the megatrends in terms of population growth and the rise in living standards around the world, and similarly for food sustainability, we see these as areas that, for the long-term, are likely to continue to generate demand, and Lockheed, where it makes sense from a business perspective, wants to be part of it," Jackson said.

Analytical Laboratory

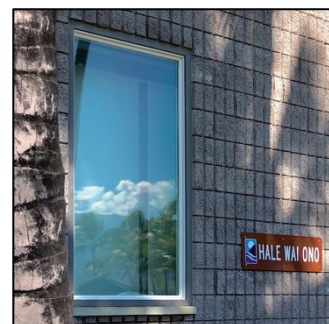


“We are the geeky side of Hawaii that’s looking toward the future. But, you don’t have to be a geek to come here and be part of it”

Sarah Crawford, Executive Director
Friends of NELHA

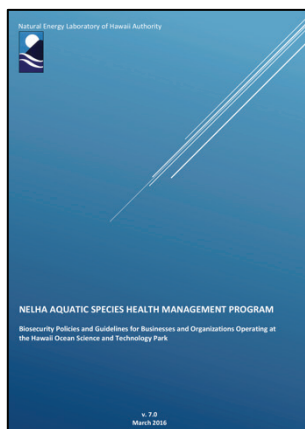
NELHA's Analytical Laboratory specializes in environmental sampling and marine water chemistry analysis. Much of the environmental monitoring work involved the implementation of NELHA's Comprehensive Environmental Monitoring Program (CEMP), collecting and analyzing samples from more than 120 sites located both onshore and offshore. In addition, the Lab is responsible for operating the NELHA weather station, SCADA system for real-time monitoring of the seawater system and biosecurity plans and monitoring.

The CEMP allows NELHA to monitor its pristine offshore environment and serves as an early detection system should any irregularities in onshore effluent disposal occur. The NELHA Analytical Laboratory again received its certified acceptable proficiency rating in FY 2015 and FY 2016 from the US Environmental Protection Agency's Discharge Monitoring Report-Quality Assurance Program on routinely performed water chemistry analytes.



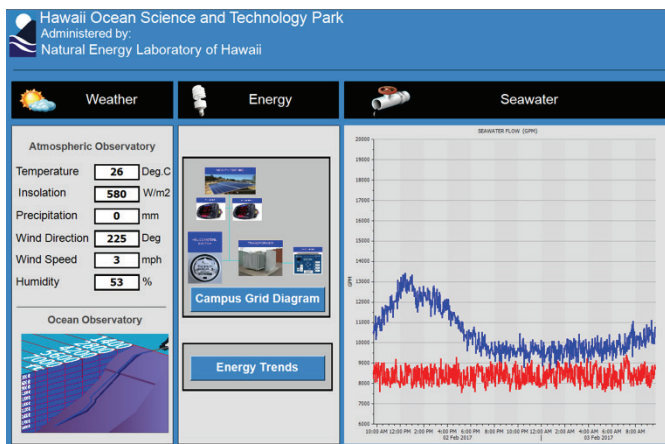
The 2015 and 2016 CEMP reports show no extraordinary groundwater water quality issues were noted. In addition, NELHA's ocean transect sampling results were within the historical range of NELHA pipeline and ocean transect data set. The results are also similar to other West Hawaii marine water quality monitoring programs.

It is important to note that since July 2010, a seawater disposal-monitoring program was gradually phased in and fully executed by January 2011. No unusual seawater disposal observations have been noted since its inception. The seawater disposal-monitoring program involves quarterly sampling of terrestrial seawater disposal sites at the NELHA facility. NELHA measures total suspended solids, biological oxygen demand, total nitrogen, and total phosphorous as guided by HAR Title 11 Chapter 62 with further recommendations from the HDOH Wastewater Branch.

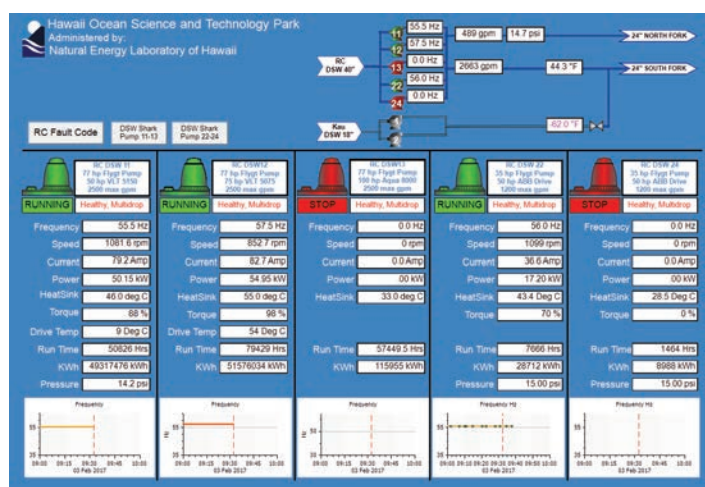


One of the key new responsibilities for the Lab is to monitor client's efforts to maintain biosecurity. A major update to the NELHA biosecurity policy was completed in FY 2016. NELHA worked closely with the Research Advisory Committee to assist in the update. The group met ten times to develop the proposed amendments and received considerable input from all stakeholders at NELHA and worldwide experts in shrimp production. All together the process amounted over 300-person hours of work. The Lab has also implemented a monitoring program and regular site visits.

Several years ago, NELHA began developing a Supervisory Control and Data Acquisition (SCADA) system and network to monitor the: 1) weather; 2) seawater structure (flows, water quality and temperature, and electrical usage); and 3) power production and storage. Responsibility for the maintenance and further development of the SCADA system has been assigned to the Lab.



Data from the SCADA system was instrumental in completing the recent seawater rate analyses and making the seawater system more efficient. The SCADA system has greatly enhanced ability to obtain real-time information to the desktop on operational performance.



The system now includes connectivity to approximately 30 sites. In the last two years we have installed 10 accurate flow meters and high-quality pressure sensors at all pump stations. We made significant efforts to refine calibration of sensors and to program variable frequency drives for increased automation. We now have the ability to make further improvements for remote control and increased efficiency.

The Lab produces several publications annually including the CEMP and Meteorological report. Both reports can be found online at www.nelha.hawaii.gov.



Research Campus

KEY FEATURES

- 6A Master Permitted.
- On shoreline w/ ready ocean access.
- Turn Key Setup – 1 day.
- Surface and deep ocean water available.
- Short term leases by SF.
- Incubator Office Building (14,000 sf).
- WetLab (4,000 sf).
- Covered Storage Space (6,000 sf).
- Seminars/Conferences.
- Small college campus atmosphere.
- Assets include SCADA, PV and ESS Testbed; OTEC; H2 Production, Storage and Fueling.



Efforts to upgrade and install new infrastructure was in full swing in FY 2015 and FY 2016. Numerous projects to transform the Research Campus were underway and completed during this period. With the exception of Hale Kaa all buildings in the Research Campus have been renovated or upgraded in the past five years. Projects completed in the past two years include:

Hale Iako: This is a mission critical piece of NELHA's efforts to transform the Research Campus in to a small college atmosphere. The building was completed in June 2016 at a total cost of approximately \$5 million. Major contractors critical for the renovation were INK Arch LLC responsible for design and construction management. The general contractor for construction was F&H Construction. The work was funded with a \$3 million grant from the U.S. Economic Development Agency; \$1 million in CIP funds and \$1 million in NELHA special funds. The building was approximately 60 percent leased upon completion. Pictures from groundbreaking through completion are shown on the following page.

Keena Hana: This building houses the NELHA administration offices and a new roof was installed at a cost of \$75,000. NELHA plans to install photovoltaic panels on the building shortly.

Hale Wai Ono: This building houses the NELHA Analytical Laboratory saw much needed interior renovation. Walls and floors were repainted, new lighting and appliances were installed.

Coverall Building: NELHA poured a concrete foundation and install a new coverall canopy on an existing frame that was no longer in use. The building now provides an additional 4,500 s.f. of outdoor storage space for new clients in the Research Campus. It was all hands-on deck to pull the cover on the existing frame and pictures on the following pages show the NELHA team effort in covering the structure.

Walkway and "Pringle Tent": Working with Makai Ocean Engineering, NELHA completed a concrete walkway and landscaping connecting the OTEC Tower, Hale Iako and Keena Hana. Also installed was a large tent structure (as shown below) for outdoor meetings in the campus.



The NELHA Coverall Team



Hale Iako Renovation



NELHA Board Members at Ground Breaking – August 2015



NELHA Staff at Ground Breaking – August 2015



Beginning renovation – old
Administration building is gutted

New walls and mezzanine erected



A new paint job

Renovation complete
June 2016





Seawater energy production launched at OTEC

By Bret Yager West Hawaii Today byager@westhawaii.com
Monday, August 24, 2015

Ocean water is finally generating a shock in North Kona. Jokes about fire and sparks notwithstanding, Gov. David Ige flipped a giant white switch at the Ocean Energy Research Center power production tower on Friday. The rising hum of the turbine — a sound like a jet warming up — signaled that electricity production had begun at the OTEC oceanside facility in North Kona.

The whining turbine is slated to continuously produce 100 kilowatts — enough to power 120 homes — and the noise marked the launch of the world's largest operational ocean thermal energy plant and the only one hooked up to a U.S. grid.

The technology uses both warm ocean surface water and cold deep sea water to generate power. The warm water heats and evaporates a liquid whose pressurized vapor runs the turbine, and the cold water pumped from deep in the ocean condenses the liquid so the cycle can repeat. The Makai Ocean Engineering project is aimed at testing and refining technology with an eye to putting it to much greater commercial use in the future.

Ige, an engineer, said OTEC was exciting to himself personally. Much renewable energy generation in the islands is intermittent and relies on the sun shining or the wind blowing — but deep sea water is a reliable, 24-hour source that doesn't depend on the vagaries of weather, Ige said.



"OTEC is a consistent power source, key to 100 percent renewability," Ige said. "This facility really establishes Hawaii as the center of OTEC in the country as well as the world." The governor was one of numerous dignitaries who feted the kick-off of power production at the end of the road at the Natural Energy Laboratory of Hawaii Authority. Mayor Billy Kenoi and Congresswoman Tulsi Gabbard were among those who lauded the project's potential for helping make the island energy-independent. Also in attendance was a delegation from Okinawa, whose prefecture has invested in the project. "The question is whether it can be scaled and made economically viable," Ige said after a tour of the facility.

The facility is key to building confidence in OTEC as a viable energy source, Ige said, noting that the Big Island is perfectly situated to tap deep seawater because of its steeply inclined seabed.

The project is a multi-party collaboration that includes Lockheed Martin, the Hawaii Natural Energy Institute, the Okinawa Prefecture and the Office of Naval Research. The Navy has pumped \$16 million into research and development of the plant since 2009, including funds to build the tower itself, whose construction cost runs in the \$2 million to \$3 million range. Rich Carlin, head of the Sea Warfare and Weapons Department at the Office of Naval Research, said the plant is the first step toward a commercial operation. Carlin touted future plans for a 100 megawatt offshore plant as important to both renewable energy interests and the Navy.

Makai Ocean Engineering hopes to build a 1 megawatt plant within five years through a partnership with Okinawa — part of a plan of stepping up to much larger power plants in the future, said Adam Wong, chairman of the board of directors for the company. The beginnings of OTEC and Makai can be traced back to the 1970s. The electricity enters the Hawaii Electric Light Co. grid, but will be used within the Hawaii Ocean Science and Technology Park, so HELCO is not actually purchasing the energy.

Advanced Energy

KEY FEATURES

- Advanced Energy Testbed and Outdoor Demonstration Site
- Ocean Thermal Energy Conversion (OTEC) Testbed
- Microgrid Development and Testing
- Biofuel Production
- Concentrated Solar Power Testbed
- Energy Storage System (ESS) Testbed
- Hydrogen Production, Storage and Fueling



NELHA's energy initiative's goal is to learn about nascent renewable technologies and grid modernization that will reduce our carbon footprint. We can provide an outdoor demonstration site to test renewable energy technologies on the cusp of commercialization.

Major aspects of this effort include: 1) Establish an energy storage systems testbed; 2) Develop an integrated energy district or microgrid; 3) Reduce our carbon footprint by adding renewable energy from solar photovoltaic (PV) panels; 4) Work with the University of Hawaii and US Department of Energy to develop a testbed for hydrogen technologies; 5) Expand efforts to assist the private sector in commercialization of OTEC; and, 6) Expand our relationships with the national laboratories and other key players in Hawaii's energy field such as the Hawaii Natural Energy Institute and the utilities.

Energy Storage Systems (ESS) Testbed

- One storage device was installed in the research campus testbed. The 21.9 kWh M100 battery module by Aquion Energy Inc. was installed in 2015. It is charged from the 36KW solar array. Sandia National Laboratories (SNL) and Hawaii Electric Light Company (HELCO) are both involved in monitoring this device. A second ESS system by a separate manufacturer is expected to come online later this year.



National Energy Labs

- Significant progress in developing strategic partnerships, especially with Sandia National Laboratory and National Renewable Energy Laboratory (NREL).
- We completed an update of previous study with NREL using their new "ReOpt Model" to determine the optimal amount of photovoltaic panels and energy storage and also completed a "resiliency analysis" of our emergency power system including the results from the ReOpt analysis.
- NELHA and Sandia signed an MOU in 2015 to implement electrical ESS in renewable-energy projects at NELHA.
- Of particular significance was our efforts to begin working closely with national labs to develop an agenda and solicit participation in an energy storage conference in September 2016. Five national labs are sending speakers and or representatives to the conference. The conference is being funded by the County of Hawaii's Research and Development Department.

Ocean Thermal Energy Conversion

- NELHA continues to work with Makai Ocean Engineering to make seawater system adjustments that could eventually allow the purchase of the net power from their existing 105Kw OTEC facility in the Research Campus.

- NELHA hosted participants of the fifth annual Hawaii – Okinawa Clean Energy Conference in August 2015. NELHA presented a proposal for Hawaii-Okinawa Collaboration for a joint venture to develop 1 MW class OTEC Demonstration Facility.
- Significant progress was made with Japanese firms to find a strategic partner and jointly develop a 1MW OTEC facility at NELHA. A MOU was signed in September 2015 between NELHA, Makai Ocean Engineering and 6 Japanese firms specializing in OTEC technologies to work together and support the design, development and construction of a joint venture OTEC facility at NELHA.



- \$5.2M in monies secured in 2016 will provide funding for a pre-feasibility study and design if feasible for a 100-300Kw OTEC facility that could be owned and operated by NELHA to produce power for the seawater system.

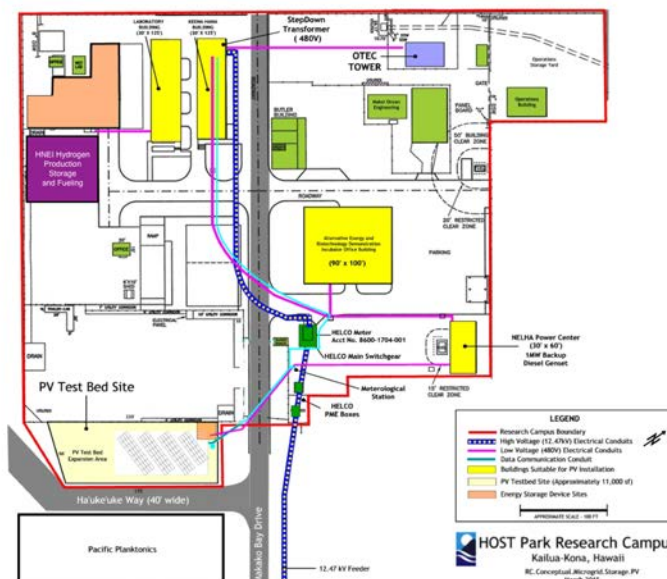
Microgrid Testbed

- NELHA applied to the US Economic Development Administration in December 2014 for \$500,000 to complete a feasibility study for a microgrid. Unfortunately, NELHA was not selected but we continue to search for other opportunities.

Hydrogen Production, Storage and Filling Station

- NELHA has been working with UH Natural Energy Institute and assisting them with planning, permitting and preliminary site work to allow for their equipment to be mounted at a site at NELHA.

CONCEPTUAL PLAN AND BASE MAP FOR MICROGRID, STORAGE, AND SOLAR TEST BED



Who's Who at NELHA



Members of the US House of Representatives Committee on Natural Resources visits Taylor Shellfish Farms hatchery



Hawaii Wildlife Funds at Wawaloli Beach Park at NELHA for a beach cleanup



Governor Ige visits Makai Ocean Engineering to hear about OTEC



House Finance Committee pays a visit



Federal, State and Private sector leaders visit NELHA to discuss options for developing hydrogen industry on Hawaii Island



Pacific Century Fellows Program visits Cyanotech



HCATT team visits NELHA

Awards

President's "E" Award for Export Service

NELHA received this prestigious award in May 2016. The "E" Awards are the highest recognition any U.S. entity may receive for making a significant contribution to the expansion of U.S. exports. U.S. Secretary of Commerce Penny Pritzker said that NELHA's achievements have undoubtedly contributed to national export expansion efforts that support the U.S. economy and create jobs .

The President's "E" Award was created by Executive Order of the President to afford suitable recognition to persons, firms, or organizations which contribute significantly in the effort to increase United States exports. During World War II, more than 4,000 "E" Pennants were presented to war plants in recognition of production excellence. The famous flag with the big "E" emblazoned on it became a badge of patriotism in action. President Kennedy revived the World War II "E" symbol of excellence to honor and provide recognition to America's exporters. Thus, the "E" Award Program was established by Executive Order 10978 on December 5, 1961. The "E Star" was authorized in 1969 to recognize "E" Award winners for continued efforts in export expansion.



Penny Pritzker - U.S. Secretary of Commerce,
Laurence Sombardier – NELHA, Gregory Barbour – NELHA, and
U.S. Congresswoman Tulsi Gabbard

State of Hawaii Service Awards



Thomas Pierce – 10 years



Karen Appleby – 10 years



Greg Barbour – 30 years



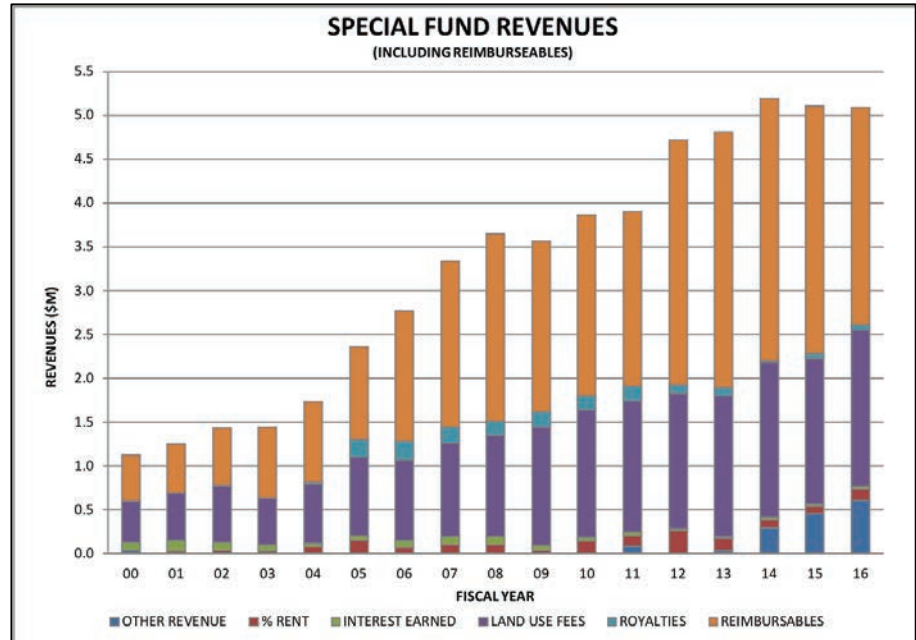
Cilly Gibo – 10 years

HIGHLIGHTS

Revenue – including reimbursables

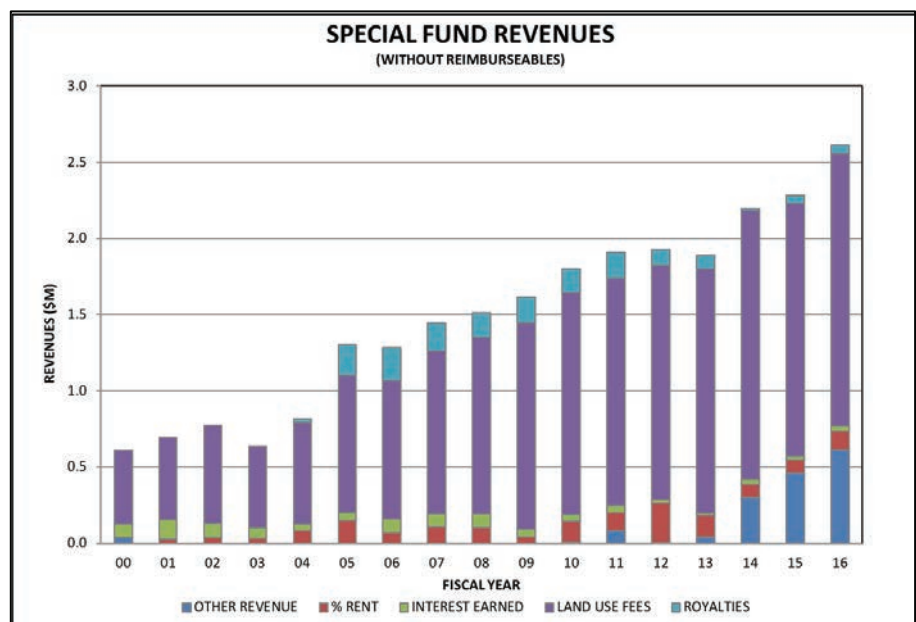
- Revenue has increased by approximately 30% in the past 5 years.
- Revenue has remained over \$5m for the past 3 years.
- The sale of seawater (reimbursables) accounts for approximately 50% of total revenue and is operated on a break-even basis.
- Revenue has declined slightly in the past several years due to a decline of \$500,000 (20%) in reimbursables.
- This is mainly due to a significant decrease in the price of electricity which makes up approximately 50% of the price of seawater. which has a significant impact on the price of seawater.

Revenues

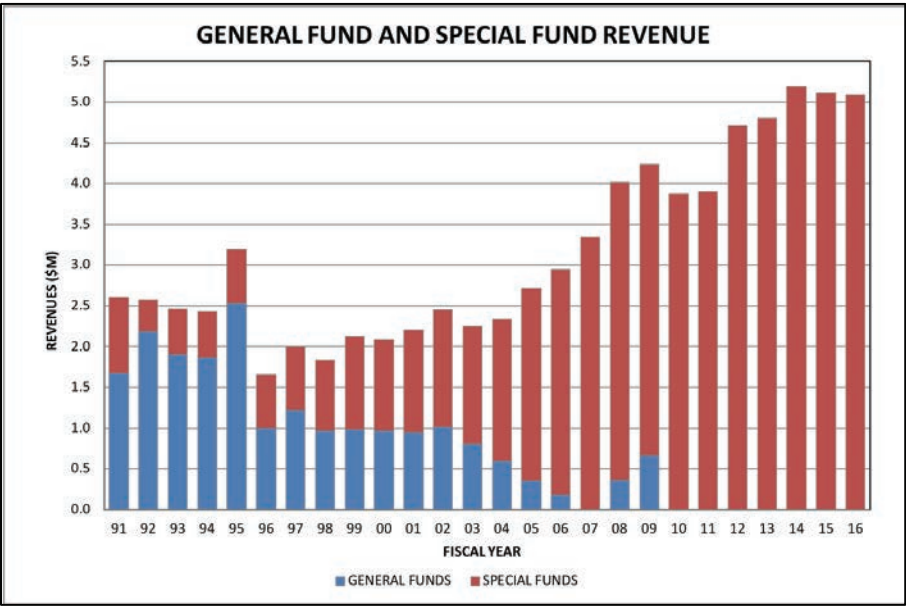


Revenue – without reimbursables

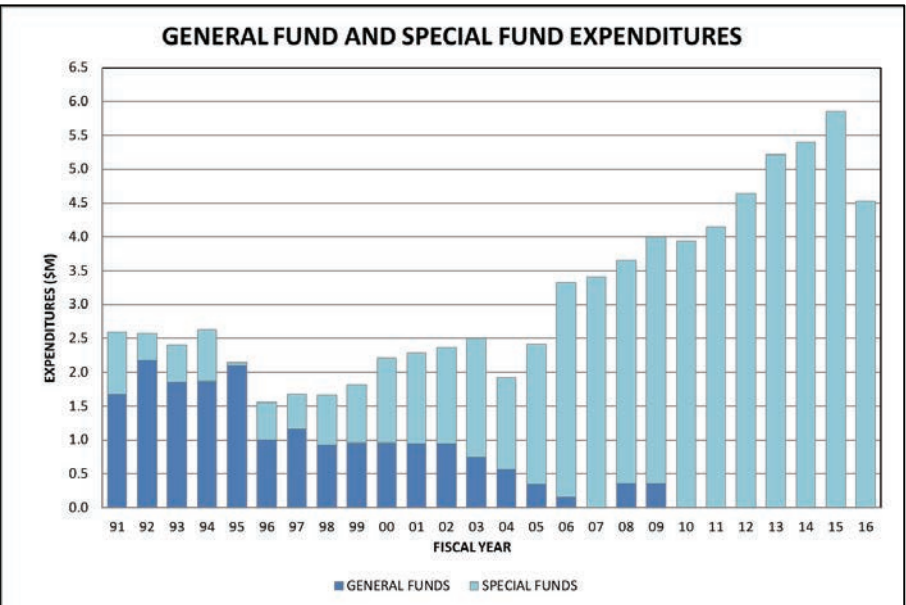
- Revenue, has increased by approximately \$600,000 (37%) in the past 5 years.
- A majority of this revenue is land use fees which has increased by 20% in the past 5 years.
- Other revenue, mainly grants and special projects, has also increased significantly in the past several years.



General & Special Funds



Expenditures



HIGHLIGHTS

General vs. Special Fund Revenue

- Over the past 20 years self-sufficiency has been the focus. Revenue growth and cost containment for operations were critical to achieving self-sufficiency and NELHA has had tremendous success.
- The chart shows an annual subsidy, shown as general funds in light blue, of approximately \$1 million annually being replaced by revenue from the seawater and land use fees being placed in NELHA’s special fund.
- NELHA has been self-sufficient from an “operating standpoint” for the past six years.
- NELHA continues to receive funds from the State for capital improvement projects, such as roads and are not included in this chart.

General vs. Special Fund Expenditures

- Expenditures show a similar pattern over the past 25 years
- The significant decline in FY 2016 is due to special one-time projects in the previous several years and reduced electricity costs for pumping seawater.
- NELHA used \$750,000 from its special funds in FY 2015 to complete the new incubator building in the research campus.

NATUAL ENERGY LABORATORY OF HAWAII AUTHORITY
FINANCIAL STATEMENT - FISCAL YEAR 2015
(Fiscal Year - July 1 to June 30)

	Fiscal Year 2015
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REVENUES

Land Use Fees	1,660,611.12
Seawater Royalties	53,655.68
Reimbursables	2,825,800.21
Interest Received	24,672.35
Other	461,233.94
Percentage Rent	83,283.28
Subtotal	5,109,256.58

EXPENDITURES

Salaries	1,541,282.25
Operations	3,972,962.86
OHA (Ceeded Lands Transfer)	342,980.10
Subtotal	5,857,225.21

FINANCIAL POSITION

Special Fund Cash Balance (July 1)	1,226,798.48
Prior Year Unrequired claims	101,534.08
Prior Year Transfers	2,285.84
Special Fund Revenues	5,109,256.58
Subtotal	6,439,874.98
Special Fund Expenditures	5,514,245.11
OHA (Ceeded Lands Transfer)	342,980.10
Special Fund Cash Balance	582,649.77

Note: All data as of end of fiscal year (June 30) unless otherwise noted.

NATUAL ENERGY LABORATORY OF HAWAII AUTHORITY
FINANCIAL STATEMENT - FISCAL YEAR 2016
(Fiscal Year - July 1 to June 30)

	Fiscal year 2016
<u>REVENUES</u>	
Land Use Fees	1,784,360.34
Royalties	56,668.62
Reimbursable	2,480,250.40
Interest Received	32,116.93
Other	613,582.40
Percentage Rent	124,586.96
Subtotal	5,091,565.65
<u>EXPENDITURES</u>	
Salaries	1,655,987.37
Operations	2,493,313.75
OHA (Ceeded Lands Transfer)	383,459.23
Subtotal	4,532,760.35
FINANCIAL POSITION	
Special Fund Cash Balance (July 1)	582,649.77
Prior Year Unrequired claims	2,674.77
Prior Year Transfers	-
Special Fund Revenues	5,091,565.65
Subtotal	5,676,890.19
Special Fund Expenditures	4,149,301.12
OHA (Ceeded Lands Transfer)	383,459.23
Special Fund Cash Balance	1,144,129.84

Note: All data as of end of fiscal year (June 30) unless otherwise noted.

Board of Directors

John DeLong, Chair (2015)

President, Hawaiian Cement

At Large Member appointed by Governor (2015)

William F. Mielcke, Vice-Chair (2015), Chair (2016)

Director, Vitus Group

At Large Member appointed by Governor (2015/2016)

Linda Rosehill, Vice-Chair (2016)

President, Linda Rosehill and Associates

At Large Member appointed by Governor (2016)

Dr. Vassilis L. Syrmos Ph.D.

Vice-President for Research and Innovation, University of Hawaii

Ex-Officio – President, University of Hawaii (2015/2016)

Race A. Randle

Senior Director of Development, Howard Hughes Corporation

Ex-Officio – High Technology Development Corporation (2015)

Derek Lau

Realtor, Real Estate Specialists

Ex-Officio – High Technology Development Corporation (2015)

William Rolston

Energy Analyst

Ex-Officio – Mayor, County of Hawaii (2015/2016)

Dr. Gerry Cysewski, Ph.D.

Chief Science Officer/Executive Vice-President, Cyanotech Corporation

Ex-Officio – Tenant Representative (2015/2016)

Michael Eldred

OTEC Project Manager, Makai Ocean Engineering

Ex-Officio – Tenant Representative (2015/2016)

Board of Directors

Richard C. Lim

Director, Department of Business, Economic Development and Tourism
Ex-Officio – Director, Department of Business, Economic Development & Tourism (2015)

Luis P. Salaveria

Director, Department of Business, Economic Development and Tourism
Ex-Officio – Director, Department of Business, Economic Development & Tourism (2015/2016)

Dr. Phillip Bossert

Co-Founder, Orien Tech
Ex-Officio – Hawaii Strategic Development Corporation (2015)

Michael O'Malley

Managing Partner, Goodsill, Anderson, Quinn & Stifel
Ex-Officio – Hawaii Strategic Development Corporation (2016)

Russell Y. Tsuji

Administrator, DLNR Land Division
Ex-Officio – Director, Department of Land and Natural Resources (2015)

Dr. Bruce Anderson

Administrator, DLNR Division of Aquatic Resources
Ex-Officio – Director, Department of Land and Natural Resources (2016)

Alan Hilton

Marine Operations Coordinator, University of Hawaii Marine Center
Ex-Officio – Research Advisory Committee Chair (2015/2016)

Dr. Jim Wyban, Ph.D.

Founder, High Health Aquaculture
Ex-Officio – Research Advisory Committee Vice-Chair (2015/2016)

The NELHA Team in 2015 - 2016

POSITION TITLE	INCUMBENT
Executive Director	Barbour, Gregory
Senior Secretary	Appleby, Karen
General Laborer II	Debina, Chad
Secretary III	Espinueva, Georgette
Maintenance Mechanic I	Gibo Jr., Celestino
Water Quality Specialist	Madden, Pamela
Fiscal Officer	Kaniho, Sheryll
Administrative and Projects Manager	Leonard, Alexander
Accounting Clerk III	Miranda, Jerrae
Maintenance Mechanic I	Mitchell, Anthony
Engineering Project Coordinator (2015)	Nichols, Jeffrey
Engineering Project Coordinator (2016)	Babbitt, Bryan
Chief Science Officer	Olson, Keith
Utility Electrician	Pierce, Thomas
Electrician II	Allon Thompson
Chief Marketing Officer	Sombardier, Laurence
Operations Engineer	Towle, Dean
Operations Manager II	War, Jan
Laboratory Intern (W. Washington U)	Corotan, Austin
Laboratory Intern (Colorado College)	Denzer, Brittany
Laboratory Intern (Kealahou HS)	Denzer, Ian
Laboratory Intern (UH Manoa)	Gaughen, Kapono
Laboratory Intern (Columbia University)	Kekaula-Basque, Kully
Laboratory Intern (Brown University)	Van Pernis, Alexandra



Appendix – Timeline of Major Events

1974	Natural Energy Laboratory of Hawaii, operated by the University of Hawaii, was established as a response to the first oil crisis.
1979	Mini-OTEC was anchored offshore of Keahole Point, demonstrating the world's first production of net electrical power via closed-cycle OTEC.
1980	Laboratory facilities and its first pipeline to draw deep seawater from 2,000 feet and surface seawater from 45-foot depths were completed.
1981	Shore-based OTEC research began with a project testing biofouling and corrosion countermeasures for the closed cycle OTEC process.
1984	Legislation authorized commercial activities, allowing the Laboratory to host new business ventures.
1985	Legislature authorizes NELH to assume the management responsibility of the Puna Geothermal Facility to NELHA. Facility consists of a 3 mW electric power plant and the Noi'i O Puna Research Center
1986	Hawaii Ocean Science and Technology (HOST) Park was created on an adjacent 500+ acres and operated by the Hawaii Technology Development Corporation (HTDC). US DOE and HOST Park combine resources to install 40" deep seawater and 28" surface seawater system at Keahole Point. Laboratory building air conditioning system converted to deep seawater cooling. Legislature appropriates funds for 18" deep seawater pipeline.
1987	Heat and Mass Transfer Scoping Test Apparatus (HMTSTA) open cycle OTEC test tower constructed and operated by Pacific International Center for High Technology Research (PICHTR).
1989	Puna Geothermal Facility and HGP-A well shut down. The Aluminum Company of Canada (ALCAN) develops program at the Laboratory for testing "roll bonded" aluminum heat exchangers.
1990	NELH, operated by UH, and HOST Park, operated by HTDC, merge to become the Natural Energy Laboratory of Hawaii Authority (NELHA).
1992	210 kW open-cycle OTEC Net Power Producing Experiment (NPPE) constructed at NELHA and operated by PICHTR.
1994	Micro-tunneling begins to construct two 66" diameter tunnels under the shoreline and offshore reef as a pipeline protection crossing in preparation for NELHA's new 55" warm and cold seawater pipelines.
1995	CEROS transferred from HTDC to NELHA
1998	NPPE Open-cycle OTEC power plant decommissioned.

2000	Construction begins for NELHA's new 55" offshore intake pipelines and pump station. Planning and design process started for new Hawaii Gateway Distributed Energy Center.
2002	Successful deployment of 55" deep seawater pipeline offshore and construction of initial phase of onshore pump station using specially designed fiberglass reinforced (FRP) intake canisters. First deep seawater desalinization project begins experimentation to develop bottled drinking water.
2003	NELHA tenant count reaches 34. Non-profit "Friends of NELHA" (FON) formed to assume basic public relations and outreach functions for NELHA.
2004	Construction of Hawaii Gateway Distributed Energy Center completed.
2005	55" warm and cold seawater pump station and distribution pipelines completed.
2006	NELHA Foreign Trade Zone status granted by US Department of Commerce. Keahole Solar Power LLC begins construction of solar thermal research and demonstration facility. Five leases to desalinize deep seawater to produce boutique drinking water.
2007	Cellana in partnership with Royal Dutch Shell begins construction of a 6-acre micro algae to biofuels research center.
2011	Makai Ocean Engineering completes construction of corrosion lab and heat exchanger test tower to investigate the use of aluminum alloys for OTEC.
2012	UH Economic Research Organization (UHERO) completes first economic impact study regarding HOST Park. Results indicate economic impact and job creation is much higher than anticipated and is almost \$90 million annually and 600 jobs. Master Plan and Strategic Plans updated. Federal grants totaling almost \$3.5 million received for renovation of Main Administration building and micro-grid infrastructure for the Research Campus.
2013	HOST Park economic impact surges by 40 percent since 2010. Repairs offshore pipeline (\$5M) completed to extend life of pipeline by 15 years.
2014	NELHA receives almost \$12 million in CIP funding for new pipelines and road construction. National Lab relationships strengthened.
2015	NELHA begins construction of numerous projects including office incubator, 28-inch cross connector surface seawater pipeline to connect the north and south seawater systems and buildout of the SCADA system to monitor real-time use of seawater and electrical consumption.
2016	NELHA completed significant improvements to the Research Campus including of the main administrative building in the Research Campus and turned it into a 14,000 s.f. blue technology and advance energy incubator building with 17 offices, covered storage space, walkways and various smaller office buildings.



2015-16
Annual
Report

