Technical Memorandum

Task 1

NELHA Distributed Energy Resources Strategy Update

Pacific International Center for High Technology Research

February 2013

PURPOSE

NELHA has retained the Pacific International Center for High Technology Research (PICHTR) to update its Distributed Energy Resources (DER) Strategy. The large amount of interest generated in the State of Hawaii by the Hawaii Clean Energy Initiative (HCEI) affords a great opportunity for NELHA to market itself as a hub for energy research and commercialization, while promoting commerce and partnerships in the Asia Pacific Region.

NELHA certainly has unique and valuable assets that can enable it to attract substantial activity and investment. This DER Strategy update will permit the organization to re-position itself among energy leaders in Hawaii, the US, and the Asia-Pacific. In order to do so management must first identify what makes NELHA uniquely positioned to succeed so that a consistent message and marketing strategy can emerge from the DER Strategy update.

The purpose of this technical memorandum is therefore to establish a baseline of current assets, potential constraints, interested potential projects and organizations, all to form the basis for the updated DER marketing strategy. This task was accomplished through PICHTR's review of current strategies and market plan for energy at NELHA, assessing current tenant mix for energy utilization and production characteristics, energy consumption patterns. A combination of interviews of NELHA management, on site visits, reviews of previously prepared documents and reports, and selected interviews with the US Department of Energy and selected national laboratories was completed in order to develop core strategies for the DER plan update. The remainder of this technical memorandum discusses findings, and describes the basic elements of the updated plan for NELHA's consideration. Upon approval the final DER Strategy update will be prepared and presented to NELHA management and Board of Directors for approval.

REVIEW OF BACKGROUND MATERIALS AND DOCUMENTS

PICHTR performed a review of key documents in the historical record in order to obtain information that would add to our understanding of current baseline conditions. There is no shortage of reports, presentations, analyses, plans and other related documents since NELHA's founding in 1974 as the OTEC research facility many years ago. For the purposes of this DER strategy update, the most relevant information are contained in the following:

- NELHA's current website, www.nelha.org
- NELHA Master Plan, Group 70, 2011
- NELHA 2012 Strategic Plan prepared by NELHA management
- 2003 DER Strategy prepared by New Energy Partners

NELHA Website

New visitors interested in NELHA are likely to be attracted to the website, and the website contains general information that might be useful to a visitor or to a potential customer interested in some background at the facility.

NELHA touts that it possesses attractive assets for energy solution ventures and partners, including access to pristine natural resources such as seawater distribution systems, abundant sunshine, and geothermal heat (when available). Office and laboratory facilities are available, and there is leasable open land for use for tenant research. Current tenant mix is featured, illustrating the good variety of enterprises that have chosen to locate at NELHA to take advantage of the unique setting.

However the website does not contain information specific to NELHA's vision for clean energy research and development or specific guidelines on ways to connect with NELHA for potential clean energy projects, a potential shortcoming that can be addressed once a plan to market the updated DER strategy is completed and approved.

NELHA Master Plan, Group 70, 2011

This master plan can be considered the foundation document that is guiding the current build out at NELHA. It combined in one document, separate plans that were prepared in past years for the research and HOST Park portions of the lands at NELHA's Keahole facility. Importantly, the plan acknowledges and sets in motion a framework for NELHA to play its potentially significant role in Hawaii's growth in renewable energy technologies and sustainable development.

The plan suggests the creation of several "zones" of clustered development activity including Zones for Applied Renewable Energy; Economic Driver; Applied Technology Labs & Containerization Research; Science and Technology Cultural Center; Ocean, Air, Energy and Biology Research; and Ocean Research Village.

The Applied Renewable Energy Zone would house enterprises that test and apply renewable energy technologies and concepts that are on the "cusp of commercialization." This facet of the master plan recognizes that the NELHA facility is situated as the ideal test bed for technology development, demonstration and commercialization. The types of projects cited as examples included a potential photovoltaic technology developer and a municipal solid waste conversion technology.

The plan suggests the development of four nodes of activities to encourage and facilitate the gathering of people and increase dialog, the exchange of ideas and social interaction. These nodes include an entrance/gateway for orientation and education; a commercial marketplace; a traditional gathering place of the ahupua'a and a research village center.

The plan also recognizes that successful execution will require new sources of revenue. Partnerships with other organizations are cited as a major strategic initiative to bring attractive projects to fruition. NELHA is encouraged to serve more like a master developer of the site, with expanded utility and institutional/anchor partners.

The direction cast by this Master Plan sets in motion key factors that can contribute to the DER Strategy update as well. Most importantly the plan, adopted by NELHA's Board, sets aside significant acreage intended for the renewable energy zone. The plan serves as the current basis for infrastructure improvements including an expanded roadway network and extension of cold seawater distribution system to previously unserved portions of former HOST parklands mainly in mauka areas of the site. The concept of an entrance/gateway for orientation and education fits with the location and use of the Gateway DER Center at NELHA's entrance very well.

Specifically as it relates to power storage and distribution, the Master Plan recognizes that smart grids and micro-grids with advanced metering be pursued for developing a distributed energy system at NELHA. These advanced distribution system improvements give NELHA the ability to monitor and control energy utilization in a more efficient and cost-effective manner, helping to address significant electricity costs at NELHA. Projects such as OTEC and other renewable energy sources supplying power for the seawater pumps and all operations at NELHA are suggested, as is consideration of back-up power generation. The use of cold water for air conditioning would significantly reduce consumption. The plan envisioned a day when smart energy investments would make NELHA self-sufficient for electricity, potable water, wastewater treatment, all with centralized communications and management via a command and control center

In short, the 2011 NELHA Master Plan recognizes key elements of a new strategy to re-position NELHA as the premier site for clean energy investments to take advantage of unique site attributes as part of an integrated test bed for energy technology and development. A copy of the figure that illustrates the conceptual master plan is reproduced in Appendix A for reference and convenience.

NELHA 2012 Strategic Plan

Following completion of the 2011 NELHA Master Plan, NELHA management prepared, and the Board subsequently adopted a Strategic Plan to guide development and investment activities at NELHA. Laid out with a broad set of key objectives and strategies, this Strategic Plan organized efforts around three broad themes:

- Maintain self-sufficiency
- Directed project focus and targeted marketing, and
- Guiding future development.

In order to maintain self-sufficiency, the plan calls for the broadening of revenue streams and diversifying funding sources, including 1) the option of providing updated and more efficient infrastructure to tenants, 2) improving efficient use of staff and facilities to increase and upgrade services, and 3) achieving a positive total economic impact to the community and state while ensuring that it remain sufficiently capitalized to invest in needed repair, replacement, and maintenance.

NELHA addresses project focus and targeted marketing objectives by facilitating and promoting new and unique uses of ocean and energy resources and co-located energy assets. Key strategies include attention to innovation through new uses of ocean and energy resources (by updating the 2003 Energy Plan) together with marketing initiatives for HOST Park.

The Strategic Plan addresses future development by planning infrastructure to support new and existing tenants with efficient pipeline distribution systems, shell buildings for tenant build out, and tenant greenways. The plan embraces facilitating and developing education and information programs for the community and visitor industry.

2003 DER Strategy by New Energy Partners

The NELHA Gateway DER Strategy, prepared and presented in 2003, considered options for distributed generation at HOST Park. At the time it was prepared, NELHA had already recognized that attracting clean energy investments presented significant opportunities for the facility. At or about that time the Gateway Distributed Energy Resources Center at NELHA was completed. For a number of years, NELHA organized and received input on targeted energy projects and investments from its Distributed Energy Resources Advisory Committee, or DERAC. Accordingly NELHA commissioned the 2003 DER Strategy that suggested several goals that included:

- Phase 1 goal: Lower cost power supply and reliability to NELHA and tenants (on-site utilization capacity of approximately 2-4 MW, addressing at the time significant electricity costs over 20¢/kwh)
- Phase 2 goal: Revenue generation to offset dependence on state funds (project development of approximately 20 MW of generation, meant to address significant electricity generation and distribution challenges faced by HELCO in West Hawaii)
- Long-term goals: Develop important linkages to the sustainable transportation sector and offer the potential site to other commercial energy tenants

The 2003 DER Strategy based its recommendations on NELHA's comparative advantages for distributed generation, which included:

- Energy intensive site (NELHA tenants demand 2-4 MW and NELHA itself demands 3 MW)
- Weak HELCO grid and high energy costs
- Location on HELCO grid ideal for sale of distributed power to meet West Hawaii power needs
- HELCO peak-off peak spread of at least 12¢/kWh
- High value for by-product integration from cheaper green electricity – steam, O_2, CO_2

- Strong community relationships and positive public perceptions
- Land availability with permitting advantages
- Climatic conditions

At the same time some comparative disadvantages were cited, including:

- A gap in capabilities at NELHA for permitting, contracting, and commercial negotiation skills to support DG
- High factor costs for all inputs (e.g. land preparation, lack of infrastructure, utilities)
- Somewhat remote location – which by extension suggests a lack of critical mass for industrial energy use compounded by low transportation density

The 2003 Strategy organized its analysis and recommendations around three major thrusts: 1) DER research, 2) DER incubation, and 3) DER commercialization. The strategy concluded that NELHA was ill suited for basic DER research, but had good potential for demonstration. In looking at incubation models, the strategy observed that incubation of energy companies at NELHA was not likely to be successful because incubator services are highly financial and human capital intensive, expertise not readily available at NELHA. Siting of commercial energy ventures at NELHA, however, appeared viable for a number of reasons. Native electricity load requirements at NELHA, anticipated load growth, reliability requirements for NELHA tenants and more broadly, West Hawaii, along with favorable climatic and business conditions existing at NELHA were attractive inducements for emerging energy enterprises.

The strategy emphasized that energy investments be pursued in order to enhance revenues that would accrue to NELHA, since attention to financial self-sufficiency was a focus of the state Executive Branch at the time. The strategy suggested that distributed generation could make a significant financial impact to NELHA, calling for commercial projects to be the “engine that pulls through research.” Both distributed generation and onsite utility-scale grid-tied generation up to 20 MW were recommended to reduce onsite electricity costs while enhancing revenue through leases negotiated with project developers. Partnerships with local energy companies should be pursued to build out the energy research cluster at NELHA for hydrogen, managing intermittent resources and managing grid side impacts.

Many of the suggestions raised by the 2003 DER Strategy remain relevant today. However, many aspects of the clean energy ecosystem on Hawaii Island and the state have changed making an update of the strategy even more urgent. Energy costs have more than doubled, and are now in excess of 40¢/kwh instead of 20¢/kwh. Hawaii has developed and is executing the Hawaii Clean Energy Initiative which is designed to transform the clean energy ecosystem throughout the state. NELHA, mainly through addressing seawater distribution rates and modifications to its leasing structure, is at or approaching a breakeven level for revenues compared to expenses. The demands on the electricity grid as a result of increased utilization of variable and intermittent renewable energy (primarily solar and wind energy) have raised new challenges for the utility around reliability and controls. The prospect for new projects has emerged at NELHA, including OTEC demonstration, solar thermal systems, advanced photovoltaic energy systems, biofuels, and storage and integration of distributed resources through grid

improvements. Many of these factors will be addressed in the update of the DER Strategy envisioned by the current effort.

INTERVIEWS WITH NELHA MANAGEMENT

In order to help establish the baseline for the current DER strategy update, and to understand more precisely NELHA's desired outcomes, PICHTR conducted an extensive interview with NELHA management with an accompanying site visit in November of 2012. This section describes the major findings from that discussion.

NELHA's broad goals for the DER Strategy update included identifying the kinds of projects that NELHA should pursue on the remaining 250 or so acres reserved for energy and applied technology development. There is much interest in identifying the sectors to focus on, the message to be conveyed, and specific suggestions on execution, including conferences and strategies to reach out to the targeted sectors.

NELHA is specifically interested in the prospects of a micro-grid at the facility. This interest is reinforced by the desire of NELHA's sponsor for this project, NREL, to investigate micro-grid potential at Keahole. NELHA observed that a possible hurdle to the development of a independent micro-grid is the state's concern over how a large customer micro-grid would set a damaging precedent for the military to come off the grid or wheel power since the loss of such customers would reduce the utility rate base and raise costs for remaining customers. A possible solution offered by PICHTR and discussed with NELHA was to pursue a micro-grid for applied research instead of energy security or independence from the grid.

NELHA is very interested in energy technology projects that can enable other energy projects. The source of funding for the DER Strategy update is from NREL, and those funds collectively are being managed with such an outcome in mind. For example, besides the DER strategy, the NREL funding is being allocated to support installation of a SCADA (Supervisory Control and Data Acquisition) capability for energy at NELHA. A portion of the funding is going toward the installation of a meteorological data collection station that is now operation with results posted online as of the end of 2012. All of these investments can help address existing energy challenges at the site and promote prospects for energy investments, including an envisioned PV test-bed site.

NELHA likes the current Master Plan and bases a lot of its development and market strategy on that plan. In the Master Plan, the lands at the upper portion of the Park are set aside for energy (about 80 acres). Overall NELHA manages about 870 acres on land and has access to a 3000-acre ocean research corridor.

NELHA has obtained federal Economic Development Agency (EDA) funding for improvements to its administration and research facilities and would like to start an incubator for energy and biotechnology businesses in the existing administration building once it is renovated. NELHA is considering options for management to run the incubator (HTDC is an option since they have experience with incubator facilities). They could provide services, like at the Manoa Innovation Center, and look for the kinds of

technology and companies to bring in. Construction is expected to start in 2013, and NELHA plans to open for business sometime in the summer of 2014.

In discussing the potential for storage technologies, PICHTR learned that Koyo currently has 850 kW solar, and a 200 kW SAFT battery that was installed in May 2012 as part of Recovery Act funding, facilitated through DBEDT. PICHTR visited Koyo and learned that they could use a bigger battery, and that Koyo may invest in more storage capacity as they already see the benefit to extend the capabilities of their PV system.

The current major direction of the Board is toward diversification of NELHA's revenue stream, adding additional revenue streams, and completing leasing of the rest of available lands at the site. NELHA currently operates with a budget based on annual revenue generation of almost $5 million. A major cost of operation, the seawater distribution system, is revenue neutral. This system costs about $2.5 million to operate. NELHA has adjusted is rate structure for seawater. From 2005-2010, rates for seawater went from 6 to 20 cents per thousand gallons in the lower elevations of the park and 80 cents per thousand gallons in higher elevations. Most of this increase in cost is due to increasing electricity prices. Big Island Abalone Co. remains the major user of cold seawater.

Revenue from leases is about $2 million per year, plus royalties derived from water bottling sales. The present revenue picture means that NELHA is largely self-sufficient and right on the edge of breaking even as an operation. At the same time, there remain challenges with maintaining major infrastructure, including landscaping, pipeline maintenance, etc.

NELHA has significant energy consumption, out of the $5 million budget, $2.2M goes to pay for electricity. The facility is on HELCO's schedule J, but management wonders whether a different schedule is better and is investigating potential.

PICHTR believed that the project would benefit from seeing a profile of energy of energy consumption and NELHA subsequently provided their energy billing information to PICHTR.

NELHA's current lease structure was described. A lease is generally structured with a base rent rate or 2% of gross receipts, whichever is higher. Companies or tenants can also receive an offset on the percentage (if lease is determined by percentage) for the first 10 years for permanent land improvements made by the tenant.

Energy projects on the horizon were described including the following:

- Alohi Sun has an approval in concept for a photovoltaic farm on the "Northern Territories" and is #1 in the reserve queue for HELCO's Tier 3 Feed-in-Tariff (FIT), but because of oversubscription for the FIT, is unlikely that they will get started in the near term.
- NELHA is still negotiating the OTEC project with OTI. The plant proposed at NELHA would be 1 MW gross, 700 kW net, and would demonstrate the technology and help the developers raise capital for the next phase. The cost of the project is $40 million. The project is funded by the Abell Foundation out of Baltimore. They are also developing a project in the Caribbean.
- Bioenergy Hawaii has proposed a waste-to-energy technology project. Founded by one of the Waste Management founders, they could use up to 30 acres, and plan to use algae ponds to

sequester CO2. There may be as much as 6 MW energy capacity from this project, but there is some question regarding power sales.

- Wave energy projects offer some potential. NELHA disclosed that they were advised that they do not have authority to lease the ocean for research projects, even though they have the permits and a master EIS was done for the ocean research corridor. This recent development could be a major hurdle to NELHA's efforts and is inconsistent with previous understanding that led to the installation of many of NELHA's seawater pipelines. DLNR currently would have to grant NELHA authority to lease the ocean area for RE projects, mainly on an individual project proposal basis.
- Compressed Air Energy Storage has been discussed in combination with Upolo Wind.
- PV test bed development remains of interest. NELHA already has received interest from at least 2 companies for the 3 total test bed sites. One is a company called SolFocus.
- There was strong interest in containerized technologies, e.g, Sopogy bringing in containerized generators/engines.

We discussed supportive and constraining policies affecting NELHA's development activity. Procurement of electricity must follow Hawaii Revised Statutes, Chapter 103D regarding competitive bidding. State law may severely impede the ability of the NELHA Board to lease lands for onsite energy development that result in promoting advanced technology while providing superior power sales to NELHA and can stop good renewable energy projects from locating at NELHA.

Ideally, the state would let project developers sell NELHA power at a competitive rate with long-term predictability. Wheeling for NELHA would allow tenants to sell electricity to each other, which would promote renewable energy development and reduce costs. NELHA is unique in that it has obtained legislative approval to wheel electricity, but impediments described prevent management from advancing wheeling to NELHA's advantage. No tax credits are available for new technology with the sunset of Act 221.

The only tax credits that may apply to NELHA are through the Enterprise Zone laws. Enterprise zone eligibility for businesses located at NELHA could help facilitate projects, but at present only wind appears included. EZ designation should support any renewable energy technology and that would help NELHA. NELHA could expand on its current contribution of $4.5 million in tax revenue to the state. Advanced technology tax credits could really help the OTEC project and other emerging clean energy technology projects.

DBEDT's philosophy is "create an environment so that companies can do it on their own," which NELHA supports as well.

Importantly, NELHA has several infrastructure improvement projects underway. At present NELHA has 2 contracts out: 1) R. M. Towill is designing pipelines to extend cold water to the upper parcels, and 2) Parsons Brinkerhoff has been engaged to design roads to the upper parcels. These improvements are viewed as major economic drivers including for commercial use. For example 80 acres of mauka lands could be developed at a "Research Inn" to house short-term researchers. NELHA plans to develop an RFP for the whole "economic driver" area because it has also received legislative approval for the development of ancillary commercial uses including short-term housing at the entrance parcel to the

facility. The planned roadway and water improvements will require $70 million in funding, and the Governor's budget has $10 million in CIP for road extensions, and $2.3 million to build a warm water connector pipe to connect 2 existing separated systems and provide redundancy. Fresh water wells would be next in terms of priority, since fresh water commitments from the County BWS is a severe impediment to further expansion.

NELHA is allowed 400K gal/day under its current water allocation from the BWS, but uses up to 650K gal/day at times. The County owns the water distribution system on the property. Most of the fresh water is used by one tenant, Cyanotech. If NELHA were to develop its own wells to meet its needs, two wells would serve the future planned build out, each of which costs $6M and would provide 2.4M gal/day apiece.

Considerable time was spent describing plans for the research campus, as there is a major initiative underway. The research campus is fully developed but has considerable vacancies while new improvements (see EDA discussion above) are planned. Research projects have a significant advantage in siting at NELHA, as researchers can do experiments here without permits, a major NELHA comparative advantage. The lab space is on the water, with deep sea water currently piped in, so it is a very unique space. The kinds of experiments going on now with the water are biological and chemical, and not related to energy.

NELHA is very interested in the profile of the ideal tenant. For example the OTEC project is a good example where needed corrosion testing can also be accommodated in existing office and lab space. Lockheed Martin appears also interested in advancing OTEC, so the natural advantages at NELHA are apparent.

Affiliation with universities and academia in general is also of high interest. Currently the University of Hawaii has two current projects: ISLA (measures infrasound), and HNEI (Package system using cold seawater to produce ice for the military). Other universities have been active on the science side at NELHA, including Scripps, Woods Hole, an international consortium of Old Dominion and the Georgia Institute of Technology.

Regarding the Gateway Energy Center, the Friends of NELHA is doing outreach from that location. The Board is very interested in doing more outreach in conjunction with the Gateway Center.

NELHA has a large degree of interest in greater collaboration with the energy programs within the Department of Energy (DOE) National Laboratory System. The types of questions for which NELHA seeks advice include marketing an outdoor demonstration facility, which programs and which labs should be targeted, the types of messages to be presented to the labs. PICHTR suggested that PICHTR could possibly bring people from DOE and the labs to NELHA for a workshop as a showcase that includes site tours. Because NELHA is master-permitted, the site may be attractive to labs which have limited space and which must also obtain NEPA approval for projects. Offsetting these advantages are the evident disadvantages such as the local high cost of construction and O & M labor.

PICHTR learned that NELHA plans to hire a part time person based in Washington, DC, to gain access to DOE, DOD and other federal agencies. This DER Strategy update could provide additional information to assist in targeting these marketing efforts.

For future consideration PICHTR suggested that an integrated two-pronged strategy would address 1) academia and research, including national labs, and 2) industry, in parallel with marketing and development of NELHA's incubator. Our belief is based on the fact that no other US facility for energy development and management, including those operated by DOE and the national labs, appears to have - in one location - both research and commercialization facilities such as those at NELHA. This could be one of several significant comparative advantages built into any DER development strategy.

INTERVIEWS WITH KEY POTENTIAL COLLABORATORS

PICHTR interviewed several key outside stakeholders in order to obtain an up-to-date assessment of project development prospects from potential funding partners especially in the US Department of Energy and key national laboratories. A number of managers, scientists, and engineers were interviewed by PICHTR. The following brief synopsis of these organizations and their interest and capabilities is provided. These organizations provided substantive input to this effort. These included:

1. Argonne National Laboratory (ANL) – as the DOE energy storage hub. ANL is interested in potentially utilizing NELHA's facilities as a test bed for storage.
2. Lawrence Berkeley National Laboratory (LBNL) – in their role as grid integrators, energy efficiency experts, and as the location of the Demand Response Research Center. LBNL has a long history in energy efficiency and demand response RDD&D and is funded by both DOE and the California Energy Commission for the development of these technologies
3. National Renewable Energy Laboratory (NREL) – as lead lab for the DOE Office of Energy Efficiency and Renewable Energy and as the state's major partner in the Hawaii Clean Energy Initiative. NREL has broad capabilities and an on-going interest in Hawaii. They are the only laboratory now funded for HCEI work.
4. Pacific Northwest National Laboratory (PNNL) – as lead lab for the DOE Office of Electricity Delivery and Energy Reliability. PNNL is the lead for micro-grid and smart grid work for DOE. They have a reputation for effectively developing new programs with other collaborators.
5. Sandia National Laboratory (SNL) – leading lab in storage, cyber-security, and grid integration as well as a previous participant in the Hawaii Clean Energy Initiative. DoD, DOE, and the California Energy Commission have funded SNL for energy storage and micro-grid demonstrations.
6. Office of Fossil Energy (DOE-FE) – potential for stationary source fuel cells, but very constrained budgets.
7. Office of Energy Efficiency and Renewable Energy (DOE-EE) – lead agency for efficiency and renewable energy technology. Currently has a staff person in Hawaii as part of an ongoing HCEI agreement.
8. Office of Electricity Delivery and Energy Reliability (DOE-OE) – grid integration of renewable resources. DOE-OE has continued to support a number of projects in Hawaii related to smart grid and micro-grid systems. While not publicly advertised, they are planning a micro-grid solicitation during this fiscal year (FY13).

Comments on Discussions

Context of Big Island Situation

While a number of the individuals interviewed were quite knowledgeable about the State of Hawaii energy situation and of NELHA in particular, other interviewees had no substantive knowledge of NELHA or Hawaii. Thus, PICHTR reviewed several points that were germane to the issues at hand:

1. NELHA's history was reviewed as well as its current status. This discussion included a review of the OTEC facility (historical and present), the Gateway Center, and the micro-algae R&D and related commercial activities. Commentary was also provided on other business activities at NELHA, including the deep drinking water bottling operations, aquaculture activities, and bio-pharmaceutical efforts.
2. There was an emphasis placed on opportunities at NELHA because of its position as a landowner and leaser of facilities.
3. There was also an emphasis placed on the availability of energy resources, including solar, wind, and ocean water both deep cold and warm surface sources. Demonstration activities were discussed in which the Gateway Center and the current solar thermal project were used as examples of activities and opportunities.

The current problems facing the Big Island grid were also discussed as a basis for pursuing unique opportunities. Specifically, high electricity costs and the fragility of the island grid can serve as opportunities for early deployment of new energy systems. This idea is consistent with the desire of state government to promote Hawaii as a natural test bed for development and early adoption and deployment of clean tech.

Current Funding Realities and Some Bad News

Federal managers all expressed concerns regarding budget uncertainty. The bad news is that the "fiscal cliff" is pre-occupying most of the people that were interviewed. The stalemate in Congress and the greater probability of the "sequestration" cuts actually taking place, makes these managers even less enthusiastic about this year's budget opportunities. Thus, very few see opportunities in the near term due to the uncertainties associated with the FY13 budget. Until that budget becomes clearer, it will also be uncertain as to what new projects may be proposed beyond FY13. Specific commentary focused on cuts in the budget that could be on the order of 40% of the proposed FY13 budget.

In addition, all of those interviewed are aware of the recent passing of Senator Inouye. With new Congressional members in both the House and Senate, many felt doubtful that Hawaii will have much political leverage in the near term.

Lastly, those interviewed that were knowledgeable of NELHA's past energy development efforts over the past decade expressed concerns about NELHA's institutional commitment and project execution. There was concern regarding the ability of NELHA to be a good partner and to be able to carry out any collaborative projects. Despite concerns expressed, all of the laboratories understand that new management at NELHA presents opportunities for positive, funded collaborations, and that the current effort embarked upon by NELHA was an important one.

The Good News and Potential Project Collaborations

Despite the "fiscal cliff" – or perhaps because of it – there is interest in a number of the national laboratories in working with NELHA. In particular, a number of the interviewees offered their ideas on how the attributes of NELHA could be utilized in a collaborative manner. Success is dependent on parties acknowledging and obtaining the best interests of all parties, but these opportunities must be understood and developed actively. Little or nothing will come if a passive posture is taken. Thus, as a plan of action is developed, it must include funding and mechanisms for pursuing these partnerships and collaborations.

Specifically, having land and energy resources is seen as a significant attribute and is highly attractive for testing and demonstration of energy systems that could not be properly tested or demonstrated at national lab facilities or in cases where a different climate regime is required for further testing and demonstration.

Additionally, the national laboratory interviewees saw the Big Island grid issues as an area of opportunity for early deployment of energy technologies that can ameliorate grid problems on the island. Thus, a number of possible initiatives were discussed. These included the following:

1. Working with Kona International Airport to utilize deep cold water for air conditioning. SNL and LBNL both possess substantive capabilities that could support NELHA. PNNL, Sandia, and NREL all expressed interest in developing micro-grid projects. Each of these laboratories has capabilities (both complimentary to one another and in competition with one another) to provide substantive support to any projects in this area.
2. In addition to general laboratory interest, PICHTR learned that DOE-OE plans to release a micro-grid solicitation during FY13. (This conversation was held prior to later news that there is a growing expectation that Congress and the Administration may allow the "sequestration" of funds to occur.) Thus, for the same laboratories described above, some meetings and planning exercises would be desirable in the near term.
3. Working with the new West Hawaii Civic Center to develop collaborative energy efficiency, demand response, and small-scale renewable energy projects that are sustainable in practice. LBNL, as a leader in demand response R&D, brought this to PICHTR's attention and could be substantively involved in this activity.
4. Working with HELCO to address grid issues related to power quality, power delivery, and incorporation of variable renewable energy systems into the grid. All laboratories have skills in working with industry and electricity utilities. This area, with agreement and support from HELCO, could provide opportunities for a number of projects, and NELHA's location in West Hawaii, where power deliverability and solar saturation remain problems for HELCO, appear fruitful.
5. While storage is of interest to a number of laboratories, ANL is particularly interested in utilizing NELHA's capabilities. The Energy Storage Hub leadership is pursuing two strategies simultaneously. One is for new breakthrough technologies. The second, which could utilize NELHA's resources, is to initiate demonstrations as soon as possible. In addition to ANL, it is likely that LBNL and Sandia would be substantively involved in these activities.

The members of the national laboratory system are aggressive in developing new programs. As stated previously, they see collaborations with NELHA as creating advantages for themselves in developing new funded projects. NELHA cannot take a passive role in this endeavor, assuming that projects and partners will simply show up at NELHA. NELHA must be actively involved in developing plans,

investing in program development and marketing activities, and in assessing the success probabilities of opportunities. Thus, NELHA will need to commit resources, both personnel and funding, to develop plans and work with interested national laboratories to make better use of existing facilities, such as the Gateway Center, for testing and demonstrating demand response, photovoltaic and solar thermal systems, bio-fuels derived from micro-algae, and energy efficiency projects

Next Steps

Despite the concerns related to future federal funding, the commentary from potential DOE and lab partners was surprisingly positive. Based on these discussions, some following steps are proposed. These are proposed recognizing that FY13 funding will be difficult to obtain, and that developing collaborations requires time and effort.

These next steps are also proposed given PICHTR's understanding that NELHA has somewhat limited financial resources for mounting a sales and marketing effort. While a number of activities can be started, NELHA must be opportunistic and at times selective, and must develop internal capability for proactive project development. Some of the laboratories were motivated to get started shortly. NREL, Sandia and the DOE-OE expected solicitation all are near term opportunities.

Some appropriate next steps might include:

1. Some laboratories were more enthusiastic than others and had specific ideas for possible collaborations. These should be pursued in the early part of calendar 2013. A number of the laboratory personnel suggested working with Kona International Airport, the West Hawaii Civic Center, and HELCO. Thus, rough outlines of possible projects should be developed and followed up by contacting these organizations. Since NELHA has limited resources to do this, some concrete suggestions can be developed as part of this DER update – based on PICHTR's on-going discussions with NELHA management - on the best methods and mechanisms for developing appropriate content and approaches. Together with a consistently managed, well-defined marketing strategy, this initiative will be a key part of PICHTR's final deliverable as part of this project.
2. It will be important to track federal budgets and the new appointees coming into the Department of Energy and Department of Defense. That will provide a sense of what opportunities there may be to pursue. PICHTR can make specific suggestions to NELHA as part of this update.
3. There should be some follow up by NELHA with both the DOE program offices and the national laboratories that were contacted as part of this effort. Based on these initial follow-up discussions, PICHTR will develop a plan in consultation with NELHA management that will incorporate all findings in a manner that will best suit future program development efforts by NELHA. This plan will be specific in terms of which laboratories are most appropriate for developing collaborative relationships. Based on previous experience, it is likely that NELHA will need to work with professionals familiar with the national laboratory system and federal agency processes and strategies in order to catalyze funded project activities.

While the individuals contacted were surprisingly open in the discussions, DOE Headquarters managers were much less so. Additionally, one needs to balance the expressed enthusiasm with the funding realities faced by all of these agencies. While there are certainly other groups that might be interested in energy project collaborations that were not been contacted as part of this effort, the DER Strategy update will provide NELHA with an ability to have a consistent message, and a sound outreach and marketing strategy for other potential stakeholders.

CONSIDERATIONS FOR A NELHA MICRO-GRID

In PICHTR's discussions with NELHA management, a strong desire to consider the development of a NELHA micro-grid was expressed. Part of this stems from suggestions offered by the project funding agency, NREL, based on their view of possible opportunities at NELHA that also influenced their support for the projects being sponsored under the NREL agreement. Further any micro-grid development would help to integrate and organize DER investments that are sought at the facility.

PICHTR initially commissioned some research on the state of micro-grids being pursued and developed by federal agencies such as the Departments of Energy and Defense. This information helps to better understand why micro-grids are being pursued so that comparisons can be made with the energy goals and strategies being considered by NELHA. Our research produced results that are summarized in Appendix B, "Selected Micro-grid Examples in the US."

The tabular information reveals that many of the relevant examples are being developed by DOD installations where maintenance of mission critical functions without electricity disruption and energy security are primary drivers. In other cases public funds through the DOE and state government sponsor micro-grids because of the potential to address power quality and grid integration challenges as increasing amounts of renewable energy and energy efficiency create new demands on conventional electricity delivery methods. While energy security is also of concern to NELHA, PICHTR believes, for reasons cited in this technical memorandum, that a major driver for NELHA would be as a test-bed to address electricity delivery and grid integration problems both within the site boundaries and to provide value to a stressed utility operating in an isolated island environment.

The examples also illustrate that even major sponsors like DOE and DOD encourage and rely on multi-agency public private partnerships to develop and complete micro-grid projects. The SPIDERS projects may appear to be an exception to this rule, but that may be because of the high-security driven demands associated with those DOD projects. Thus any micro-grid project at NELHA is likely to succeed because of the interest and commitment of multiple parties through public-private partnerships.

PICHTR also found several interesting and relevant analyses of micro-grids in the literature. The Lincoln Laboratory of the Massachusetts of Technology (MIT) conducted an analysis for the DOD, and the Oak Ridge National Laboratory (ORNL) reported on micro-grid examples for DOE-OE. Both institutions reflected the current primary emphasis on achieving energy security for critical domestic operations in the face of increasing vulnerability of the electric grid, uncertainty about the cost of oil-based resources, and increasing amounts of distributed renewable energy resources (primarily solar) within domestic installations which is mandated by executive directive.

The DOE's focus has been to invest in research and application of advanced technologies for the 21st Century grid. These technologies include grid visualization, smart metering, energy storage, visualization and operations software, data acquisition and management, advanced transmission

technologies, and renewable energy integration with our without vehicular battery storage. The smart grid project on Maui is an example of a federal-state-utility-private sector partnership that advances some of those technologies in a constrained utility environment with high penetration of variable renewable energy technologies both of utility-scale and customer-sited. PICHTR believes that a similar approach would be useful on Hawaii Island and NELHA may eventually position itself, starting with this updated DER strategy, to be the catalyst to attract such a micro-grid project example. Initially for the purposes of the current assessment, NELHA may find itself more suited to promote the prospects of a future micro-grid by initially attracting those federal, state, academic, and private sector interests whose project activity in research and demonstration can build toward an eventual micro-grid at Keahole. This DER strategy will build upon this theme.

MAJOR ELEMENTS OF THE DER STRATEGY

PICHTR will take the findings summarized in this report, complete its reviews, analyses and assessment in the coming weeks, and compile the updated NELHA DER Strategy for submittal and presentation to the Board of Directors for discussion.

The strategy will be prepared and presented in a slide deck so that it can be used, easily updated, and tailored by NELHA to suite the audience. PICHTR has prepared an outline that is contained in Appendix C. NELHA can expect that the DER strategy can include the following major elements:

- Background—Setting the Stage
- Establishing the Baseline
- Comparative Advantages of the Site
- Opportunities and Potential Comparative Advantages
- Constraints
- Value Proposition for Clean Tech/Distributed Energy Resources Strategy
    - Research and Development: Government/Research/Academia
    - Industry and Commercialization
- Execution of DER Strategy
    - Targeted Marketing Strategy
    - Communicating Value

On January 29, 2012, PICHTR presented our approach along with findings to date to the NELHA Board at its regularly scheduled meeting. A copy of the presentation is included with this technical memorandum in Appendix D.

SUMMARY

NELHA holds a unique place in the Pacific for energy and distributed energy applied research, demonstration, test and evaluation, and deployment of clean energy technologies. NELHA possesses an extraordinary combination of physical infrastructure and access to natural energy resources. At its strategic location on the Kona coast of Hawaii Island, these assets can be coupled effectively with the challenging demands faced by Hawaii Island's electrical system to integrate substantial amounts of renewable energy, efficiency resources, and other non-fossil fuel distributed energy resources on a relatively small, isolated island electrical grid. This strategic location makes NELHA the ideal clean

energy R and D through deployment test bed on Hawaii Island, and is consistent with broader state efforts to position Hawaii as such test beds. With timely implementation of an updated DER Strategy NELHA can take advantage of the growing interest among academia, utilities, federal and state government agencies, and industry to address the types of deployment challenges that are already being faced on Hawaii Island.

References

1. Master Plan for Natural Energy Laboratory for Hawaii, prepared by Group 70 and adopted by NELHA Board of Directors, 2011.

2. NELHA Gateway DER Strategy, presentation to NELHA Board of Directors, New Energy Partners, Keahole, Hawaii, March 25, 2003.

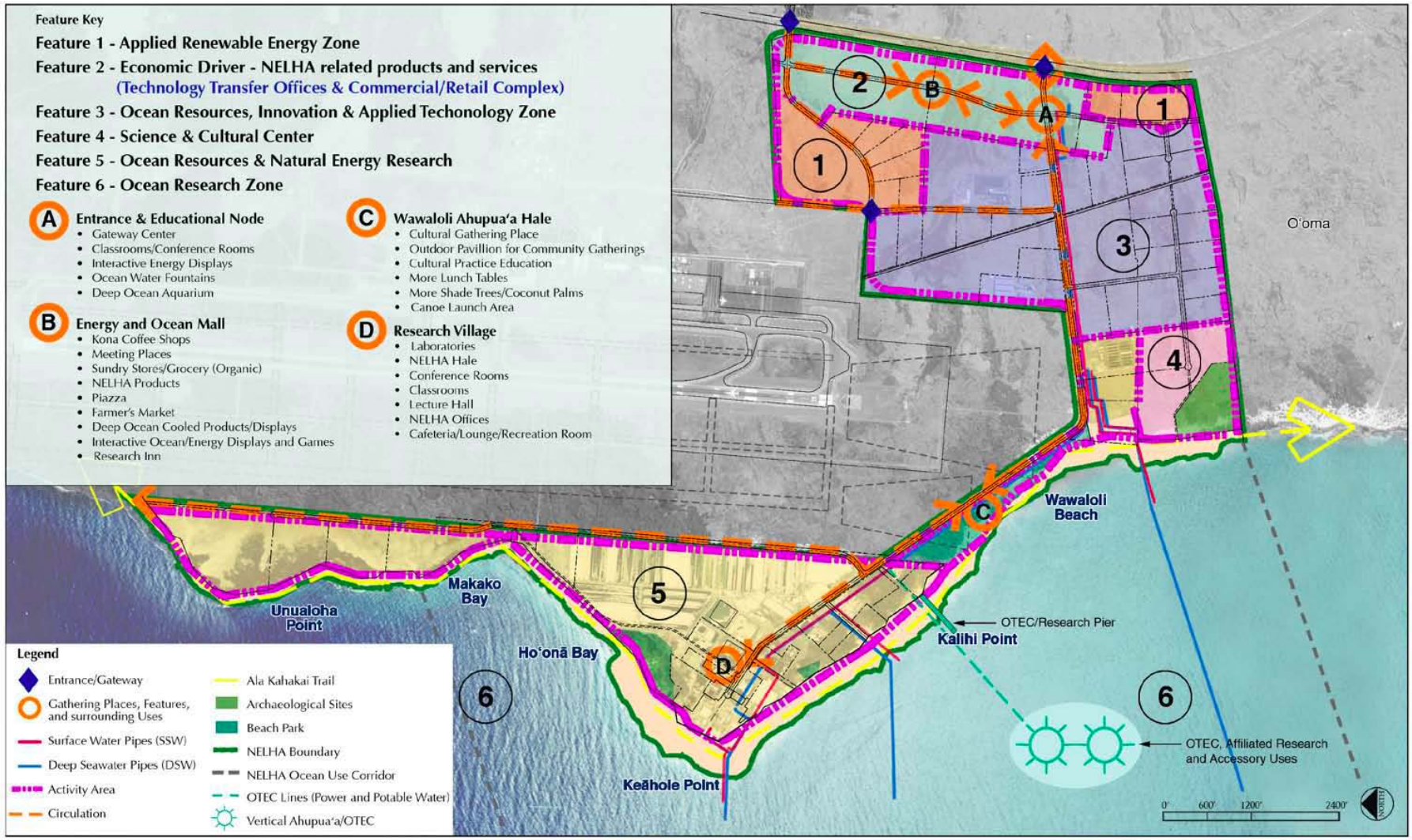
3. Van Broeckhoven, S. B. et al, “Microgrid Study: Energy Security for DoD Installations,” Technical Report 1164, Lincoln Laboratory, Massachusetts Institute of Technology, Lexington, MA, 18 June 2012.

4. Ozpineci, Biurak, “Micro-grid Systems,” Sustainability Summit Electricity Session, Oak Ridge National Laboratory, March 31, 2011.

Appendices

A. Conceptual Master Plan
B. Selected Micro-grid Examples in the U.S.
C. NELHA DER Strategy Update Outline
D. January 29, 2013 PICHTR Presentation to NELHA Board

Appendix A Conceptual Master Plan



Appendix B Selected Micro-grid Examples in the U.S.

	LOCATION	PURPOSE	STATUS	SIZE	TECH CHOICE	ENERGY INTENSITY	FACILITY ENERGY USAGE	LESSONS LEARNED	PARTNER
Hickam AFB (SPIDERS)	Honolulu,	Risk mitigation in water treatment plant	Construction	196 kW	PV+ Wind	0.58 MBTU/KSF (w/o housing)	0.31 MMBTU		
Fort Carson (SPIDERS)	El Paso County, CO	Protect task critical assets	Planning	3-4 MW	Solar + diesel + biomass	125 KBTU/SF (w/o housing)			
Camp H.M. Smith (SPIDERS)	Honolulu,	Testing micro-grid application for entire military base	Planning	5 MW	Solar + diesel	0.47 MMBTU/KSF			
Santa Rita Jail	Dublin,	Demonstrate commercial applications of CERTS micro-grid reduce peak load utility distribution feeder, increase grid efficiency	Operational	4.6 MW SOURCE	PV + fuel cell + diesel		3.0 MW (peak load)	CERTS: Protocol is powerful tool for simplifying integration of DG sources, battery trickle charge control less accurate than current-source mode; Utilities more comfortable with static disconnect switches if used with conventional equipment; Charge balance of battery cells, strings, enclosures should be carefully managed	DOE (funding) CA Energy Commission (funding) CA PUC (funding) CERTS (micro-grid concept) Berkeley Lab Chevron

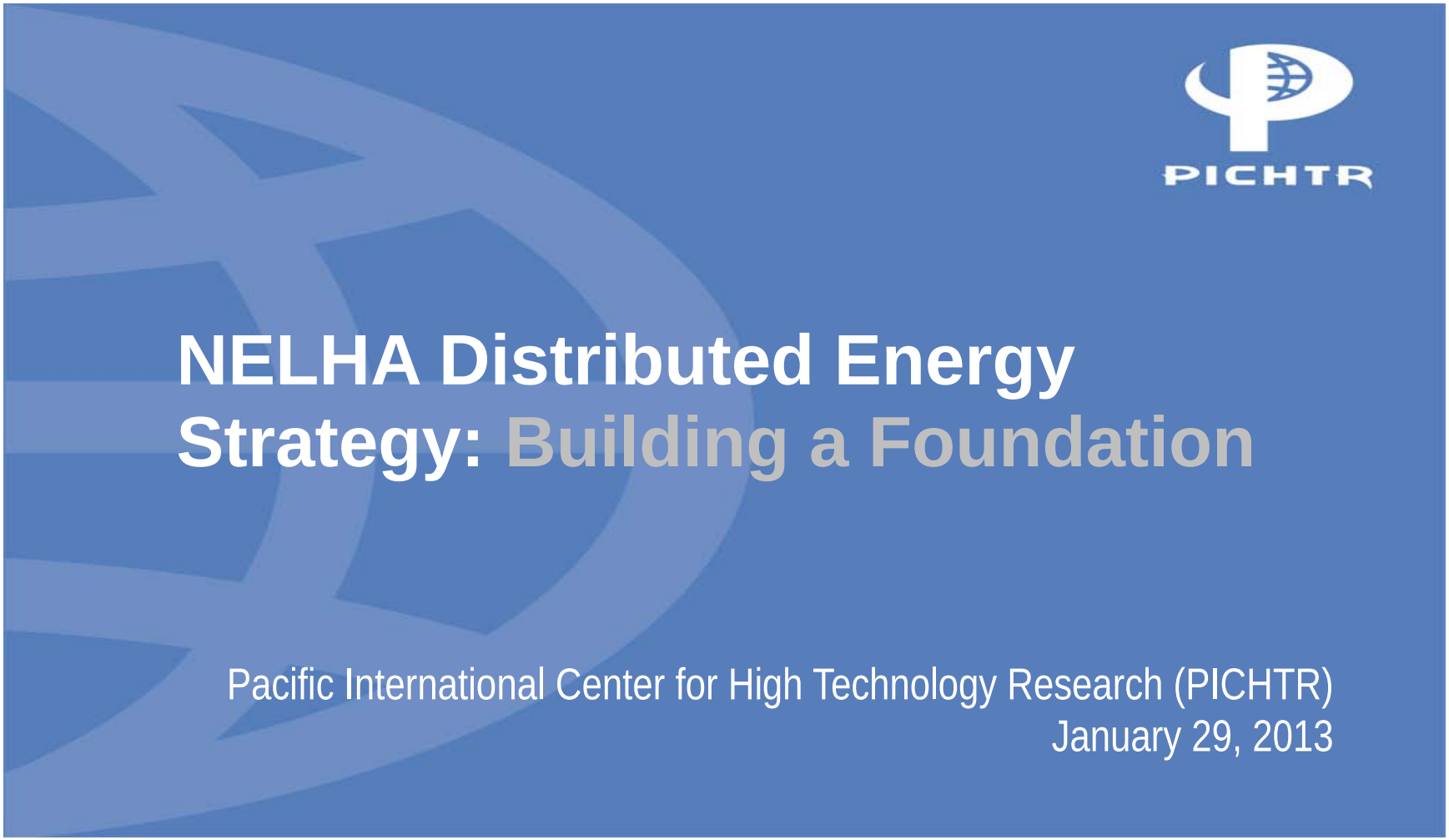
	LOCATION	PURPOSE	STATUS	SIZE	TECH CHOICE	ENERGY INTENSITY	FACILITY ENERGY USAGE	LESSONS LEARNED	PARTNERS
Wheeler AFB (Honeywell)	Honolulu, HI	Solar carport, mobile solar generators	Operational	250 kW (SCMG); 400 kW (Aloha System)	PV+ diesel			Energy storage: adv. controls required; Cyber security: access control/intrusion detection; Grid stability: significantly improved for receiving base	SAIC (Aloha system) PowerSecure, Inc. (energy technologies & services) TARDEC (smart charging micro- grid) Garrison Hawaii HECO State of Hawaii
Fort Sill	Fort Sill, OK								Encorp (micro-grid-like system) Sandia Army Corps of Engineers
Lanai Micro-grid	Lanai, HI	100% renewable energy goal	Assessing options/economic benefits		PV+ CSP + CHP + Wind + battery		5.4 MW (peak load)		NREL Sandia DOE HCEI
Maui smart grid project	Kihei, HI	Evaluate new smart grid technologies to enable cleaner, more efficient energy system on island of Maui	Planning		Smart meter				HNEI MECO Alstom Corix HECO HNU Energy MEDB Silver Spring Network

Appendix C NELHA DER Strategy Update Outline

- Background—Setting the Stage
  - The 2003 Gateway DER Strategy
  - The 2011 NELHA Master Plan
  - Current Gateway DER Center Utilization
  - What the Outside World Sees About Clean Energy in Hawaii
- Establishing the Baseline
  - Management Aspirations
  - Current Tenant Mix
  - Current Marketing Strategy
- Comparative Advantages of the Site
  - The Big Island as a “Living Laboratory
  - Natural Assets at NELHA: solar energy, cold seawater, access to transportation
  - Challenges and Needs of the Island Electricity System
  - Investments in SCADA, energy management
- Potential Strategic Partners
  - USDOE
  - NREL
  - Sandia National Labs
  - The University of Hawaii Manoa: Hawaii Natural Energy Institute
  - The University of Hawaii at Hilo
  - USDOD: Office of Naval Research
- Opportunities and Comparative Advantages
  - Ability to Wheel
  - Streamlined siting and permitting
  - Integrated energy campus through a micro-grid
  - Onsite utilities with planned expanded roadway and cold water service
- Constraints
  - Limited marketing budget and effort
  - Internal institutional barriers and impediments
- The Clean Tech/Distributed Energy Resources Strategy

- Research and Development Thrust
  - Government and NGOs
  - University/Academia
  - Clean Energy Technology Development (company profiles, portfolios)
  - Electric Utilities
- Commercialization Thrust
  - Prospects for a NELHA Micro-grid
  - Optimal Commercial Tenant Mix
- Opportunities to Bridge R,D, and D with Commercialization in One Location: Development of a Center of Excellence (Center for Renewable Energy and Sustainable Technology Transition, CRESTT)
- Targeted Marketing Strategy
  - Human Resource Capability
  - Collateral Materials
  - Leveraging Current Assets
- Prospects for Statewide Replication of the NELHA model

Appendix D January 29, 2013 PICHTR Presentation to NELHA Board



On the Agenda Today re: DER Strategy

1. Scope of work
2. Approach
3. Progress to date on Task 1 and Findings from Interviews
4. Outline of key report elements
5. Remaining schedule and presentation of Pre-final Report
6. Discussion and Q&A

On the Agenda Today re: DER Strategy ?

1. Scope of work
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NELHA's Baseline--Assets

- Master Plan is a good driver for direction
- Concrete goals: kinds of projects, sector strategies, messaging and outreach
- Single site R & D and commercialization, master permitting
- Reasonably good current project portfolio represents good base: solar, microalgae, OTEC, storage
- Mauka commercialization site
- Part-time representative in DC
- Reputation as a energy test-bed, both at NELHA and Hawaii Island
- Apparent commitment to extend infrastructure to mauka parcels

NELHA's Baseline—Constraints

- Limited marketing budget
- Inconsistent, unorganized energy development strategy and messaging
- Lack of funding (cost-share or "skin-in-the-game" needed?)
- Extraordinarily high energy cost relative to operations
- CPO limitations on procurement of electricity
- Lack of clarity on ability to develop and "wheel" electricity
- Limitation on fresh water
- Weak relationships with academia including UH

PICHTR Draws on Existing Relationships to Interview Managers & Engineers in DOE System

1. Department of Energy HQ
   - **Office of Electricity** Delivery and Energy Security
   - **Office of Energy Efficiency and Renewable Energy**
   - **Office of Fossil Energy**

2. Selected National Laboratories
   - **Argonne National Laboratory -** lead lab for DOE Energy Storage Hub
   - **Lawrence Berkeley National Laboratory -** excellence in energy efficiency and demand response
   - **National Renewable Energy Laboratory -** DOE/EERE lead lab and DOE lead for HCEI
   - **Pacific Northwest National Laboratory -** lead lab for DOE/OE smart grid
   - **Sandia National Laboratory -** excellence in solar energy and smart grid technologies

Interviews Included Discussion of NELHA Assets and Opportunities

1. Land and infrastructure availability
2. Energy resource availability
3. Energy pricing and cost issues on Big Island - seen as opportunity
4. Energy infrastructure issues on Big Island grid - another opportunity area
5. New, motivated management at NELHA

The Bad News

1. Fiscal cliff issues will continue to constrain new funding of project opportunities
2. Lack of strength in Hawaii's Congressional delegation will be an on-going and long-term issue
3. Poor previous track record for energy projects at NELHA
4. Uncertainty in Washington=hesitancy of program managers to commit

The Good News

1. All laboratories see collaboration with NELHA as an opportunistic solution to improving their funding
2. Fiscal cliff actually can create opportunities for national labs to create advantages for themselves with innovative collaborations
3. All labs understand that future collaboration with NELHA -- with its new and positive management - is to their advantage

Potential Areas of Interest—Partnering!

1. **New collaborations on efficiency and micro-grids with Kona International Airport**
   - Sandia and NREL both saw advantages in this concept due to an opportunity to effect change with a broader set of buildings
2. **Collaborations on sustainable building technologies with the new civic center**
   - LBNL brought this to our attention as a possible way to make use of additional facilities near NELHA
3. **Use of existing facilities (Gateway Center) for demand response and renewable systems R&D**
   - All labs interviewed believed that they could make use of the facility

Potential Areas of Interest (cont'd)

PICHTR

4. **Testing of solar thermal, PV, and energy storage**
   - All laboratories believed that NELHA could make good use of land and facilities - ANL was particularly interested in energy storage test beds
5. **New initiatives with Smart Grid: Solutions for Big Island infrastructure and integration problems**
   - PNNL, NREL, LBNL, and Sandia saw this as a significant opportunity. All of these labs have worked in some way with HCEI and believe that utilizing the NELHA facility can further HCEI goals

Possible Next Steps for NELHA (examples)

1. **Follow up with all labs in terms of greater specificity**
   - Requires some level of funding for planning and pursuit of contacts to prepare for future collaborative funding
2. **Track budgets and new political appointees in DC and DOE**
   - A new proposed solicitation on Smart Grids and micro-grids will be developed by DOE/OE
3. **For some laboratories, follow up soon with planning meetings for developing project outlines to present to DOE**
   - At least one laboratory has expressed interest in this
4. **Work with island-based organizations to strengthen NELHA's position for future funding**
   - Kona Airport, West Hawaii Civic Center, HELCO

On the Agenda Today re: DER Strategy

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Key Report Elements in the DER Strategy

- Background—Setting the Stage
- Establishing the Baseline
- Comparative Advantages of the Site
- Opportunities and Potential Comparative Advantages
- Constraints
- Clean Tech / Distributed Energy Resources Strategy – present value proposition of NELHA, approach for working with each organization, and key contact(s) at organization
    1. Research and Development: Government/Research/Academia
    2. Industry and Commercialization
- Execution of Clean Tech / Distributed Energy Resources Strategy
    1. Targeted Marketing Strategy
    2. Communicating Value

On the Agenda Today re: DER Strategy

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Timeline

- **February and March**: Additional Interviews, Information Gathering, and Development of Clear DER Strategy
- **March 19**: Presentation to the NELHA Board of Directors in Kona
- **Late March**: Incorporate Board Feedback
- **April-May**: Finalize DER Strategy

On the Agenda Today re: DER Strategy

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