# **Smart Grid for Smart Cities**

### "The Maui Smart Grid – A Smart Energy Technologies Showcase"



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# Hawaii is Paradise Found





## But, Hawaii's Isolation Poses a Serious Challenge ....

Nearly 90% of Hawaii's total energy is met using <u>fossil fuels</u>

100% of the crude oil for the State is *imported* 



### **Threat** to Hawaii's:

- Security
- Environment
- Economy

US Dept of State Geographer © 2013 Google Image © 2013 TerraMetrics Data SIO, NOAA, U.S. Navy, NGA, GEBCO

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# High Energy Cost Drains the Island Economy

### High Cost of Service

Hawaii ranks #1 in U.S. electric energy costs:

46.4 cents/kWhMolokai46.3 cents/kWhLanai42.2 cents/kWhHawaii37.8 cents/kWhMaui34.6 cents/kWhOahu(Avg. residential rates for **2013**)

11 - 12 cents/kWh U.S. avg. Source: Hawaiian Electric Company



#### Fuel costs make up more than 70 percent of the typical bill

High Electricity Price and Volatility Linked to Cost of Oil

**Renewable Energy Aimed to "Break the Link" and Lower Cost** 



## **<u>Opportunity</u>** for Sustainability in Hawaii is Abundant



























# Progressive Leadership in Clean Energy <u>Policy</u>



### Hawaii Clean Energy Initiative (HCEI)

The State of Hawaii, US DOE, and local utility launched HCEI in January 2008 to transform Hawaii to a 70% clean energy economy by 2030:

- Increasing Hawaii's economic and energy security
- Fostering and demonstrating Hawaii's innovation
- Developing Hawaii's workforce of the future
- Becoming a clean energy model for the U.S. and the world

### Strong Hawaii Policies <u>Highest</u> RPS Target in the United States

40% by 2030 (2015 - 15%; 2020 - 25%) Other key policies:

- Net metering
- Feed in tariffs
- Tax incentives





# **Exceeding Hawaii RPS Goals**

Renewable Generation for Hawaiian Electric Companies – Current Generation Achieved and Generation Required





# Hawaii's Renewable Energy Projects

"Clean Energy, Lower Bills"



Source: Hawaiian Electric Companies 2013 Clean Energy Update Report



On Oahu, 250 MW of large-scale PV projects in PPA negotiation

## **Rapid Growth in Customer Sited Solar PV in Hawaii**

- Rooftop PV in Hawaii has grown 15 fold in less than 5 years
- PV generation can exceed customer demand in many areas of the island



Cumulative Installed PV -- As of June 30, 2014

	Number of PV Systems			PV Capacity, MW		
	Number	% Residential	% Commercial	Capacity	% Residential	% Commercial
Hawaiian Electric	33,861	97%	3%	254	67%	33%
Hawai'i Electric Light	6,231	93%	7%	44.0	61%	39%
Maui Electric	6,187	92%	8%	47.5	61%	39%
Total	46,279	)		346	$\mathbf{)}$	



Data subject to change





# **Renewable Portfolio Standards (RPS) Projections**



Hawaiian Electric Companies Power Supply Interconnection Plan (PSIP) (Filed: August 26, 2014)



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# Wind and Solar Resource Intermittency and Variability

MECO Frequency & KWP MW Output - Feb. 29, 2008

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MĀNOA

N.M



### Wind Energy



# Maui Island Leading the way in Wind and Solar Power



# Maui Island Test Bed

## A Model of Smart Grid Innovation & Collaboration

- Maui Smart Grid Project (2009) ~\$12 M
  - US DOE funded, <u>HNEI led</u> project to integrate smart grid technology to achieve reduced peak load on a distribution circuit and better management of intermittent renewable energy
- Maui Advanced Solar Initiative (2012) ~\$11 M
  - US DOE & ONR funded, <u>HNEI led</u> project to develop and demonstrate advanced PV inverter functionality in a smart grid environment
- JUMPSmart Maui (2011) ~\$30 M
  - NEDO funded, <u>*Hitachi led*</u> project to integrate high levels of PV, wind energy, and EV into an island wide smart grid environment
- Great Maui Project (2013) ~\$20 M
  - NEDO funded, <u>*Hitachi led*</u> phase 2 of JUMP Smart Maui project, to demonstrate EV vehicle-grid and Virtual Power Plant integration

### All projects have partners in common and share hardware, results, and lessons learned





- 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





http://www.mauismartgrid.com/maui-smart-grid-project-description/project-team

Maui

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





### **OBJECTIVES**

- Deploy new Smart Grid Inverters
- Utilize Inverter Management Control Software (IMCS)
- Utilize <u>standards-based</u> controls and communications
- Employ <u>detailed</u> distribution modeling and <u>high-resolution</u> field data to develop advanced inverter settings

#### **Research Project lead**

- Project oversight, management and direction
- Smart Inverter application design; performance and data analytics

#### **Communications Technology Lead**

- Mesh Communication System; IMCS
- Customer Engagement via PV Customer Portal

#### Inverter technology leads

- Leads for communications integration into inverter
- Develop control functionality in inverter; implement control programs sent from IMCS

#### Host utility in Hawaii

• Inverter operations for field pilot; performance evaluation

#### **Co-Services lead**

• Sales, marketing, installation, project management, customer service

#### Host utility in Washington DC

• Inverter operations for field pilot; performance evaluation

#### **Co-Services lead**

• Sales, marketing, installation, project management, customer service

#### **Inverter Testing Facility**

• Site of functional requirements and inverter testing



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wai'i Natural Energy Institute

Silver Spring



#### RISING SUNSOLAR+ELECTRIC





**NGH** 





#### **SOLUTION ARCHITECTURE**

#### **Utility Back Office Systems**

### Inverter Management & Control Software

UNIVERSITY of HAWAI'I



**Smart Grid Network** 

Silver Spring Networks

**Network Interface Cards** 

#### **INVERTER TESTING, DETAILED DISTRIBUTION MODELING, & FIELD PERFORMANCE ANALYTICS**







Smart Meter

Utility owned



Home



# **JUMPSmart Maui Project**

A Japan – United States Smart Grid Demonstration Project

NEDO























## **JUMPSmart Maui Project**



In Maui, large scale renewable energy (72 MW of wind and 72 MW of distributed PV) has been introduced. In addition, many electric vehicles (EV) are expected soon.



### Issues

 Excess Energy
System Frequency Impact
Distribution Line Voltage Impact
Solutions
Integrated DMS
µDMS &Smart PCS
EV charger control
Battery system
Direct Load Control
ICT Platform

### **Basic Policy for Demonstration**



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MANOA

Maximize Utilization of Renewable Energy (RE)

Stable Supply of Electric Power

Solution for Impact of EV & PV High Penetration

HITACHI

**Inspire the Next** 

## **Overall View of System Configuration**







## **EV Fast Charging Stations on Maui**





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# **Great Maui Project**

### **Development of VPP solutions in Maui**



# Integrate Renewables and Transform the Maui Grid



# Partnering for a Clean Energy Future

- International collaborations, such as the successful Japan-US partnership in smart grid technology development on Maui island, serve as a crucial catalyst to drive smart energy technology innovation
- Hawaii is an ideal 'test bed' to prove concepts and learn lessons about smart energy technologies in action that will achieve ...
  - $\sqrt{\mathbf{A}}$  clean natural environment
  - $\sqrt{}$  Energy independence and security
  - $\sqrt{}$  Affordable and stable energy costs
  - $\sqrt{1}$  Increased societal productivity

## All Keys to Delivering a Sustainable Energy Future









# Mahalo! (Thank you)





### For more information, contact:



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