

Hawaii-Okinawa Partnership: Smart Grids for High Penetration Renewable Energy



**Japan-IRENA Joint Workshop
Okinawa, Japan
May 26, 2012**

**Rick Rocheleau
University of Hawaii at Manoa**

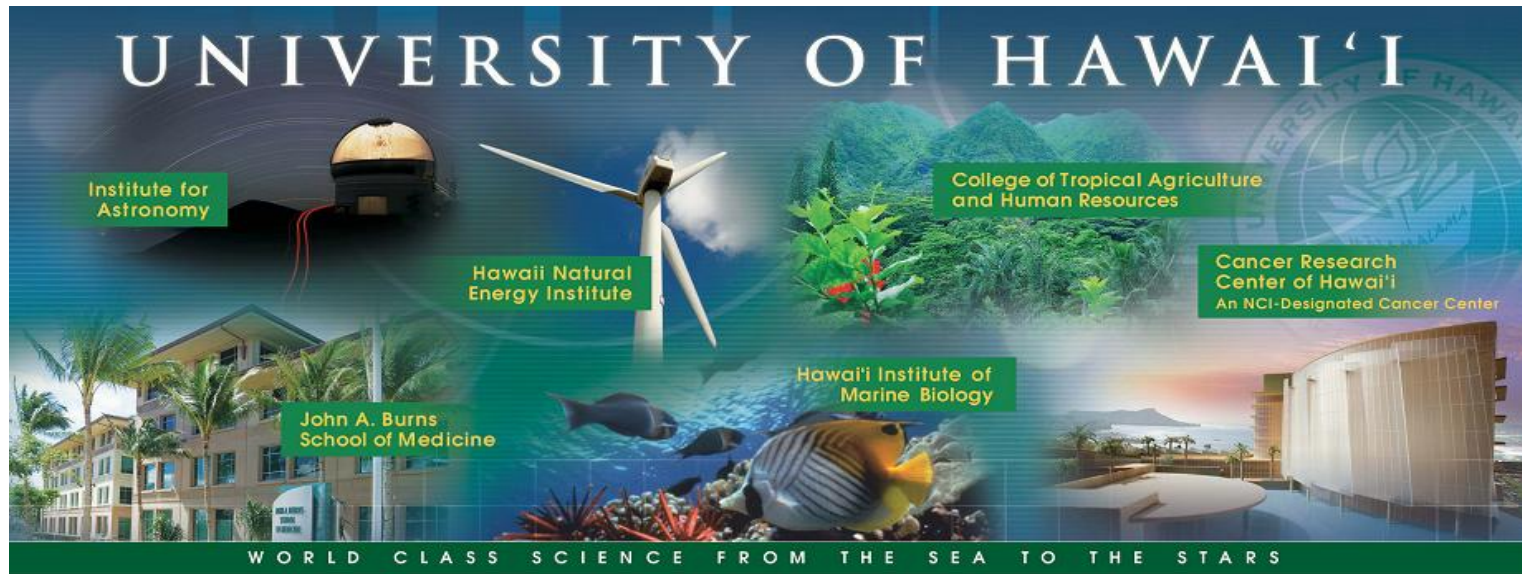
Outline of Talk

Hawaii Natural Energy Institute

Hawaii Island Integration Studies

Hawaii-Okinawa Partnership

Smart Grids Activities on Maui



Established in 1907

3 universities & 7 community colleges

Over 53,000 students

Manoa is the largest and main research campus

- 14000 undergraduate students
- 6000 graduate students

Hawaii Natural Energy Institute (HNEI)

Organized research unit in School of Ocean and Earth Science and Technology, University of Hawaii at Manoa

In existence since 1974. Established in statute in 2006 with mandate to develop renewable sources of energy and to demonstrate and deploy efficient energy end-use technologies

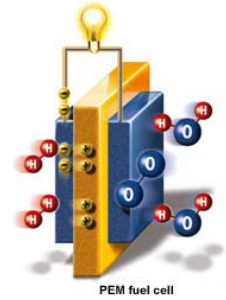
Program Objectives

- Research and development of new energy technologies**
- Testing and evaluation of emerging technologies**
- Research to support renewable energy deployment**
- Energy assessments and policy development**
- Develop and manage research partnerships to leverage investment in Hawaii**
- Contribute to STEM and workforce development**

HNEI programs are multi-disciplinary efforts with strong collaboration and cost share from industry

HNEI Program Areas

- Hydrogen:
 - Hawaii Hydrogen Power Park
- Fuel Cells:
 - Testing and systems optimization
- Photovoltaics:
 - Thin film solar cells, deployment, testing, and analysis
- Electrochemical Power Systems:
 - Batteries and electric vehicles
- Ocean Resources:
 - Seabed methane hydrates, [ocean thermal and wave energy](#)
- Biofuels and biotechnology:
 - Biomass conversion - solid, liquid and gaseous fuels
 - Biofuels fit-for-use
- [Grid Analysis and Smart Grids](#)
- Technology Validation, Energy Assessment and Policy



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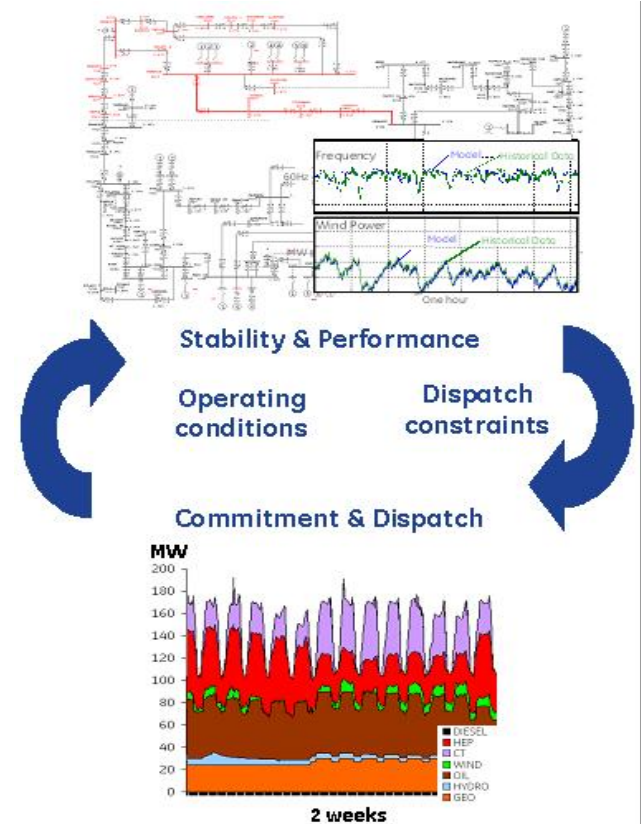
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Hawaii Island Integration Studies (2005)

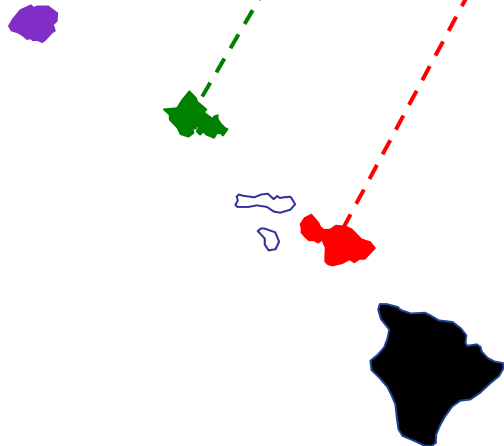
- Develop rigorous analytic models of electricity grids on each island (MAPS, PSLF)
- Analyze impact of deploying new energy systems including renewable generation, end-use efficiency, and novel transportation systems
- Identify and analyze solutions to address systems integration issues resulting from intermittent renewable technologies (e.g. wind and solar)
 - Advance controls
 - Forecasting
 - Demand management, EV
 - Storage
 - Smart grids



Develop demonstration projects to validate proposed technology solutions

Smart Grid Programs are Natural Extension of Ongoing Grid Integration Studies

• *Significant investment by US DOE, NEDO, ONR, and industry partners*



3) Oahu Grid Studies 2008-2012 - Validated Oahu grid model being used to address integration of large wind via undersea cable and high penetration solar

4) Maui Grid Modernization (2009)- US DOE funded, HNEI led project to integrate smart grid technology to achieve reduced peak load and better management of intermittent renewable energy

5) Japan-US Smart Grid Project (2011)- NEDO funded, Hitachi led project to integrate advanced PV, energy storage, and EV into island wide smart grid environment

6) Smart Inverters in Smart Grid Environment (2012) : Demonstration of advanced PV inverter functionality in smart grid environment

2) Maui Grid Studies (2005-2012)

- Validated power systems model used to address impacts of high penetration wind and solar. Focus on the necessary mitigation technologies

1) Big Island Energy Roadmap (2004)

- Identify strategies for increased energy security and the penetration of renewable energy
- Demonstration projects (storage, H2 for DSM) underway

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U.S. – Japan Cooperation on Clean Energy Technologies

The White House

Office of the Press Secretary

For Immediate Release

November 13, 2009

FACT SHEET: U.S.-Japan Cooperation on Clean Energy Technologies

President Obama and Prime Minister Hatoyama met on November 13, 2009 in Tokyo. The two leaders affirmed the intent of the United States and Japan, as the two leading global investors in energy research and development, to expand already strong cooperative activities in technology research and development to provide solutions to the challenges of global energy security and climate change. They announced initial areas for joint activities to strengthen their cooperation that include:

- Establishment of a task force that will evaluate the achievements of existing clean energy projects in Hawaii and Okinawa to enable the islands to be energy independent, including micro-grid projects, and develop activities to help the two islands share experiences and knowledge with each other;

Okinawa-Hawaii Task Force

- (1) Energy Efficient Buildings:** *A bilateral energy expert team composed by US and Japanese experts will evaluate a building in Okinawa and in Hawaii and reports will be shared*
- (2) Smart Grid:** *Both the US and Japanese governments as well as the Prefecture of Okinawa and the State of Hawaii will promote cooperation through **smart grid demonstrations** in Miyako, Okinawa and Maui Island, Hawaii*
- (3) Renewables:** *Promoting information exchange of renewable energy including **ocean energy** such as Ocean Thermal Energy Conversion (OTEC)*
- (4) People-to-People Exchange:** *The work program includes: the dispatching of staff from Okinawa Prefectural government to Hawaii to nurture expertise on energy efficient building, implementing a joint online project on energy efficiency and promoting cooperation among academia as well as utility related companies of Okinawa and Hawaii.*

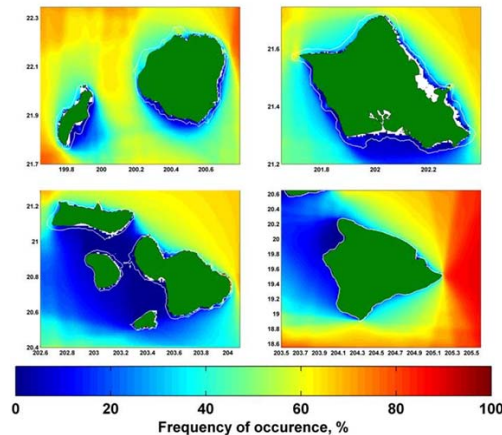
Wave Energy

Wave Energy could supply a significant amount of electricity to coastal communities throughout Japan and United States;

Development and validation of commercial wave-energy-conversion (WEC) devices often limited by access to real-world at-sea testing;

US Navy, USDOE, & University of Hawaii are currently implementing a grid-connected wave energy test site (WETS) off Kaneohe Bay in Oahu with multiple test berths to be open to all developers;

WETS will be pre-permitted with oceanographic instrumentation, submarine power cables and mooring infrastructure.



Advanced wave forecasting



***Kaneohe Bay
WETS***



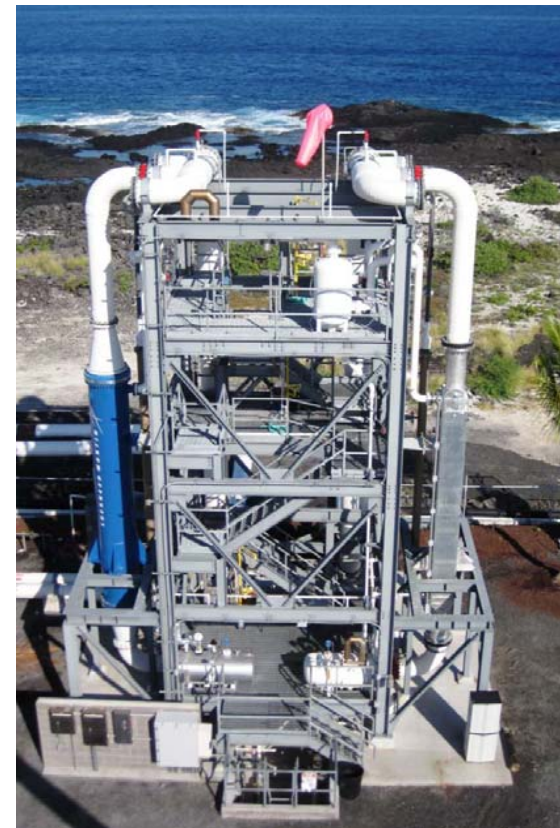
OPT Buoy Deployment

Ocean Thermal Energy Conversion (OTEC)

- OTEC has energy production potential of more than 50% world wide consumption within territorial seas of 98 nations;
- OTEC has direct application in Hawaii and Okinawa Prefecture;
- Electricity and desalinated water production has been demonstrated by Japanese companies and in Hawaii

Makai Ocean Engineering (HI) under contract to HNEI is conducting testing of alternative materials, alternative designs of heat exchangers and turbine designs

Makai OE Heat Exchanger Test Facility at NELHA

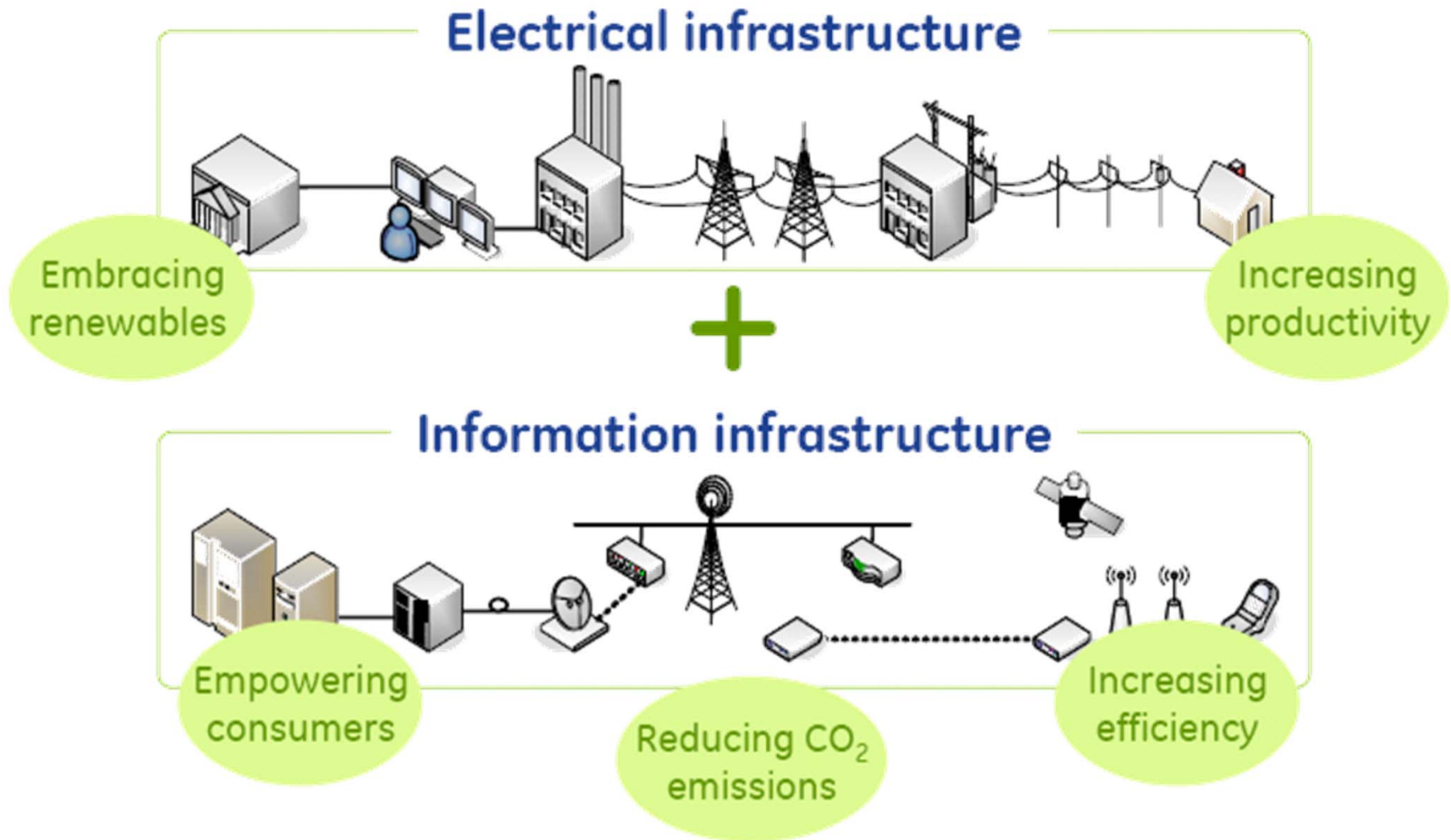


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Smart Grid Solutions

Secure Integration of Two Infrastructures



Hawaii Smart Grid Demonstration Projects

- Maui Smart Grid Demonstration Project (2009)
 - US DOE funded, HNEI led project to integrate smart grid technology to achieve reduced peak load and better management of intermittent renewable energy.
- Japan-US Island Grid Project (2011)
 - NEDO funded, Hitachi led project to integrate advanced PV, energy storage, and EV into island wide smart grid environment
- Smart Grid-Enabled PV Inverters (2012)
 - Demonstration of advanced PV inverter functionality in smart grid environment, (Maui and Oklahoma City)

Three projects have partners in common and propose to share hardware, results, and lessons learned

Maui Smart Grid Demonstration Project (2009)

- Funded by US DOE with cost share from partners
- Implement advanced communications and control technologies to improve grid performance
- Demonstrate new “Smart Grid” technologies to:
 - Reduce peak demand by 15%
 - Better integrate wind and solar power
 - Improve grid reliability
 - Inform consumer demand decisions



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University of Hawaii at Manoa

ALSTOM



Maui Electric Company, Ltd.



Hawaiian Electric Company



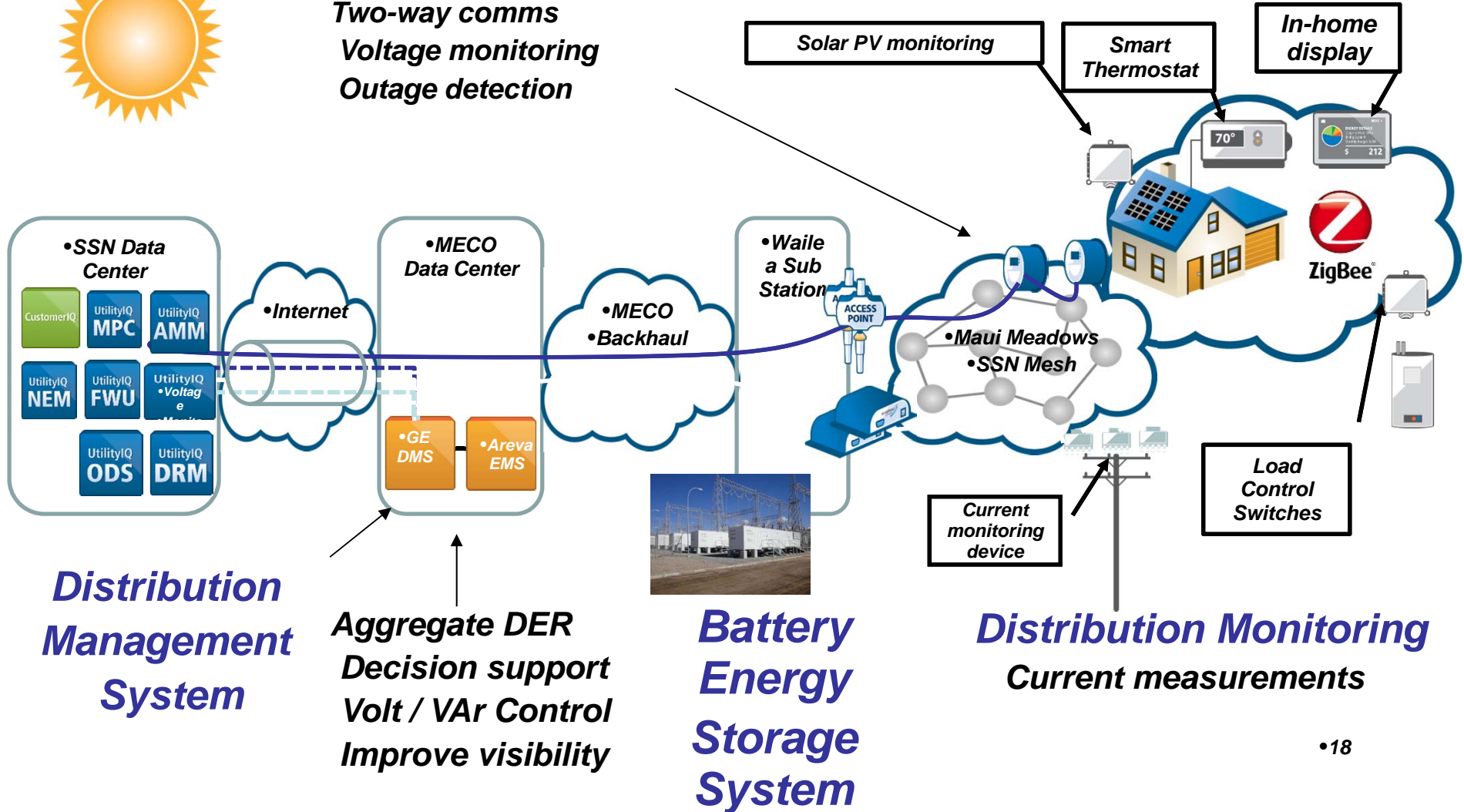
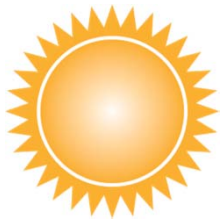
Project will Manage Distributed Energy Resources (DER) to Support Grid Operations

Advanced Metering Infrastructure

Two-way comms
Voltage monitoring
Outage detection

Home Area Network

- Demand response
- Monitor PV
- Customer feedback



NEDO Solicitation and Selection (2011)

Press Release



New Energy and Industrial Technology
Development Organization

<http://www.nedo.go.jp/english/index.html.jp>

November 2, 2011

Participants Selected for a Smart Grid Demonstration Project in Hawaii – Commencement of a Japan-U.S. Collaborative Demonstration Project for World-leading Remote Island Smart Grids –

The New Energy and Industrial Technology Development Organization (NEDO) has selected a consortium of three companies, Hitachi, Ltd., Mizuho Corporate Bank, Ltd., and Cyber Defense Institute, Inc., led by Hitachi, Ltd. to participate in its Smart Grid Project to be carried out in the State of Hawaii of the United States.



Japan – United States Smart Grid Demonstration Project 2011



CyberDefense



Other supporting partners

- Nissan Motor Co., Ltd.
- Advanced Energy Company
- U.S. Verizon Gr.
- Okinawa Electric Power Company



Hawaiian Electric Company



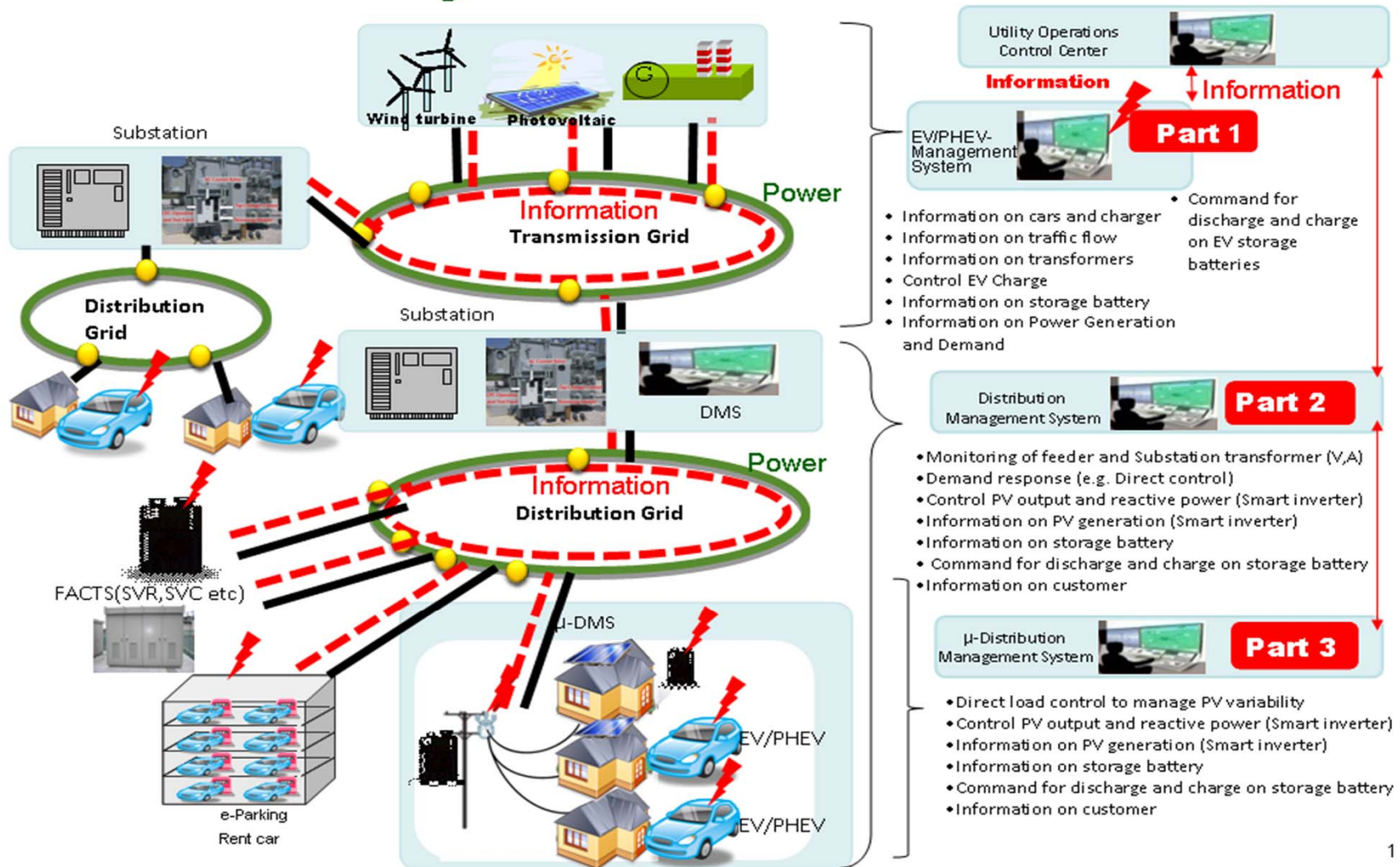
Maui Electric Company



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NEDO Project Scope

Project Architecture



Development and Demonstration of Smart Grid Inverters for High Penetration PV Applications

Funded by US Department of Energy with cost share from industry partners



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University of Hawaii at Manoa



Maui Electric Company, Ltd.



Hawaiian Electric Company



POWERING YOUR FUTURE



New Energy and Industrial Technology
Development Organization



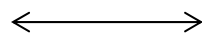
Power at the speed of life.



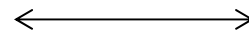
PV Inverters Integrated into Home Area Network (HAN)

enabling two-way communication and grid support features

***Integrate into
Utility
Software
Applications***



**SSN
Smart
Meter**



Smart Grid-Enabled Inverter



***Fronius Inverter: 3 kW - 5 kW
Grid support features
developed to meet German grid
codes***

***Project will demonstrate inverters at two utility sites –
Maui Electric and Oklahoma Gas & Electric***

Collaboration between Projects

- **Common Goals**
 - **Build the capability to integrate more renewable energy while managing costs**
 - **Leverage resources to test new smart grid technologies and concepts in Hawaii**
 - **Enhance grid operability and reliability**
 - **Ensure cyber security**
- **Share equipment across projects**
- **Share experiences and lessons learned**
 - **Siting and liability issues**
 - **Community education and outreach**
- **Interconnection standards and test protocols**
- **Exchange of personnel**



