special contribution

Securing Paradise in Hawaii

A Japan — Hawaii Partnership to Develop Smart Technologies and Unlock a Renewable Energy Future

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INTRODUCTION

AS a life-long Hawaii resident, I am blessed with the opportunity to live in a true island "paradise."

Hawaii is a land of seemingly endless beaches and surrounding ocean that you can swim and surf in year round, where days of ample sunshine are cooled by consistent trade winds that keep hot weather at bay. The enjoyable climate in Hawaii is the perfect setting for a day outdoors, whether you find yourself relaxing beachside sipping your favorite beverage of choice, or trekking along a lush mountain hillside beneath the soaring Koolau cliffs that have been carved over the millennia to perfection by countless waterfalls.

If you want to see things from an ocean vantage point, take one of the many tours ranging from Pearl Harbor excursions, sunset cruises, whale watching experiences, a ride on a glass bottom boat, or even climb aboard a submarine and view ocean wonders from below. Whether it is tours, fishing, horseback riding, shows, restaurants, or shopping galore, there are many things to do and experience in Hawaii.

Steeped in history, you can visit Iolani Palace, the only true royal palace in the United States, or go to the Pali Lookout and experience breathtaking views of Kaneohe Bay while learning about the history of King Kamehameha, his unification of the Hawaiian islands and establishment of the monarchy. In traveling about the islands, one will not only see the beautiful blend of ethnicities in the faces of island residents and taste the rich cultural diversity of the local cuisine, but also experience a unique spirit of aloha bestowed to locals and visitors alike.

Even if you lived in Hawaii your entire life as I have, you wouldn't be able to do and experience everything available. There is something for everyone to do and enjoy. Everything we dream of when we think of our "perfect" life. Well, almost perfect ….

PARADISE IN PERIL?

That envisioned perfection is lost when one considers that Hawaii, like many island or isolated communities across the world, is faced with a profound and fundamental challenge. It is a challenge that threatens the entire Hawaiian economy, its environment, its security, and the quality of life of its residents. That challenge is the overdependence on oil; and imported oil, to be precise. Yes, that black, sticky, oozing stuff that is the product of dinosaurs of long ago. Imported oil is the primary means by which Hawaii powers its modern society. We ship in and burn though oil at an astounding rate. Hawaii today is roughly 90% dependent on fossil fuels, the vast majority of which is oil, with a third of all imports going directly to the production of electricity across our islands. The other two-thirds primarily supplies aircraft fuel demands and automobile and marine transport needs. The overdependence on oil has placed Hawaii in a precarious and costly predicament.

Hawaiian Electric Company (HECO), with a service territory that covers the most populated island of Oahu, is a vertically integrated investor-owned electric utility with two wholly-owned subsidiary utilities, Maui Electric

Company (MECO), and Hawaii Electric Light Company (HELCO). MECO serves the county of Maui (Maui, Lanai and Molokai islands), and HELCO serves Hawaii Island. Together, HECO and its subsidiaries serve 95% of the State of Hawaii's nearly 1.4 million residents. There are no transmission interconnections between the islands so each island's generating system must stand alone without backup from its neighbor island utility grids. And with 2,500 miles of open ocean between Hawaii and Los Angeles, and 3,900 miles separating Hawaii from Japan, Hawaii's extreme isolation places it at the end of a long and risk-exposed oil supply chain. This risky dependence on an increasingly scarce commodity for its energy production has resulted in the highest and most volatile electricity rates in the United States.

As a point of reference, residential electricity rates on the islands of Molokai and Lanai topped 44 cents/kWh in March, 2012, while rates on Hawaii island and Maui exceeded 42 cents/kWh and 36 cents/kWh, respectively. On the island of Oahu, where rates are the lowest, residents paid 33 cents/kWh to keep their lights on. In contrast, average residential rates in the United States over the same time period were 11 – 12 cents/kWh. This high cost of electricity ripples throughout the Hawaiian economy and is reflected in the cost of all goods and services. Since the significant run-up in world oil prices in 2008, the price of paradise in Hawaii has undoubtedly gone up, eating away at household incomes and eroding business profitability.

However, as is often the case when one is confronted with a great challenge, significant opportunity for change and improvement resides therein. That opportunity for Hawaii is found in the significant renewable energy resource potential that exists across the islands. Proven commercial technologies like wind, solar, geothermal, hydro, biomass, waste-to-energy, and biofuels are available in Hawaii today, and emerging technologies such as wave and ocean thermal energy conversion are the focus of continuing research and development (R&D) work.

SUCCESS OF STAKEHOLDER ALIGNMENT AND BOLD ENERGY POLICY

Most Aggressive Clean Energy Goals in United States

Recognizing the need for an energy paradigm shift in Hawaii, local and national government joined with the Hawaii utilities to chart a new direction for energy policy and development. This alignment of stakeholder interests and establishment of an aggressive 70% clean energy target for Hawaii by the year 2030, with 30% realized by reduction in energy use through energy efficiency and 40% by electricity produced from renewable energy resources, were set in 2008 under the Hawaii Clean Energy Initiative (HCEI) energy agreement. The HCEI process was strongly supported by the U.S. Department of Energy and the energy agreement was ultimately signed by the Hawaiian Electric companies, the Governor of Hawaii, the Hawaii Department of Business, Economic Development & Tourism, and the Hawaii Office of Consumer Advocacy. The Hawaii Legislature then mandated these Renewable Portfolio Standards (RPS) goals into state law.

Today, this alignment of stakeholder interest and bold policy has resulted in Hawaii having the most aggressive RPS goals in the country. Backed by policy-driven renewable energy incentives (in the form of feed-in tariffs, a popular net energy metering program, and generous state and federal tax credits) and combined with the high cost of electricity, these RPS goals have ignited a red-hot market in renewable energy development in Hawaii.

With these policy measures now in place, long-term fixed-price contracts for new renewables offer a growing hedge against rising oil prices. Absent the risk of a fuel component, the fixed price of many renewables today such as geothermal, wind, and solar energy is competitive with the volatile and uncertain prices of oil-fired generation. The last several years have seen rapid growth in the development of renewable energy projects in Hawaii, particularly wind and solar energy technologies. At the close of 2011, the Hawaiian Electric companies reported 12 percent of electricity sales from renewable resources, a significant step in the right direction.

Growth in New Wind Energy and Solar Photovoltaic Development in Hawaii

In 2011 and 2012 alone, 99 MW of new wind projects came on-line on the island of Oahu, and 42 MW of new wind developments were added to the island of Maui, bringing the total wind energy on Maui, for example, to 72 MW. With these latest additions of wind power projects, there is now more than 200 MW of wind power in commercial operation across the Hawaiian islands today. This is significant, when one considers that the annual peak electricity demand on Hawaii island is less than 200 MW.

Photovoltaic (PV) development has been growing at an exponential rate in Hawaii for several years now. At the end of 2011, more than 10,000 customer-sited PV systems on Oahu, Hawaii Island, and in Maui County totaled more than 78 MW. In 2012, the year closed with Hawaiian Electric reporting more than 171 MW of PV installed across its service territory. In effect, over the last two years alone, rooftop PV installations have doubled year over year across the state, and that growth trend continues into 2013.

MAKING MAUI'S SMART GRID

With the rapid proliferation of renewable energy resources on each of the isolated power grids across the Hawaiian Islands, significant focus is being brought to the effective integration of large amounts of intermittent and variable renewable energy resources such as wind and solar power (both utility scale and distributed applications).

At present, the island of Maui has a notable 72 MW of wind energy, more than 25 MW of PV, and 12 MW of biomass generation in operation. In context, this power feeds a grid with an annual peak demand of approximately 200 MW and a minimum load at night of only 85 MW. Undoubtedly, the Maui power system has a high penetration of renewable energy, most of which is intermittent and variable in nature. With the operational challenges posed by these renewable resources, the power grid on Maui is quickly becoming a center of Research, Test, and Evaluation (RT&E) activities for the development of smart energy technologies, control systems, and algorithms to enable continued growth in renewable energy developments.

Three exciting smart grid RT&E projects are underway on the island of Maui and when combined form the making of a Maui "smart grid." Two of the projects are smart grid projects funded by the U.S. Department of Energy and led by the Hawaii Natural Energy Institute (HNEI), University of Hawaii, with the first focused on home energy use and distribution system management and the later on development of a standards-based smart inverter (a device that converts DC power to AC power) and related communications and control technology to enable high penetration of rooftop PV on distribution circuits.

The third project on Maui is a smart grid project funded by the New Energy and Industrial Technology Development Organization (NEDO) of Japan and focused on enabling high levels of distributed PV and electric vehicles on Maui, where the installed wind capacity is already 35% of peak and 85% of minimum system demand. Hitachi, the lead technology provider for the NEDO-funded project, has been working in close collaboration with its Hawaii partners and project

stakeholders.

Through such collaborative engagements, which involve the government, utilities, community volunteers, academia, and global industry giants like Hitachi, new technology and clean energy "know-how" is being developed on Maui while real-world solutions to the islands' pressing energy needs are being realized. The end-goal of these multi-disciplinary projects is to develop new technologies and operating strategies for rapid transition from RT&E to full commercial deployment in Hawaii and abroad. Executing these demonstration projects in close collaboration with the local utility on a live electric grid (in contrast to research conducted solely in a virtual/simulated or closed laboratory environment) yields ideal conditions to prove novel concepts and learn lessons about advanced energy technologies and solutions.

A systems engineering approach is brought to all three projects to execute a well-structured and phased design process that incorporates RT&E objectives and an implementation strategy of working closely with MECO, the Maui community, and other key stakeholders like HNEI. To realize an integrated smart grid architecture, the approach will utilize and explore the best available smart grid technology concepts in topic areas such as:

(1) Advanced sensing and measurement to provide planning and operational visibility that extends to the edge of the power grid and supports programs and activities that benefit both grid operation and end-users, such as demand side management and load control

(2) Advanced components and subsystems such as energy storage, power electronics and advanced-function inverters for high renewable penetration, and grid-to-vehicle and vehicle-to-grid technologies

(3) Integrated communications and security covering both the physical and cyber layers

(4) Advanced control methods and topologies such as coordinated system control layers and distributed controls, grid automation, and adaptive protection and control to address the expansion of distributed resources and two-way power flow

(5) Decision and operations support tools, such as renewable resource energy forecasting aimed to improve operational efficiencies and reliability (through, for example, tighter management of operating reserves), forecasting of demand response, distributed generation and storage resources, and dispatch of active and reactive power though distributed energy resources to optimize voltage profile and power flow losses.

Ultimately, focus will be brought on extending the lessons learned in Hawaii to the broader Pacific-Asia region, leveraging funding, collaboration, and knowledge exchange opportunities to the fullest.

CONCLUSION

The common mission today is to decisively and irreversibly get Hawaii off of imported oil for electricity and ground transportation. To achieve that mission, our aim is not just to meet the RPS goals, but to exceed them. We will aggressively reduce our energy use and add as much renewable energy as possible, as soon as possible, at prices that provide more stable and lower energy costs. Investing to support renewable energy now will provide greater energy security and environmental and economic well-being for Hawaii's future.

With the daily progress being made, I am optimistic that the paradise found in Hawaii will remain secure for the long-term. I hold this optimism with the knowledge that capable and dedicated individuals working in collaboration can and will solve the energy challenges we face today. And the solutions that will be derived in the process of unlocking a renewable energy future for Hawaii will ultimately be a gift to others, charting a promising path for our collective future.

Leon R. Roose

Mr. Roose joined the faculty of the Hawaii Natural Energy Institute (HNEI), School of Ocean and Earth Science and Technology, University of Hawaii at Manoa, in 2012 as a Specialist in the integration and analysis of energy technologies and power systems. Prior to joining HNEI, he was with the Hawaiian Electric Company for 19 years serving in numerous management roles, including responsibility for renewable energy planning and integration, smart grid planning and projects, distribution planning, transmission planning, generation resource planning and procurement, the purchase and distribution of fuel to utility generating plants across the service territory, and the negotiation of power purchase contracts for the Hawaiian Electric utilities. Mr. Roose also directed major programs across all three companies, including Hawaiian Electric's commitment to integrate large-scale wind energy resources via a proposed HVDC undersea cable linking the islands. He is also a licensed attorney and worked in private law practice in Hawaii and has held the position of Associate General Counsel at Hawaiian Electric. He holds a B.S. in Electrical Engineering and a J.D. from the University of Hawaii.