Public Utilities Commission

Docket No. 05-0145

O`ahu Power Plant

Testimony of

Henry Curtis

Vice President, Life of the Land

re Solutions

LOL T-6

Overview

I believe that we are facing a monumental choice -- and the future of the planet hangs in the balance. Or at least, life as we know it. Fossil Fuels have transformed the world (agricultural --> industrial --> information age) while leaving a terrible legacy (acid rain, asthma, resource wars). Today there is no denying that Climate Change is a serious issue that must be addressed. We can face it, deny it, straddle the paths, or get rich studying it. While the ice-caps melt, we can talk about future potential long-term changes -- alternative energy paths that need a lot more research. If we decide that we should go down a new path, why not go to the state that has the highest utility rates, the most dependent upon oil, the one with the greatest variety and abundance of renewable energy resources. Hawai`i. O`ahu. Now. What portfolio of efficiency, conservation, displacement, and renewables is reasonable?

I begin with a simply idea. The change must start here. Others should change also. But that is beyond my immediate control. What I can do, and I will do, is to lay out a clear option for the future. Life of the Land's proposal will CUT greenhouse gas emissions. It will not merely stabilize, or slow the growth of, but actually cut harmful emissions.

HECO states that they need 170-200 MW of new generation so they are proposing 100-110 MW. HECO's Maximum Renewable Energy Plan (IRP-3) will emit over 100 million tons of additional CO_2 into the atmosphere over the next 20 years.

Our plan will cut emissions. We advocate 200-250 MW in local, cleaner, greener renewable energy projects: OTEC to supply peak power, energy efficiency and SWAC to decrease peak power needs, wind, solar and wave energy to displace oil. We propose tearing down the pre-statehood Honolulu Power Plant in Downtown Honolulu.

I will give the overview of a variety of energy solutions: efficiencies, photovoltaic, wind (land, water, micro), wave (blow hole, reservoir, pelamis), sea water air conditioning, ocean thermal energy conversion. Four specialists, all with extensive knowledge of ocean energy systems will follow. Three live in Hawai`i. All have knowledge of Hawai`i.

We hope that the Commission recognizes that renewables are available today. Renewables offer reliability, security, and protection against climate change. We must do our part. I will discuss economic and finances in a subsequent testimony. We would like the Commission either on their own, or by direction to the utility, to authorize Request for Proposals (RFP) Oahu will have a portfolio of new firm and intermittent renewable systems which will become operational in the 2009-2010 time frame. It is possible, and it is the right path for a living planet.

Our expert witnesses are:

Dr. Hans Krock is President of OCEES International Inc.—a firm focusing on OTEC related projects and involved in SWAC. OCEES is installing OTEC facilities at NELHA and Diego Garcia in the Indian Ocean. Dr. Hans Krock has a BS in Civil Engineering; MS in Sanitary Engineering; Ph.D. in Environmental Engineering; Minors in Chemistry and Chemical Engineering; and Registered Professional Civil Engineer. Past President of Engineers and

Architects of Hawaii. (EAH) UH faculty (1980-). UH Professor of Ocean & Resources Engineering.

Dr. Tom Denniss is founder of Energetech Australia Pty Ltd, a renewable energy company developing oscillating water column wave energy systems. Dr. Tom Denniss has a PhD in Mathematics (Thesis: Studies in Ocean Dynamics). Lecturer in mathematics and oceanography at the University of New South Wales.

Dr. David Rezachek is Associate Development Director of Honolulu Seawater Air Conditioning LLC. Dr. David Rezachek is a Nuclear Engineering: U. S. Navy Nuclear Power School and Nuclear Power Plant Prototype; BS in Chemistry; BS in Environmental Technology and Urban Systems; MS in Mechanical Engineering; and Ph.D. in Ocean Engineering

Reb Bellinger is vice president of sales and marketing for Makai Ocean Engineering Inc., a company specializing in installing pipes and cables in the ocean.

TESTIMONY

Firm and Intermittent power

Firm power is available 365/24/7. This includes fossil fuel based generators, biomass, ocean thermal energy, and tidal power. Intermittent power (as-available power) is conditionally available, that is, when the wind is blowing, when the sun is shinning, when there are waves , etc.

Existing Firm Power

HECO has 3 Generation Stations containing 16 Generating Units with a net capacity of 1208.6 MW.

The Downtown Generation Station is located adjacent to Aloha Tower was built in the before statehood. The generators are the Honolulu 8 (52.9 MW) and the Honolulu 9 (54.4 MW).

The Waiau Generation Station has 8 generators built between 1947 and 1973. The generators are the Waiau 3 (46.2 MW), Waiau 4(46.4 MW), Waiau 5 (54.6 MW), Waiau 6 (55.6 MW), Waiau 7 (88.1 MW), Waiau 8 (88.1 MW), Waiau 9 (51.9 MW), and the Waiau 10 (49.9 MW).

The Kahe Generation Station has 6 generators built between 1963 and 1981. The generators are the Kahe 1 (88.2 MW), Kahe 2 (86.3 MW), Kahe 3 (88.2 MW), Kahe 4 (89.2 MW), Kahe 5 (134.7 MW) and the Kahe 6 (133.9 MW).

There are 3 major Independent Power Producers:

Kalaeloa Partners, L.P. (208 MW; 2004 Energy Sales of 1.3 billion kilowatt-hours; Contract Expires 2016);

AES-Hawai`i (180 MW; 2004 Energy Sales of 1.5 billion kilowatt-hours; Contract Expires 2022); and

H-POWER (46 MW; 0.3 billion kilowatt-hours; Contract Expires 2015)

Existing Intermittent Power

Tesoro and Chevron refineries at Campbell Industrial Park provide energy to the HECO system on an as-available basis

Need for New Power Plants

A utility must have sufficient firm capacity to meet the maximum peak load between today and when the next power plant comes on-line, while assuming that the largest plant is out for maintenance, the second largest plant crashes. Thus the rate of increase in peak demand and the size of the largest two plants determines the amount of reserves that are needed. Building a system with small distributed plants allows for smaller reserves and quicker supply adjustment to load demand.

Reserve Capacity

Reserve capacity is the difference between the total installed generating capacity and the expected or actual peak demand. The amount of reserve capacity needed on the system in order to provide adequate generating system reliability is determined by Public Utility Commission rulings.

Peak Demand

The all-time record demand was recorded on October 12, 2004 at 1,327 MW (gross) or 1,281

MW (net). In 2005, the recorded peak demand was 1,273 MW (gross) or 1,230 MW (net) which occurred on September 14, 2005.

Delaying New Generation

Postponing or delaying new power plants can be achieved through energy conservation, energy efficiency, and peak load programs ("negawatts"); the installation of customer-sited combined heat and power ("CHP") systems; and public education.

Available New Generation

Kalaeloa Cogeneration, AES Hawaii and H-POWER can each provide additional firm power. Kalaeloa increased their output from 180 MW to 208 MW through an agreement which became effective on September 28, 2005 . AES Hawaii has offered additional power, and if H-POWER adds a third boiler they could provide additional power. HECO installed 15 MW of Substation-based Distributed Power in October - December 2005.

HECO's DSM Program

A. HECO's IRP-3 preferred plan, filed with the Commission on October 28, 2005 in Docket No. 03-0253, proposed cumulative peak reduction of 24 MW (energy efficiency), 30 MW (load management) and 18 MW (CHP).

Primary Focus

Should the primary focus be building more power plants (renewable or fossil fuel) or focusing first on conservation and efficiency? Dollar for dollar, the biggest bang for the buck is energy conservation and energy efficiency. Conservation refers to not using electricity when you don't really need it. Efficiency refers to doing the same work with less energy. Often the two terms get intermingled. Studies such as Energy Efficiency and Job Creation by Howard Geller et al have consistently shown that reducing energy requirements results in the largest payoff in terms of reducing pollution and imports while increasing jobs, and diversifying and strengthening the business sector.

LOL's Energy Efficiency Utility Proposal

Electric utility companies operates under conflicting objectives. An electric utility must sell electricity to earn a profit: while providing customers with energy efficiency devices designed to reduce their electricity usage.

This is obvious in the case of HECO's proposed 2009 power plant at Campbell Industrial Park. In the IRP process, no alternative was permitted that denied HECO's building the power plant in 2009. No plan permitted deferring it to 2010 or later; looking at alternative technologies; or abolishing the need for the plant altogether.

In 1999 the Vermont Public Service Board (PSB), the Vermont Legislature and the state's electric utilities determined that a conflict of interest was inherent in the manner that energy efficiency services were delivered to the people of Vermont.

The Vermont Public Service Board selected the Vermont Energy Investment Corporation (VEIC) from a field of six competitors to operate Efficiency Vermont.

The winning bid was from VEIC, a company founded in 1986 employing over 100 employees with expertise in residential, commercial, and industrial energy efficiency, building science, engineering, renewable energy and database management. It offers services to a diverse range of clients, including consumer advocates, environmental groups, government agencies, utilities and other program administrators in more than 20 states, as well as in Canada and several other countries. (www.veic.org) VEIC formed a consortium of partners and subcontractors to provide services to Vermont customers.

Efficiency Vermont won the prestigious Innovations in American Government Awards from Harvard University. (2003). Other locations that are or have implemented similar entities include: Efficiency Maine; Efficiency New Brunswick; New Jersey's Clean Energy Program; Energy Trust of Oregon; New York State Energy Research and Development Authority's Energy $mart Program (NYSERDA).

Hawaii should adopt a similar approach by creating Efficiency Hawai`i to oversee energy efficiency installations would allow the utility to focus on electric sales while allowing the efficiency utility to focus on decreasing sales. The Public Utilities Commission would regulate each utility - the Megawatt electric utilities and the Negawatt Efficiency Utility.

The Public Utilities Commission shall oversee the transformation from an electric utility-based demand side management system to an Energy Efficiency Utility, an independent entity, unaffiliated with any of the state's electric or gas utilities. The Energy Efficiency Utility will be regulated by the PUC in accordance with HRS Chapter 269 and the Commission's rules and regulations. The Commission sets the policy and structure for the Energy Efficiency Utility. The Commission will select the Energy Efficiency Utility through a single or multi-tiered Requests For Proposals and/or Competitive Bidding process. The Commission will review and approve the Energy Efficiency Utility budgets and allocations among program categories. The Commission is the final authority responsible for directing and reviewing the work of the Energy Efficiency Utility. Other parties may be called upon to advise the Commission (through filings or dockets), but it will retain final responsibility for assuring that the system functions as intended.

The Consumer Advocate will continue to be a party to any Commission proceeding and will continue, as it does now, to represent consumers in those proceedings. The CA may develop and present avoided cost information, necessary to assess program design and expected benefits, for consideration by the Commission. The Consumer Advocate will not have any direct authority over the Energy Efficiency Utility, except that the Department will be able to require the Energy Efficiency Utility to make information in its possession available to the Consumer Advocate on request.

Electric utilities shall collect a Public Benefit Surcharge from their ratepayers and transfer this money directly to the Energy Efficiency Utility on a timely basis.

The Energy Efficiency Utility will be an independent organization, a for-profit or non-profit corporation. The Energy Efficiency Utility may not be affiliated or financially-linked with any company which appear before the Commission in any other capacity. The Energy Efficiency Utility will acquire funds from electric utilities through their collection of the System Benefit Charge. The Energy Efficiency Utility may also receive funds from grants, donations, a portion of the Energy Cost Adjustment Clause and a portion of excess funds in Commission accounts.

The Energy Efficiency Utility will: (1) administer the Solar Water Heating Program; (2) monitor long-range electric utility planning (IRP) processes; (3) evaluate and implement energy efficiency programs designed to defer or eliminate the need for new power plants and high voltage transmission lines; (4) establish outreach programs for schools

The Energy Efficiency Utility may: (1) intervene in Commission dockets; (2) participate in conferences; and (3) offer energy efficiency programs to selected target groups (low income, students, seniors) that is not cost effective.

Life of the Land is a party in the Hawai`i Public Utilities Commission Docket No. 05-0069 which is examining statewide energy efficiency programs.

The outcome of that docket will directly affect this docket by determining how much new generation is needed. This needed generation should be met by renewable energy only.

Renewable Energy

A simple definition of renewable energy is energy produced using a technology that relies on a resource that is being consumed at a harvest rate at or below its natural regeneration rate. This includes land based systems such as biomass, hydroelectric, photovoltaic and wind; and ocean-based power such as off-shore wind, wave energy, Sea Water Air Conditioning (SWAC), and Ocean Thermal Energy Conversion.

Hybrid Renewable/Fossil Energy Systems

Some systems are Hybrid Renewable/Fossil Energy Systems. These include waste-to-energy systems (where some or most of the BTUs of electricity created is derived from discarded products made of fossil fuel, such as plastics); and biofuels (which often need large amounts of fossil fuel to make them). In these hybrid systems, the BTUs of fossil fuel must be subtracted from the BTUs of the system output, to determine how much of the final product can be attributed to renewable inputs.

Batteries

Batteries hold a charge and allow it to be used when it is needed. Batteries include chemical batteries (cars, appliances), hydrogen (for fuel cells), and pumped storage hydroelectric. In each case, electricity is needed to charge the battery or to create the fuel (hydrogen), and then the battery returns that electricity to the customer when it is needed. To avoid double counting, only the amount of fuel used to charge the battery, less the amount lost in the battery process, should be counted. For example, if 100 MWh of wind moves water from a lower reservoir to an upper reservoir during off-peak periods, and then the water is released during on-peak periods resulting in 96 MWh of electricity, then the net renewable energy produced is 96 MWh, not 196 MWh. The 96 MWh should be credited to the wind energy system. The Second Law of Thermodynamics requires that the battery produce less electricity than the amount needed to charge it.

Photovoltaic Energy

Most commercial photovoltaic cells are manufactured from silicon, the same material from which sand is made. In general, environmentalists support photovoltaic energy. Photovoltaic systems are often located where the electricity is needed. They are largely unobtrusive. However, all energy projects have environmental impacts, and therefore projects must be evaluated on a case-by-case basis.

The sun showers the Earth with an amazingly large supply of energy. Each day more solar energy falls to the Earth than the total amount of energy the planet's 6.1 billion inhabitants would consume in 27 years. While it's neither possible nor necessary to use but a small portion of this energy, we've hardly begun to tap the potential of solar energy. Only in the last few decades — when growing energy demands, increasing environmental problems and declining fossil fuel resources made us look to alternative energy options — have we focused our attention on truly exploiting this tremendous resource.

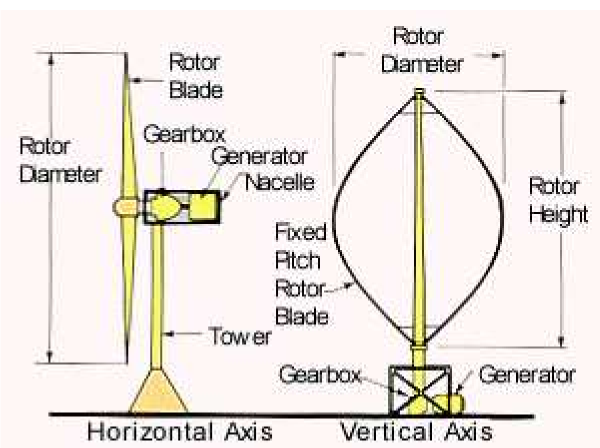
HEI's auditor, KPMG, found that existing rooftops in the Netherlands could provide 29% of the nations electrical needs

Every year, the sun pours 220 million TWh of solar energy onto the Earth's surface, 1,864 times the world's entire energy consumption. At current levels of solar photovoltaic (PV) efficiency, and allowing for cloudier conditions in the north, the entire current US electricity demand (3,836

TWh) could be met from 10,000 square miles of PV, an area equivalent to 9 percent of Arizona. America's rooftops could generate 964 TWh (24 percent of our sustainable electricity needs) if solar shingles were used to roof 540 square feet per dwelling. Many open-air car parks could also be covered, providing welcome shade for the vehicles. A sustainable energy plan for the US *by Guy Dauncey.* Earth Island Journal (Fall 2003) www.earthisland.org/eijournal/new_articles.cfm?articleID=711&journalID=69

Wind Energy

The sun heats different parts of the earth (water, land, forests, glaciers, pavement) and different times (day, night, summer, winter) at different rates. Warm air rises and colder air moves in. A wind energy system transforms the kinetic energy of the wind into mechanical power (raising water, grinding grain, pushing a sail) or electrical power. There are two basic designs of wind electric turbines: vertical-axis ("egg-beater") style, and the horizontal-axis (propeller-style) machines.



Wind Turbine Configurations

www.awea.org/faq/wwt_basics.html

Utility-scale wind power plants require minimum average wind speeds of 6 m/s (13 mph). The power available in the wind is proportional to the cube of its speed, which means that doubling the wind speed increases the available power by a factor of eight.

Turbine subsystems include: a tower (to support the rotor and drive train), a rotor (blades which convert the wind's energy into rotational shaft energy), a nacelle (an enclosure containing a drive train, a generator and usually including a gearbox), and electronic equipment (controls, electrical cables, ground support equipment, and interconnection equipment). The towers are mostly tubular and made of steel. The blades are made of fiberglass-reinforced polyester or wood-epoxy.

Wind turbines getting larger over time. The blade has increased in size from 30 feet (1981), 80 feet (1990), to 210 feet (2000). The rating increased from 0.025 MW (1981), 0.55 MW (1990), to 1.65 MW (2000). Land-based wind farms can have 270 foot towers and 270 foot rotors for a total height exceeding 440 feet.

Capacity factor is one element in measuring the productivity of a wind turbine or any other power production facility. It compares the plant's actual production over a given period of time with the amount of power the plant would have produced if it had run at full capacity for the same amount of time. Although modern utility-scale wind turbines typically operate 65% to 90% of the time, they often run at less than full capacity. Therefore, a capacity factor of 25% to 40%

is common, although they may achieve higher capacity factors during windy weeks or months. If a wind turbine's capacity factor is 33%, that doesn't mean that it is only running one-third of the time. For example, a wind turbine at a typical location in the Midwestern U.S. should run about 65-90% of the time. However, much of the time it will be generating at less than full capacity making its capacity factor lower.

Availability factor (or just "availability") is a measurement of the reliability of a wind turbine or other power plant. It refers to the percentage of time that a plant is ready to generate (that is, not out of service for maintenance or repairs). Modern wind turbines have an availability of more than 98%--higher than most other types of power plant. After more than two decades of constant engineering refinement, today's wind machines are highly reliable.

Land-Based Wind Systems

The US has enough wind resources to generate 3500 gigawatts (GW) of wind power, and has installed only 2.6 GW, revealing great potential for continued expansion in the use of wind power. ...The Pacific Northwest Laboratory (PNL) of the Department of Energy (DOE) has published estimates of the wind power resource available in the United States. PNNL estimates that 9% of the lower forty-eight states had "good" (class 4) or "excellent" (greater than class 4) wind resources. ... The total amount of US land with "excellent" wind characteristics, with moderate exclusions, is just over one percent of total land area. This would support approximately 3,500 gigawatts (GW) of wind capacity, with nearly eight megawatts (MW) of rated capacity per square kilometer. The rated (peak) wind capacity of 3,500 GW is about five times the 713 GW of 1999 installed conventional utility and non-utility generating capacity in the United States. The difference between the installed US capacity and the potential US capacity (3500 GW) reveals great potential for continued expansion in the use of wind power. www.thegreenpowergroup.org/wind.html

The developable wind power resource of the US, that is, what could be developed without incurring undue impacts to birds, noise, or visibility, is estimated to be between 2 to10 times the entire electricity consumption of the US. www.cfcae.org/Wind_Power/Wind_Facts.htm

A recent study by the World Wildlife Fund shows that the lower 48 states have 14,244 TWh of wind energy potential. The best land areas are North Dakota, Texas, Kansas, and South Dakota, which have a potential of 4,500 TWh, 17 percent more than America's current electricity demand. ... And modern turbine design and judicious siting nearly eliminate the well-publicized risk to birds. A sustainable energy plan for the US *by Guy Dauncey.* Earth Island Journal (Fall 2003) www.earthisland.org/eijournal/new_articles.cfm?articleID=711&journalID=69

Kahuku-Kawela (Turtle Bay), Oahu

The coast at Kahuku has wind speeds of 7.0 -7.5 m/s, while both the land and water areas along the coast at Kawela have wind speeds of 7.5 - 8.0 m/s. This exceeds the utility requirement of having minimum average wind speeds of 6 m/s (13 mph). (Oahu Wind Speed at 50 meters LOL-EXH-ENV-11). The other advantage of the sight is that giant windmills have already been located in that area.

Microwind Systems

Small wind energy systems can be mounted on commercial roofs. Newsweek (August 14, 2006) has a picture of a Tesco retailing store where the cash registers are powered by rooftop wind turbines (Tesco is the world's third largest retailer).

Indigenous People's wind energy

In October 2001 the 72-metre tall “Weather Dancer 1” wind turbine went on-line. The Peigan (Piikani) First Nation wind turbine is a joint venture between the Peigan Indian Utility Corporation and Edmonton, Canada-based EPCOR Power Development Corporation. The wind turbine generates nearly 3000 megawatt hours of carbon-dioxide-free power per year.

The Spirit Lake Sioux at Fort Totten and the Turtle Mountain Chippewa, both in North Dakota, the Inupiat Alaska Native community in Kotzebue, and the Sicangu people of the Rosebud, have found single wind towers or a cluster of 10 to be economical and largely trouble-free. In April 2003, the Rosebud Sioux Tribe activated a 0.75 MW wind turbine. up and running, the first payoff of an eight-year process that has given Indian country a model for wind power operations.

The project was the first DOE commercial tribal project, first tribally owned 750 kilowatt wind turbine, first Rural Utilities Service loan to a tribal wind power project, first tribal "green tag" power sales and first tribal 'green power' sale to the Department of Defense.

An additional 110 MWs of renewable wind energy are on the intertribal drawing boards, with 30MWs at Rosebud Sioux reservation, and an 80MW project to be distributed on eight reservations along the Missiouri River.

At Iolani Palace, Robert Gough, a commissioner of the Rosebud Sioux Tribe Utility Commission and secretary of Intertribal COUP (for Council on Utility Policy) noted that the Dakotas could supply half of the electricity needs of the country, and that the Northern Great Plains reservations have more than 200 gigawatts of clean wind energy potential.

Ocean Power

Earth Island Institute, founded in 1982 by veteran environmentalist David Brower, reported in their newsletter that "If less than 0.1 percent of the renewable energy within the oceans could be converted into electricity, it would satisfy the present world demand for energy five times over." See: www.earthisland.org/eijournal/new_articles.cfm?articleID=173&journalID=46

The Union of Concerned Scientists, Environmental Defense, and the Natural Resource Defense Council support off-shore renewable energy. They jointly estified before Congress: "Impacts of offshore renewable energy projects are generally limited to the installation and dismantling of structures that are attached to the seabed. Once in operation, renewable energy projects have minimal impacts and risks compared to oil and gas operations. ... Project-specific reviews and permitting processes should include state environmental and marine resource agencies and governors from affected states. ... Construction of an offshore renewable energy project should be fully subject to existing federal law ... Offshore renewable energy legislation should authorize term-limited leases, rather than easements or rights of way, for eligible offshore energy projects." See: www.ucsusa.org/clean_energy/clean_energy_policies/testimony-on-bill-to-amend-the-outer-continental-shelf-lands-act-h-793.html

Water-Based Wind Systems

All energy projects have environmental impacts. All energy projects have environmental footprints. Offshore wind projects are no different than other projects. As with any project, there are site specific conditions which must be examined. Siting a wind farm is not unlike buying real estate, there are three key issues, location, location, location. Off-shore wind systems can provide clean green power. One must carefully evaluate each potential site. The Sierra Club, Union of Concerned Scientists and Greenpeace all support the Cape Cod Wind project.

The Sierra Club is concerned about (1) Completion of wildlife impact studies with a finding of no significant threat; (2) Appropriate compensation for the usage of public waters; (3) Adoption of a rigorous monitoring program; and (4) Plan to adopt additional environmental protection measures should unanticipated impacts be revealed once the project is operating. More information on their position can be found at: www.sierraclubmass.org/pdf/SC_Cape_Wind_051906.pdf

The Union of Concerned Scientists supported the project contingent of the impacts being non-significant. They noted: "Offshore wind offers significant potential for clean, safe renewable energy in the region. If the scientific, technical, and economic conclusions of the draft impact statement are supported in final report, UCS believes the Cape Wind project should go forward." See: www.ucsusa.org/clean_energy/renewable_energy_basics/cape-wind-comments-on-draft-environmental-impact-statement.html

Greenpeace also supports the project. Their Executive Director wrote: "The people of Massachusetts know first hand the drastic effects of an oil spill – the 100,000-gallon spill in Buzzard's Bay in 2003 soiled coastlines, closed shellfish beds, and killed nesting shore birds and seals. And we are all feeling the pain of our country's reliance on foreign oil. Cape Wind will be an important step toward putting all that to an end, and that is why Greenpeace strongly supports offshore wind for Cape Cod. ... Let me say unequivocally that if Greenpeace had any concerns that this project would have long-term consequences for the marine ecosystem of Nantucket Sound, we would be the first to oppose it. We have opposed wind farms both on and offshore in the past, and we will continue to do so when projects are ill sited or improper in size and scope. Cape Wind, however, is the right project, in the right place, at the right time.

Unlike opponents of Cape Wind, Greenpeace has first hand experience with offshore wind. In the United Kingdom, where Greenpeace worked to develop the country’s first offshore wind farms, initial fears that the projects would lower property values, decrease tourism, or harm the environment were completely unfounded. In fact, because of broad public support, the UK now plans to build additional offshore wind farms that will supply 1 in 6 UK households with energy from this clean renewable resource. Europe is proof of the benefits created by offshore wind; now that opportunity is coming to Massachusetts.

The wind farm proposed for Nantucket Sound will provide 75 percent of the Cape and Island’s energy without emitting asthma-causing pollution, spilling oil in the water, or producing any of the greenhouse gasses that cause global warming. In addition to protecting the environment, the wind farm will benefit the Cape’s economy by creating jobs and attracting tourists.

The opponents of Cape Wind would have you believe that to protect the environment, we need to oppose the wind farm. In fact, the opposite is true. Global warming poses significant risks for the Cape and Islands. From more frequent and severe red tides to rising sea levels and more intense storms, a warming planet is a big problem for the same beachfront homeowners who oppose Cape Wind. The environment that is so important to the way of life on Cape Cod is in jeopardy, and projects like Cape Wind are the solution." See: John Passacantando, Executive Director, Greenpeace USA. www.greenpeace.org/usa/campaigns/global-warming-and-energy/copy-of-wind-power/cape-wind

Ocean Wave Energy

DBEDT’s Feasibility of Developing Wave Power as a Renewable Energy Resource for Hawaii: Waves Power (buoys) could generate all (100%) of the state’s electrical needs. As with any project, there are site specific conditions which must be examined. Siting a wave energy system is not unlike buying real estate, there are three key issues, location, location, location.

The Sierra Club supports the Pelamis wave system off Portugal. The Surfrider Foundation supports an Oregon Wave Energy System but has serious concerns about a Vermont Wave Energy System.

The Sierra Club noted: "Neptune's Power. Here's a form of energy that will last as long as the moon circles the earth. British company Ocean Power Delivery is building the world's first wave farm three miles off the coast of Portugal. Three wave-energy converters will be moored to the seafloor to capture the ocean's ebb and flow. With an expected capacity of 2.25 megawatts by the end of 2006, the farm could satisfy the average electrical demands of at least 1,500 Portuguese households." See: www.sierraclub.org/sierra/200603/lol.asp

"Ocean Power Technologies has applied for a permit to build an electricity-generating wave power system 2.5 miles off the coast of Reedsport, Oregon. At first, the wave power system is expected to generate 2 megawatts, with plans to increase that later to 50 megawatts. This represents the first permit request in the USA for a wave-powered electricity generating project of this magnitude. Unlike some other similar proposals in Europe that are slated to be built close to shore, this project is far enough away from the beach to allay concerns about impacts on surfing waves and shoreline views." See: www.surfrider.org/Coastal_news.aspx

"The Rhode Island Chapter is currently monitoring a proposal for an experimental offshore power generation project located near the outer breakwater of the Harbor of Refuge in Narragansett, Rhode Island. The project, proposed by an Australian firm named Energetech (pronounced 'energetic'), involves a unique system that generates electric power from wave energy. As proposed, the project involves a floating generator structure that will be moored just outside the Harbor of Refuge's central, offshore breakwater adjacent to the "East Gap" passage. Although the Chapter strongly supports alternative energy projects, it has voiced concern over the proposed location of this project. As many surfers from Rhode Island (and many other states) are aware, the area just inside the East Gap is the home to one of the region's best surfing breaks. Known colloquially as 'K-38 and K-39' this break is powered by large swells from the south-southeast that pass through the aperture of the East Gap and break on Narragansett's south-facing shoreline. The Rhode Island Chapter is concerned that the Energetech structure may impede the free flow of wave energy through the East Gap thereby damaging an important recreational resource. Also, because the power to be generated by the single proposed generating unit is fairly small, the Chapter is concerned that, if the project is successful, more units may be proposed in the future that could magnify this problem. ... The Rhode Island Department of Environmental Management has expressed concern about the project due to potential impacts on commercial and recreational marine fisheries resources and the Army Corps of Engineers has reportedly expressed concerns with respect to potential impacts to the breakwater itself."
www.surfrider.org/stateofthebeach/05-sr/state.asp?zone=NE&state=ri&cat=sa

Indigenous People's wave power projects.

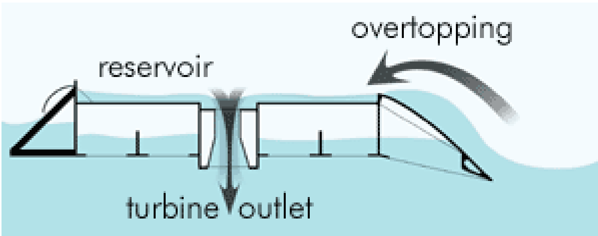
The Makah Indian Nation, on the tip of the Olympic Peninsula, is working with Mercer Island-based AquaEnergy to develop ocean wave energy projects in Makah Bay.

Wave Power Energy Systems

Three wave systems are suited for Hawai`i, have proponents who visit Hawai`i and have met with the utility, and the executive and legislative branches of government, and are ready for installation: Energetech (Oscillating Water Column), WaveDragon (Resevoir), and Ocean Power (Pelamis).

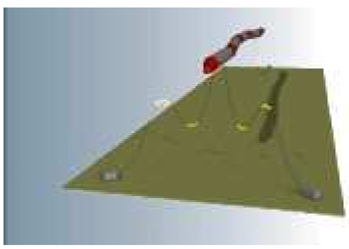
Blow-Hole (Oscillating Water Column) Wave Energy System consists of a compartment with water at the bottom and air on top. When a wave arrives, the water level rises and air is forced out of the blowhole. When the wave recedes, the air is sucked back into the blowhole. A two-way air turbine spins as the air goes in and out. Energetech ("energetic"), an Australian company, worked first on shore-based devices, and then off-shore devices that can be built in water depths up to 150 feet. Each unit is rated from 0.5 to 2.0 MW. (Pictures: see **www.energetech.com.au/)**

WaveDragon Wave Energy System is an overtopping device elevates ocean waves to a reservoir above sea level where water is let out through a number of turbines and in this way transformed into electricity, i.e. a three-step energy conversion: Overtopping (absorption) -> Storage (reservoir) -> power-take-off (low-head hydro turbines). "An ocean wave in deep water appears to be a massive moving object - a crest of water traveling across the sea surface. But to understand wave energy it is important to realize that this is not the case. An ocean wave is the movement of energy, but the water is not moving like that. Out in the ocean where waves move the water's surface up and down, the water is not moving towards the shore. So, an ocean wave does not represent a flow of water. Instead it represents a flow of motion or energy from its origin to its eventual break up. This break up may occur in the middle of the ocean or against the coast." (LOL-EXH-ENV-26. See also LOL-EXH-ENV-15, LOL-EXH-ENV-16, LOL-EXH-ENV-17)

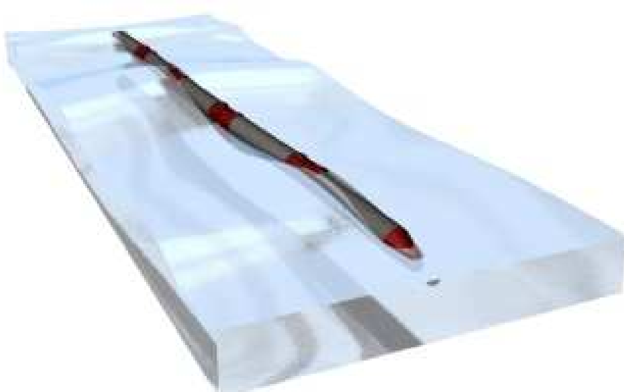


Pelamis Wave Energy System is a semi-submerged structure composed of cylindrical sections joined by hinged joints. The wave-induced motion of these joints is resisted by hydraulic rams, which pump high-pressure oil through hydraulic motors via smoothing accumulators. The hydraulic motors drive electrical generators to produce electricity. Power from all the joints is fed down a single umbilical cable to a junction on the sea bed. Several devices can be connected together and linked to shore through a single seabed cable. The freely floating hinged contour device, pointed perpendicularly from the coast. Each Pealmis is about 450 feet long, 15 feet in diameter, with 9 feet above water. The Pelamis can be located several miles off shore.

An artists impression of a wave farm (www.oceanpd.com/Pelamis/default.html)



A representation of a moored Pelamis (www.oceanpd.com/Pelamis/default.html)



www.wave-energy.net/Projects/ProjDescriptions/pelamis.htm

A fourth wave technology may be appropriate for Hawai`i.

<u>Archimedes Wave Swing (AWS)</u>

"The AWS wave energy converter consists of a large air-filled cylinder which is submerged beneath the waves. As a wave crest approaches, the water pressure on the top of the cylinder increases and the upper part or 'floater' compresses the air within the cylinder to balance the pressures. The reverse happens as the wave trough passes and the cylinder expands. The relative movement between the floater and the fixed lower part or 'basement' is converted directly to electricity by means of an innovative linear generator. First-generation machines will be rated at over 1MW and have a load factor in excess of 35%. The device is intrinsically simple with only one main moving part - the floater. Ancillary systems are limited to ballast water pumps, an integral damper to absorb excessive power and modules for air supply control and lubrication. ...'The AWS is submerged at least 6m below the sea surface and therefore avoids the high storm loadings to which other devices are subjected. This reduces mooring costs and the risk of damage." (www.waveswing.com/ www.**aws**ocean.com/)

Thermocline Energy

Thermocline energy is based on the temperature differences between surface water, which is heated by the sun, and deep water, which stays very cold. Thermal energy conversion plants use the surface water to make steam and then pass the steam through a turbine generator to make electricity. Ocean thermal makes use of temperature gradients in a thermal (Rankine) cycle process. It requires the use large plants because of the low thermal efficiency, and hence, a large capital investment is needed for such plants.

Based on 35°F temperature difference, the Carnot cycle (best possible) efficiency is low, i.e., approximately 6%. The actual efficiency is 2-3% since the water must be pumped and there are thermal losses. To compensate for its low thermal efficiency, OTEC has to move a lot of water. That means OTEC-generated electricity has a glut of work to do at the plant before any of it can be made available to the community power grid. In smaller plants, some 20 to 40 percent of the power goes to pump the water through intake pipes in and around an OTEC system.

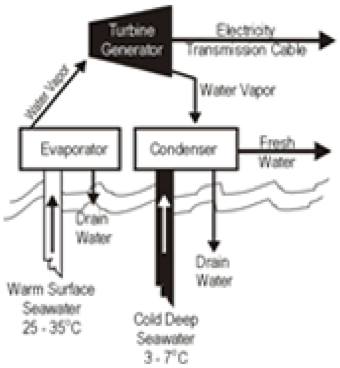
OTEC plants must be located where a difference of about 40° Fahrenheit (F) occurs year round. Ocean depths must be available fairly close to shore-based facilities for economic operation. Floating plant ships could provide more flexibility. In the US, ocean thermal energy conversion is limited to tropical regions, such as Hawaii, and to a portion of the Atlantic coast.

There are three potential types of OTEC power plants, open-cycle, closed-cycle and hybrid systems. Open-cycle OTEC systems, illustrated in Figure 2a, exploit the fact that water boils at temperatures below its normal boiling point when it is under lower than normal pressures. Open-cycle systems convert warm surface waters into steam in a partial vacuum, and then use this steam to drive a turbine connected to an electrical generator. Cold water piped up from deep below the ocean's surface condenses the steam. Unlike the initial ocean water, the condensed steam desalinated (free of salt) and may be used for drinking or irrigation.

Closed-cycle OTEC systems use warm surface waters passed through a heat exchanger to boil a working fluid, such as ammonia or a chlorofluorocarbon, which has a low boiling point. The vapour given off is passed through a turbine/generator producing electricity. Cold deep ocean water is then used to condense the working fluid and it is returned to the heat exchanger to repeat the cycle. Alcan Aluminum of Canada is working with a consortium of companies to build a pilot 500 kilowatt closed-cycle OTEC facility at Keahole Point, Hawaii. Hybrid OTEC systems produce both electricity, with a closed-cycle system, and fresh water, with an open-cycle system.

Unlike electrical generation from most other forms of renewable energy which varies with weather and time of day, such as solar and wind energy, OTEC power plants can produce electricity 24 hours per day, 365 days per year. This capability makes OTEC an attractive alternative to conventional base load power plants powered by fossil fuels or nuclear fission. Fresh water production is just one of the potential beneficial by-products of OTEC. The cold deep ocean water can be used for aqua-culture (fish farming) as it is pathogen free and nutrient rich, or air-conditioning and refrigeration in nearby buildings.

Cold water released at the ocean's surface will release trapped carbon dioxide, a greenhouse gas, but emissions are only about 4-7% of those from a fossil fuel power plant. Discharging the cold water at the oceans' surface could change local concentrations of nutrients and dissolved gases. However, these impacts could be minimized by discharging the cold water at depths of greater than 150 feet. Major implementation of OTEC might impact the effectiveness of ocean-based carbon sequestration.



www.eia.doe.gov/kids/energyfacts/sources/renewable/ocean.html

Environmental Groups

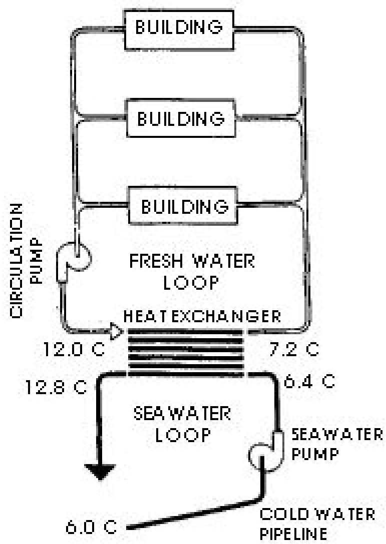
The Institute for Science in Society notes: "The deep ocean has also been put forward for the 'blue revolution', a sink for converting the energy of sun-warmed surface water to electricity (ocean thermal energy conversion or OTEC) and at the same time enriching the surface waters with nutrients from the depths to support the growth of phytoplankton that sustains both fish and marine mammals. Electricity can be generated from surface water warmed by the sun, while the cool water from the depths is used in the cooling cycles to drive turbines generating electricity.

Pumping deep ocean water to air condition cities, produce energy and fresh water, and to fertilize the productive surface waters appears to be a promising approach to mitigate global warming by reducing consumption of polluting oil and coal burning and to reduce the impact of overgrazing on marine food production.

Is the large scale pumping of deep ocean water sustainable? As indicated earlier, current evaluations suggest that even the most ambitious projects are unlikely to significantly impact ocean-related climate controls. The deep ocean is ventilated through open ocean convection and cascading down coastal waters. The relatively puny human efforts seem unlikely to impact the natural processes, at least for the immediate future. The other concern has been that of eutrification, a process by which an excess of plant nutrients, mainly nitrogen and phosphorous, causes the overgrowth of microbes and reduces oxygen needed to support fish life. This often occurs where sewage is discharged into harbours, fjords, coastal waters and lakes. The deep waters provide a range of needed nutrients for overgrazed waters, but are not rich enough in nitrogen and phosphorous to cause eutrification. See: The Blue Revolution: Air Condition and Energy from Deep Waters of Lakes and Oceans: *Deep lake and ocean water is being exploited for cooling buildings, provide drinking water and generate electricity. Prof. Joe Cummings.* www.i-sis.org.uk/DeepWaterEnergy.php

Sea Water Air Conditioning

Sea Water Air Conditioning (SWAC), and its counterparts Deep Lake Air Conditioning (DLAC), Deep Water Air Conditioning (DWAC), and Ocean Water Air Conditioning (OWAC) are means of using cold water (c39 degrees F), to cool buildings and commercial facilities. One good example is Cornell University's Lake Source Cooling Project.



Cornell University's Lake Source Cooling Project

A. Cornell University's Lake Source Cooling Project would bring in water from the deepest part of the lake which is at an almost constant 39 degrees, ship it 4 miles to a heat exchanger at Cornell University, and then return the water to Lake Cayuga's shallow, warm south end. The temperature of the piped lake water would rise 10 to 15 degrees at most as it absorbs the heat removed by the campus cooling system.

Environmental Groups re: Cornell University's Lake Source Cooling Project?

Cornell University's Lake Source Cooling Project was supported by the local Sierra Club, but opposed by the Cayuga Lake Defense Fund (CLDF) on several grounds including thermal pollution, chemical toxicity, pipe fouling, growth of undesirable algae and bacteria, and the movement of microorganisms from one water layer to another. Ralph Nader wrote a letter supporting the CLDF.

The Institute for Science in Society notes: "Many great cities around the world are located near ocean shores or deep lakes. The cities of Toronto, Stockholm and Honolulu, and the Cornell University campus are showing the world what can be done using cold deep water to power the cooling of large buildings, providing a large saving in energy and cutting down on carbon emissions and pollution from energy generating plants. ...

A territory-wide system for cool water air-conditioning is planned for Hong Kong, the proposed project included consideration of environmental impact. China undertook a study of the impact of proposed Chinese coastal municipal air conditioning using deep ocean water. The study dealt with the issue of warming deep water on the intensity of El Nino effects, and concluded that the impact of deep water-cooling to air-condition coastal cities was negligible at a coarse-grained level, but there could be local hotspots in temperature changes.

Deep-water air-conditioning could be considered for other major cities located near the ocean or near deep lakes, as it has the advantages of low cost, great savings on energy and on air-conditioning chemicals. From the systems described above, deep-water air-conditioning may be suitable for both large and midsize to small communities or for universities, hospitals or hotel resorts.

Even though London, England, is not located near a useful source of cool water for air-conditioning, the underground railway has begun to use cool ground water to cool the tunnels for the comfort of the passengers. Groundwater seepage has been a growing problem causing damage to tracks and switches, so the seepage is simply bled off and used to cool the tunnels.

The system promises to be both cost effective and cost-saving with regard to the maintenance of the railway.

Pumping deep ocean water to air condition cities, produce energy and fresh water, and to fertilize the productive surface waters appears to be a promising approach to mitigate global warming by reducing consumption of polluting oil and coal burning and to reduce the impact of overgrazing on marine food production.

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Exhibits

I am sponsoring the following exhibits:

LOL-EXH-ENV-1 EPRI Wave Energy Devices

LOL-EXH-ENV-2 EPRI Wave Environmental Issues

LOL-EXH-ENV-3 EPRI Wave Permitting Issues

LOL-EXH-ENV-4 EPRI Wave Economic Modeling

LOL-EXH-ENV-5 EPRI Hawaii Wave System

LOL-EXH-ENV-6 EPRI Hawaii Site Report

LOL-EXH-ENV-7 Hawaii Seasun 1992

LOL-EXH-ENV-8 KMACS FEA

LOL-EXH-ENV-9 Luis Vega OTEC

LOL-EXH-ENV-10 Oahu Transmission System

LOL-EXH-ENV-11 Oahu Wind Map

LOL-EXH-ENV-12 Offshore Ports Kona OTEC

LOL-EXH-ENV-13 Offshore Ports Power Point

LOL-EXH-ENV-14 Wave Power DBEDT 2002

LOL-EXH-ENV-15 WaveDragon 2004

LOL-EXH-ENV-16 WaveDragon video 1

LOL-EXH-ENV-17 WaveDragon video 2

LOL-EXH-ENV-18 OPD Brochure 1

LOL-EXH-ENV-19 OPD Brochure 2

LOL-EXH-ENV-20 ocees video

LOL-EXH-ENV-21 Ocean Energy Elefant

LOL-EXH-ENV-22 FERC AquaEnergy

LOL-EXH-ENV-23 Buoy Impact

LOL-EXH-GW-9 Carbon Trust

LOL-EXH-GW-10 PEW Synthesis

LOL-EXH-GW-11 Sea Rise NWHI

LOL-EXH-GW-12 NRC Surface Temp

LOL-EXH-GW-13 EDF Consensus

LOL-EXH-GW-14 Newsweek

EPRI Wave Assessment (2004)

E2I EPRI Assessment: Offshore Wave Energy Conversion Devices. Principal Investigator: Mirko Previsic. Contributors: Roger Bedard and George Hagerman (June 16, 2004)

"A Request for Information was sent to the seventeen (17) WEC device manufacturers listed in Table 1. Twelve (12) supplied information, three (3) declined to respond and two (2) wanted to respond but were unable to. The three that declined were Ocean Power Technology of the US (no reason given), WaveGen of the UK (does not have a near-shore/offshore system ready within the time frame of our project) and Hydam Technologies of the UK (device designed to desalinate water, not for electric power production). The two that were unable to respond were Float Inc. of the US (in the process of patent protection – E2I EPRI would not sign a nondisclosure agreement because the project is a public benefit project with full public disclosure) and Ocean Wave

Energy (the principal was out of the country and only returned after the deadline date for responding had passed). ...

Initial Screening of Companies. The information received in response to the RFI was screened based on three core criteria: 1. Was the device team responsive to data requests making an initial assessment possible? 2. Is the device likely to be ready for demonstration by 2006? 3. Is survivability addressed satisfactorily in the response? Of the ten companies that provided responsive information, eight (8) devices passed the initial screening criteria. ...

E2I EPRI believes that only one of the eight devices evaluated in this wave energy conversion device assessment study is acceptable for selection by the State Advisors for application in a pilot plant for testing without addressing further device specific issues; namely, the Ocean Power Delivery Pelamis. Three devices (Energetech, Wave Dragon and WaveSwing) could be used if a few remaining issues are addressed, which are mostly related to deployment and recovery. The remaining four devices (WaveBob, AquaBuOY, SeaDog and OreCon MRC 1000) are still in an R&D stage of development. They could be used if remaining R&D issues are addressed. ...

• Group 1 – Development near completion and full-scale long-term testing in the ocean underway

• Group 2 – Development near completion, only deployment, recovery and mooring issues are yet to be validated. Construction of full-scale devices is in some cases completed.

• Group 3 – Most critical R&D issues are resolved. Additional laboratory and sub-scale testing, theoretical simulations and systems integration work is needed prior to finalization of the full-scale design ...

Group 1 consists of Ocean Power Delivery. This device manufacturer has chosen a low risk technical approach by using a highly survivable design and well-proven technologies and has recently started in-ocean trials at full-scale. The device development program, which was carried out over the last couple of years, provides a significant amount of reassurance, that the device will operate as predicted. Risks were reduced or eliminated at the appropriate scale and consistent reality checks were done in each phase of the program to provide reassurance. It is however important to understand, that even at this stage, there are risks which still remain to addressed in the coming months.

Group 2 consists of Energetech, WaveDragon and Wave Swing. These devices are at a stage where critical R&D issues are resolved and the device manufacturers have funding for and are getting ready for in-ocean technology demonstrations at full scale within the next year. The group may still have some outstanding issues, most of which relate to the deployment & recovery and mooring design." (LOL-EXH-ENV-1, pages 3-10)

EPRI Offshore Wave Power in the US: Environmental Issues (2004)

"Like any electrical generating facility, a wave power plant will affect the environment in which it is installed and operates. There is no actual environmental effects data available at this time ... We conclude that, given proper care in site planning and early dialogue with local stakeholders, offshore wave power promises to be one of the most environmentally benign electrical generation technologies. We recommend that early demonstration and commercial offshore wave power plants include rigorous monitoring of the environmental effects of plants and similarly rigorous monitoring of a nearby undeveloped site in its natural state (before and after controlled impact studies." (LOL-EXH-ENV-2, pages 3,5)

Wave Power in the US: Permitting and Jurisdictional Issues (2004)

"There is not a national program promoting the development of wave energy projects in the US though wave energy is consistent with the National Energy Policy (NEP). The NEP seeks to promote cost effective, clean, domestic energy resources and strengthen national security and energy independence. At this point, there is very little political awareness of the role of wave power in increasing production of renewable energy except on the state level where demonstration projects are proposed" (LOL-EXH-ENV-3, page 4)

E2I/EPRI Offshore Wave Energy Plant Site Assessment - State of Hawaii (2004)

"Oahu. ... Very good energy resources along its northeast coast from Kahuku to Makapuu Points. ... Honolulu is the best port harbor and port infrastructure in the Islands to support device fabrication and assembly. ... A unique opportunity for a wave energy pilot facility exists off the northeast coast of Oahu, just west of the humpback whale marine sanctuary boundary. The unique opportunity is the existence of Makai Ocean Engineering's fully instrumented pier and offices." (LOL-EXH-ENV-6, page 58).