Moloka‘i Secure Renewable Microgrid Project

Hawai‘i Natural Energy Institute

The Moloka‘i Microgrid Project focuses on improving power system operation with high penetration levels of distributed photovoltaics (PV) on a small electrically islanded micro grid. The Hawai‘i Natural Energy Institute (HNEI) is leading this research and demonstration effort providing overall project management, power system monitoring, modeling, planning, and design support for microgrid components.

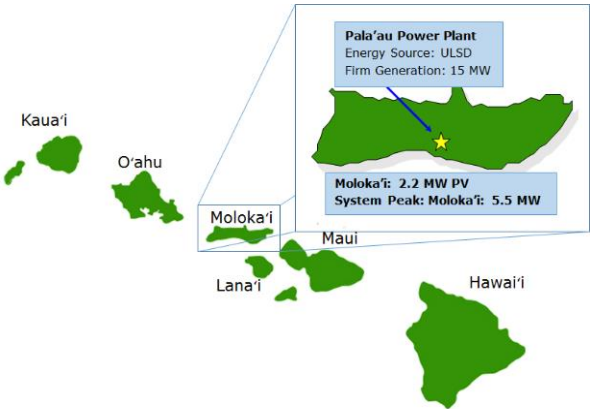

Figure 1. Location of Moloka‘i Microgrid Project.

Challenge & Significance

Small electrically islanded power systems, such as on the island of Moloka‘i with a peak demand of approximately 5.5 MW, can derive significant economic benefits from utilizing indigenous renewable energy resources such as wind and PV. However, a relatively small number of distributed generation additions to the grid can quickly add up to a significant and impactful level of penetration on these small systems. Rooftop PV systems on Moloka‘i will soon be able to provide nearly half the daytime power demand for the island. Small power systems like Moloka‘i typically operate with only a few diesel generating units online making the system very “light” by measure of the system’s inertia, and consequently less stable and more prone to service disruption. This is a potential factor limiting the addition of more PV on the island, which is contrary to goals of increased power provided by renewables. HNEI is working to design a stable microgrid system on Moloka‘i that will serve as an example to other small systems throughout the world.

Status & Accomplishments

System Stabilization

- An Altairnano 2MW/333KWh lithium-ion titinate battery energy storage system (BESS) was purchased.
- A memorandum of understanding was executed (March, 2014) between HNEI and Maui Electric Company to install the BESS on Moloka‘i.
- The BESS interconnection design is complete.
- Maui Electric Company and Altairnano are negotiating terms for the installation of the interconnection facilities.
- The interconnection requirement study (IRS), is nearing completion.

Microgrid Development

- Discussions are underway to refine the scope of the microgrid project given recent system operational events, continued growth in PV development and results of the IRS for the BESS.

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Period of Performance:

2014-2017

Partner(s):

- Maui Electric Company
- Okinawa Enetech

Funding:

- Office of Naval Research
- Maui Electric Company

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Project Objectives

- Maintain microgrid reliability with high penetration levels of distributed PV.
- Reduce the operating cost of electricity on the island.
- Demonstrate the use and value of a BESS to address microgrid grid stability issues.
- Demonstrate the use and value of a microgrid controller to manage and optimize the island’s energy balance.
- Demonstrate maintaining service to select critical loads on the island in the event of an extended loss of grid power (as may occur following a natural disaster)
    - Contingent upon Department of Agriculture funding award from the Assistance to High Energy Cost Rural Communities opportunity (RD-RUS-HECG2014).

Figure 2. Containerized Battery Cells

Project Detail

Approximately 400 hundred rooftop PV systems on Moloka‘i totaling 2.4 MW are enough to provide half of the mid-day power needs for the island on sunny days. At times, this may push the firm diesel generators down to their lower operating limits. The reduced system inertia leads to very large and extremely rapid frequency excursions following a loss of generation or load event. These rapid frequency excursions are well outside the operational settings for PV systems causing them to turn off following these events, which worsens the energy-load imbalance condition, driving an ever larger frequency excursion that can rapidly overwhelm the power grid and potentially lead to a system-wide blackout. In addition to frequency stability, running with less online generation reduces the amount of available short circuit current needed for proper operation of system protective relays, particularly on long distribution feeders. Further, running the diesel generators at their lower operating limit is inefficient, resulting in increased cost of production per unit of fuel burned. This inneficient and increased cost of energy production is passed on to island customers on their electric bill. This project will strive to develop an integrated solution to the challenges faced by islanded systems with high penetration levels of distributed renewable energy resources by adapting and integrating new grid resources such as a BESS, flywheels, and load control with intelligent control systems needed to coordinate and optimize the use of these resources. The project team will collaborate with other industry and academic partners who are also working on smart soltuions for islanded power systems including Okinawa Enetech and Hitachi Ltd. Okinawa Enetech, a subsidiary of Okinawa Electric Power Company, has implemented microgrid systems and components on island power system in Okinawa and the Asia-Pacific region. Hitachi is the technology provider and project lead for the JUMPSmart Maui project and other smart grid projects around the world. The lessons learned on Moloka‘i can then be used in other partnership opportunities on islanded systems in Hawai‘i, Okinawa, and the broader Asia-Pacific region.

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