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Building Up Grid SMARTs for Hawaii



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Outline

- Hawaii Energy Landscape
 - HECO and UH Introduction
 - Hawaii grid "SMART" efforts
- HECO – UH Collaborations
 - Workforce Training
 - Research in Micro-grids



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HECO Information

- **Locally owned and operated**
- **400,000 customers (Oahu, Maui, Hawaii Counties)**
 - Residential, commercial, military customers
- **2,000 employees (HECO, MECO, HELCO)**
- **19,000 Hawaii shareholders**
- **Over \$2 billion in assets**



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UH Information

- **University of Hawaii (10 campuses)**
- **UH Manoa (flagship campus)**
- **Research extensive founded in 1907**
- **20,000 students (14000 UG, 6000 grad)**
- **College of Engineering (EE, CEE, ME)**
 - 60 faculty, 750 UG students, 200 grad students
- **Renewable Energy and Island Sustainability (REIS) group**



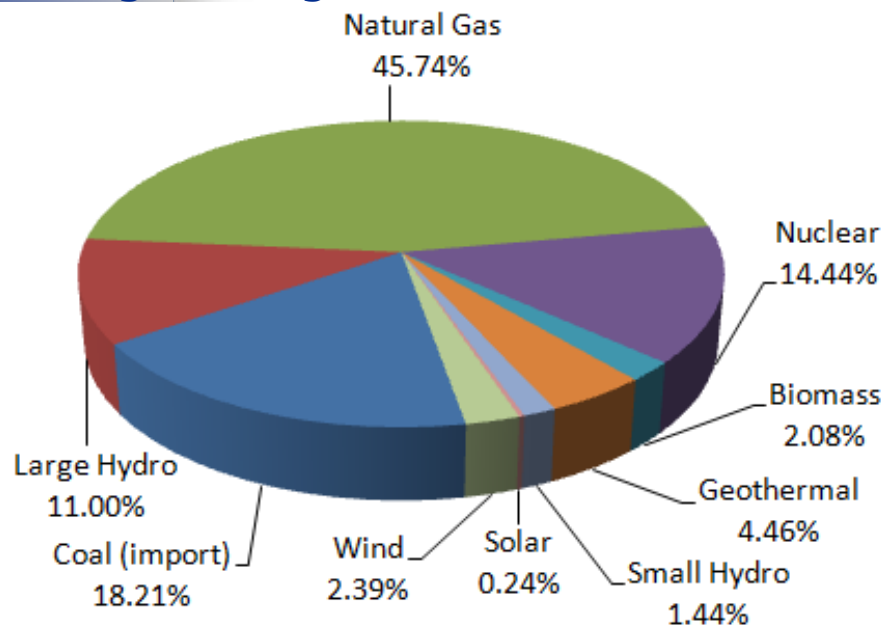
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CA & HI Energy

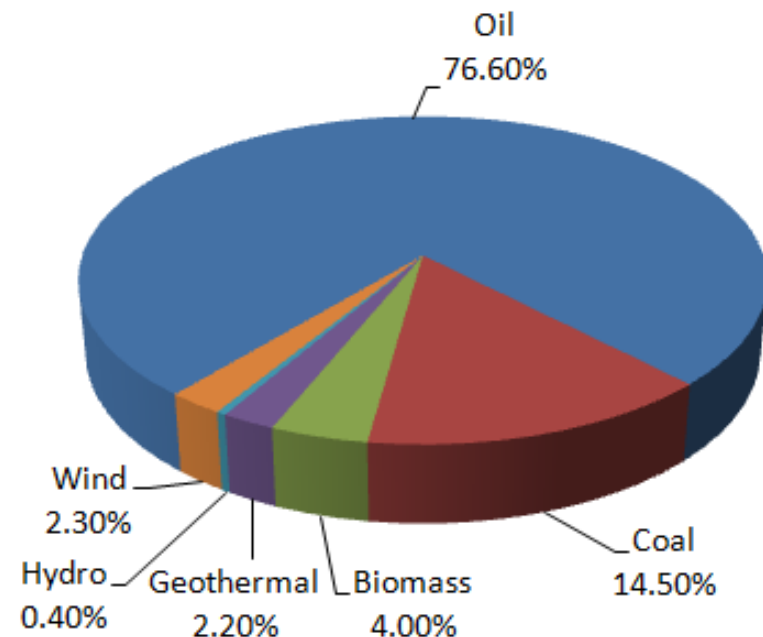
California

- Primary resource is natural gas, 80% imported from other states & Canada
- Top 10 generation plants are gas, nuclear and hydro resources
- Nearly 25% of electricity consumed is imported from neighboring states



Hawaii

- Primary resource is petroleum, 90% imported (30% for electricity, 60% transportation)
- Top 10 generation plants are petroleum, coal, and waste resources
- Islanded systems



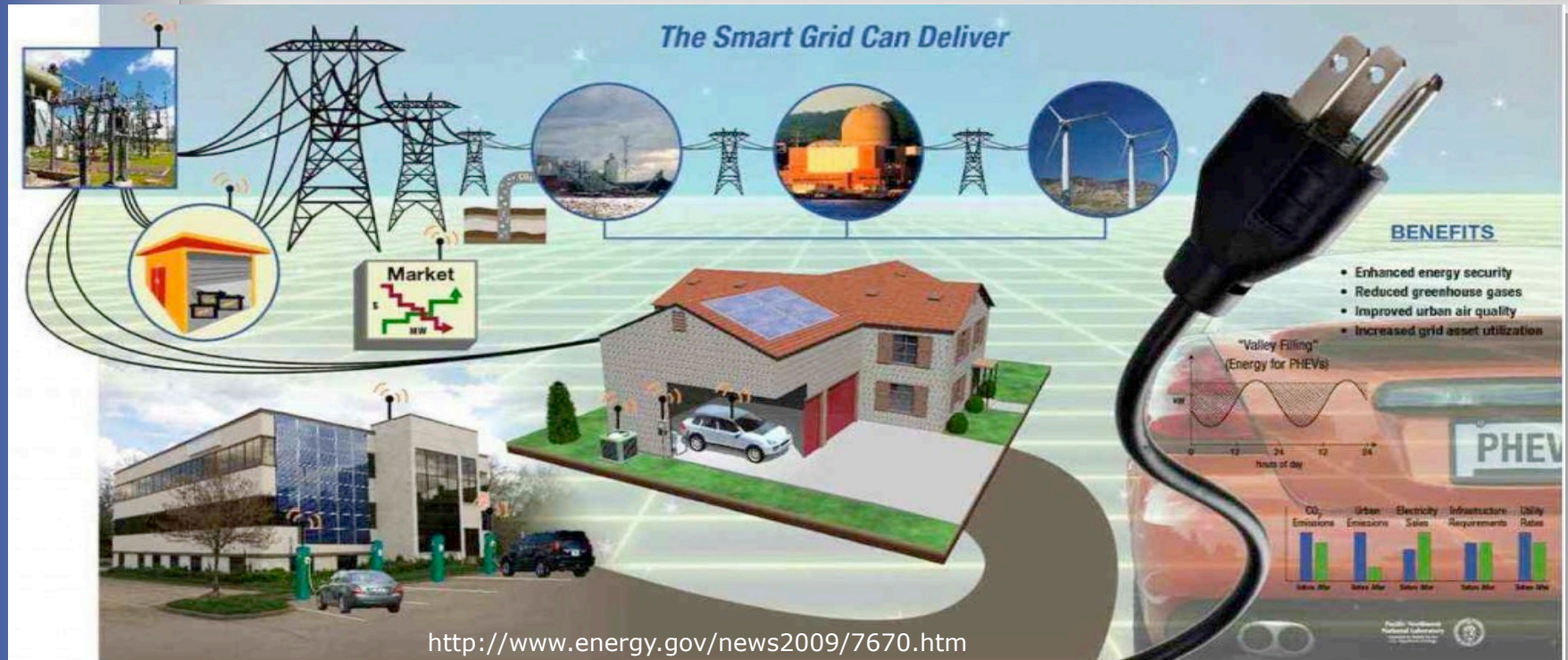
* Source: CEC 2008; HECO 2008



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Desired Characteristics of a Smart Grid



Energy Independence & Security Act 2007, Sec 1304 Smart Grid RD&D Highlights

- Enable **active participation** by consumers
- Accommodate *all* generation and storage options (including vehicles)
- Enable new tools, products, services and markets
- Provide power quality reliability for the digital economy
- **Optimize** asset utilization and operate efficiently
- Enable the *self-healing* grid to anticipate and respond to system disturbances
- Operate resiliently against attack and natural disaster

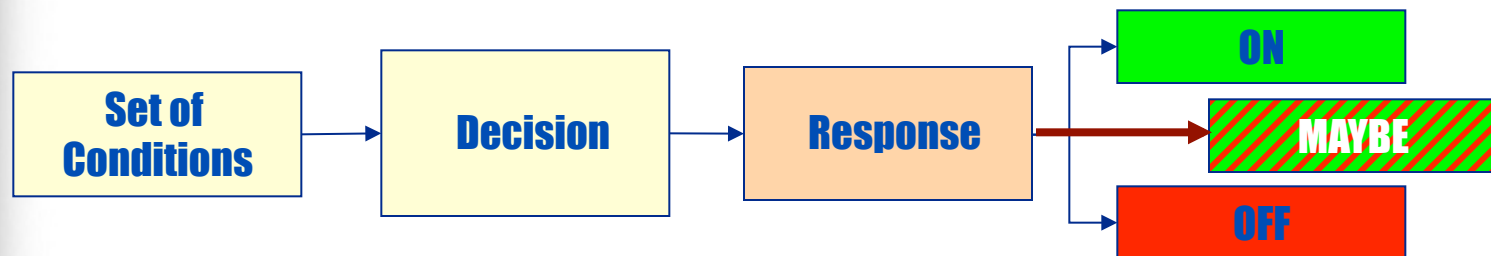
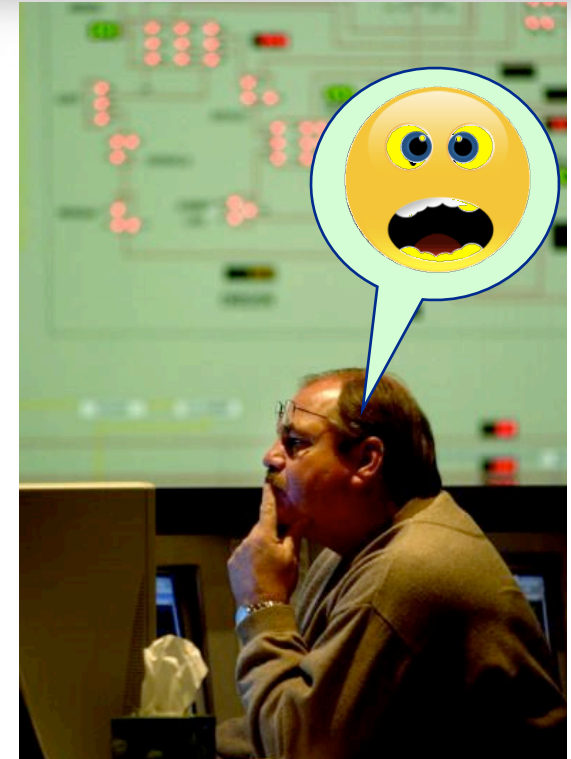


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The Intelligent Grid of Today

- Today's system has a level of automation and intelligence
- Decisions are based on a set of deterministic conditions (**ON** or **OFF**)
 - "Experience" determines resources committed and response; Supply meets Demand
 - If resources do not respond or are insufficient... alternatives are dispatched
- Wind, solar and DR/DER add "unplanned" variability to conditions used in informing unit commitment
- Current intelligence is not sufficient (resolution & time) to actively deal with the variability of new resources





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"SMARTing" the Grid for Hawaii

<i>REQUIREMENT</i>	<i>OUTCOME</i>
Sustainable resources for the islands	Developing a stable & secure portfolio of resources
Managing a flexible mix of resources	Maintaining a flexible and interoperable resource mix
Awareness of renewable resource characteristics and impacts	Building <i>confidence and knowledge</i> to cost-effectively use alternative technologies (education, training, analysis/visualization)
Resilient architecture & workforce	Ensuring communication infrastructure redundancy & workforce responsiveness
Tangible Technologies	Minimize risks and unintended consequences

NEEDED: Strategic Plan with enhanced tools & knowledgeable workforce



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Sustainable Portfolio of Resources to Meet Energy Policy Targets

1. Renewable Portfolio Standard
2. Hawaii Clean Energy Initiative
3. Green House Gas
4. Reduce Dependence on Fossil Fuel
5. Energy Efficiency & Conservation





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Managing the Portfolio Mix

Current Paradigm

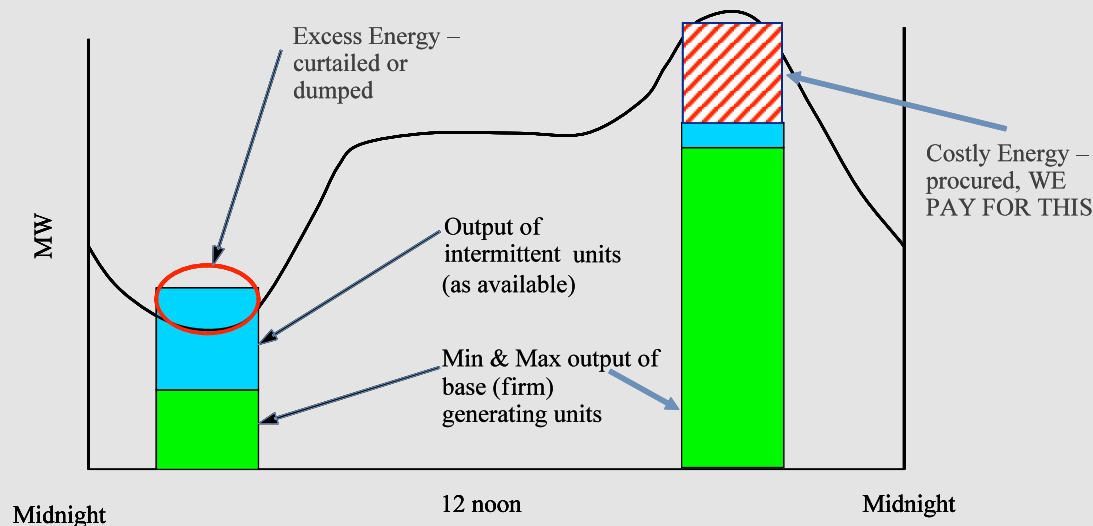
$$Demand = Supply$$

Emerging “Smart” Grid Paradigm

$$Demand = Supply + \sum_0^{\infty} VariableSupply$$

Enable active participation of diverse resources to improve grid reliability

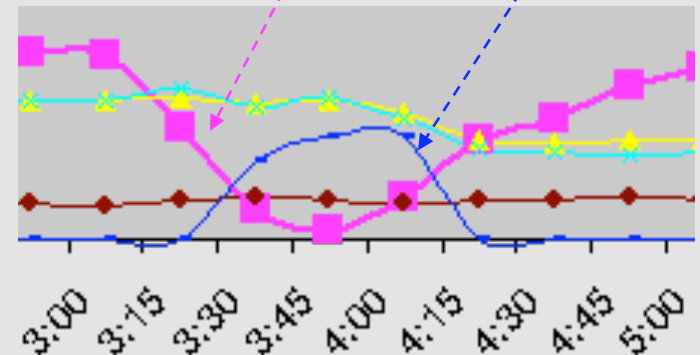
Supply exceeds Demand at minimum load



Variability Events

Wind drop off over 15 minutes

Flexible unit started to fill gap





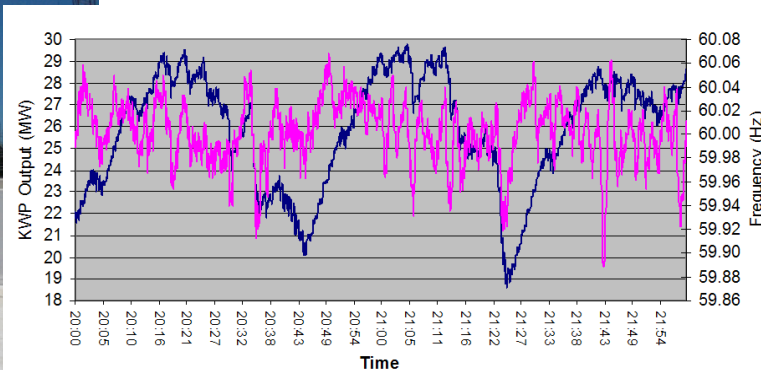
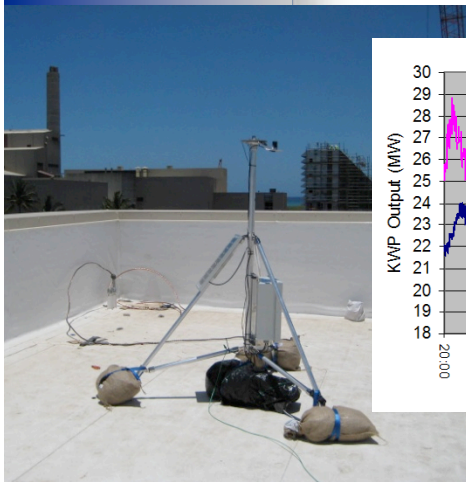
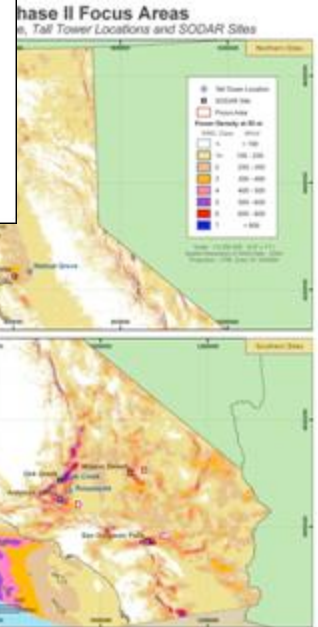
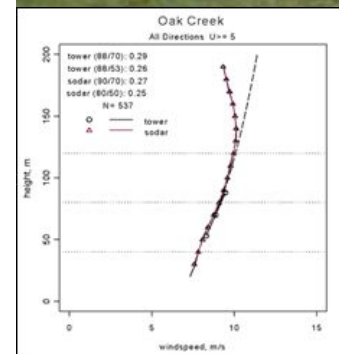
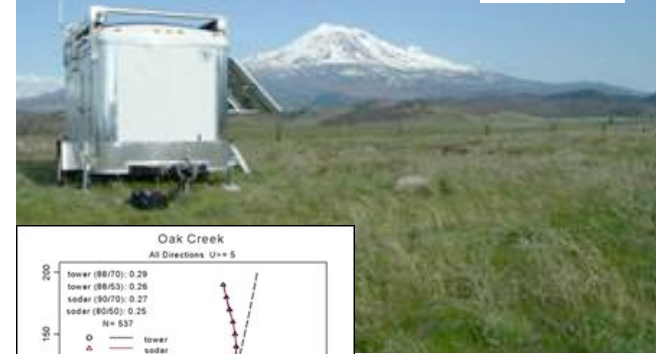
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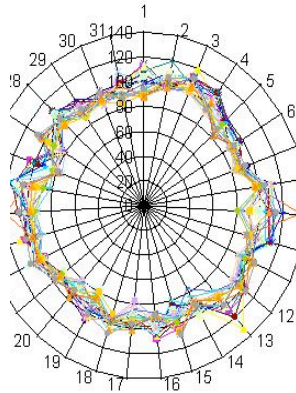
Awareness: New Hi-Res Data, Remote Sensing in 4-D Space

- Develop high resolution wind and solar time series data for ramp event forecasting & integration analysis (CA, HI, OR partnership)
- Deployment of hi-resolution data monitoring equipment to characterize resource (wind, solar, distribution-level data)
- Support building of operator confidence in use of new forecasting tools and observational data

Ex. SODAR unit in the field



Solar Resource Monitoring Efforts in HI



Wind Resource Monitoring in CA

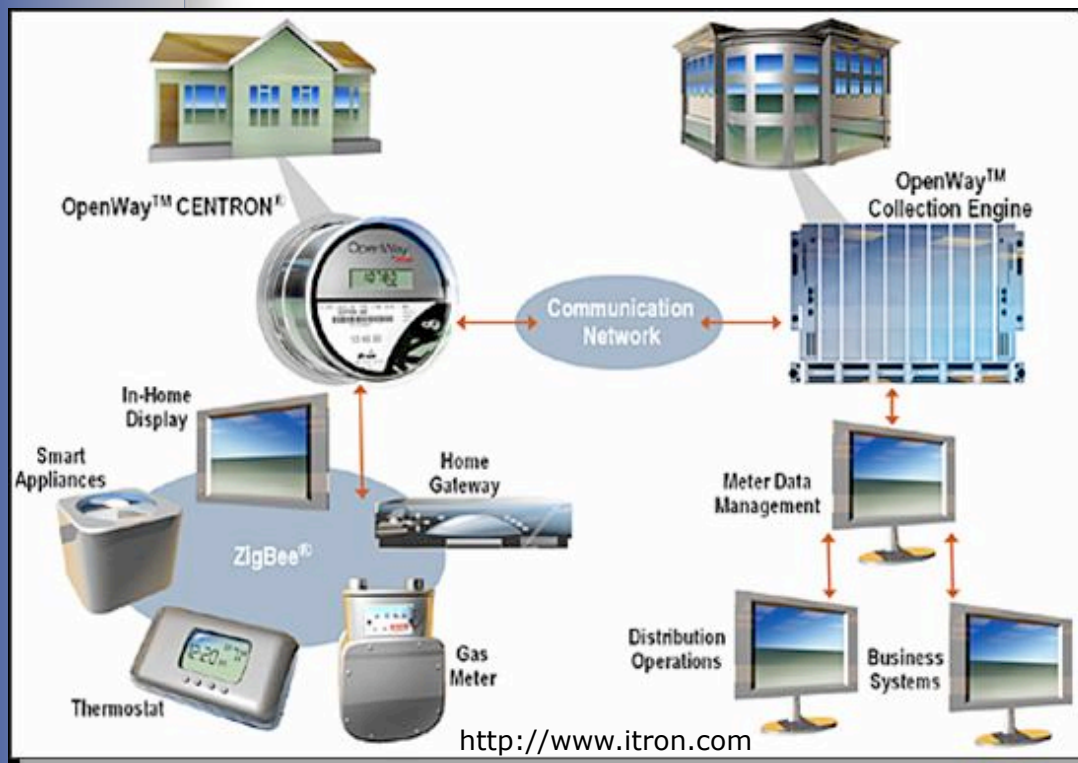


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Resilient Infrastructure & Knowledgeable Workforce

- Redundancy & security of related infrastructure
- Responsiveness to central control
- Bi-directional flow & control (of data & electrons)
- Interoperability & operator confidence



* Illustrative



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Tangible Technologies

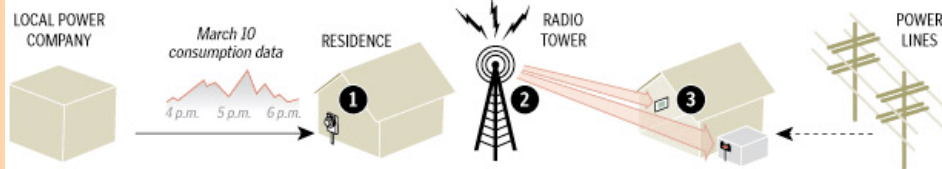
Study, pilot & demonstrate



Empowering Customers

How smart
grids can
avoid
blackouts

- 1 A power company can remotely collect hourly usage data from smart meters to identify potential power failures during high-demand periods.
- 2 The utility can redistribute power across its service area by sending a radio signal to customers' smart thermostats inside their homes or smart switches attached to their central air-conditioning compressors.
- 3 The signal turns power on and off to the air-conditioning compressor for up to four hours. After the cycling, power is fully restored.



How smart
grids can
help save
energy

GATHERING DATA

Smart meter
Installed by the utility company to replace a home's analog meter; it transmits hourly usage data to the utility.



Customers can view daily usage data online and decide when to conserve power and save money.

CONTROLLING POWER

Smart thermostat
Installed inside of a house by the utility company; allows customers to manage energy use, enables utility to cycle power on and off to central air-conditioning compressor.



Customers can participate in a utility's incentive program for credit, allowing the company to reduce power via the thermostat.

Smart switch
Attached to a switch to a home's central air-conditioning compressor; can cycle the air conditioning on and off.



Customers participating in incentive programs allow the utility to cycle power on and off to their air conditioning for a credit.

Minimize risks by ensuring operational fit

- Assess technology performance via demonstration and pilots
- Facilitate demonstration and lessons learned on new devices and control protocol
- Improving industry decision tools and simulation models
- Track, trend and monitor renewable performance data to inform mitigation strategies

Touch, Feel, Hear, Taste, Smell

Ex: Utilities deploying State-of-the-Art technologies



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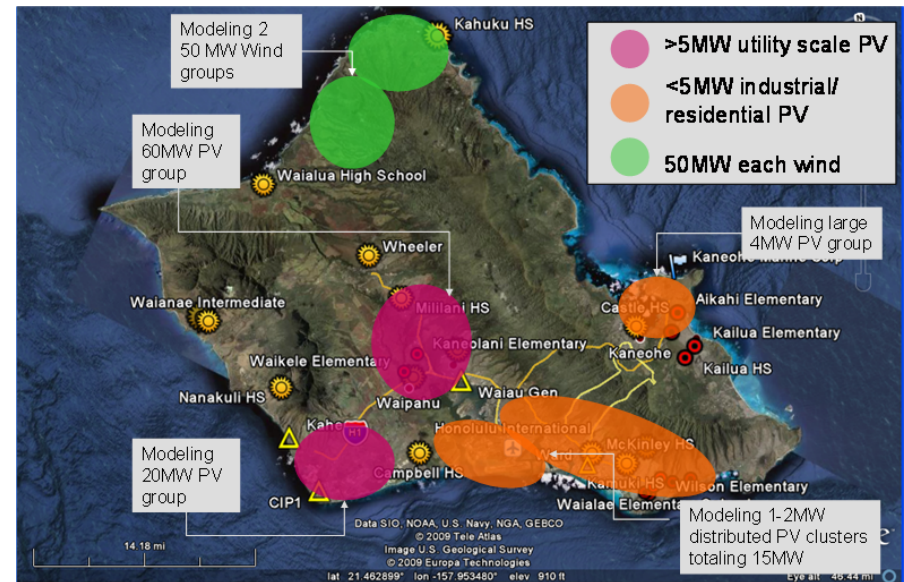
What Else Are We're Doing

Activities

- Renewable Resource Characterization
- Workforce Training & Education Pipeline
- Education Programs – Collaborations with Univ.
- Working on ARRA funded efforts in WindSense ramp forecasting and smart grid switching technologies demonstration and pilot efforts with mainland utility and industry partners

What are We striving toward?

- Energy price stability
- Reduce dependency on fossil fuels
- Management of risks and unintended consequences



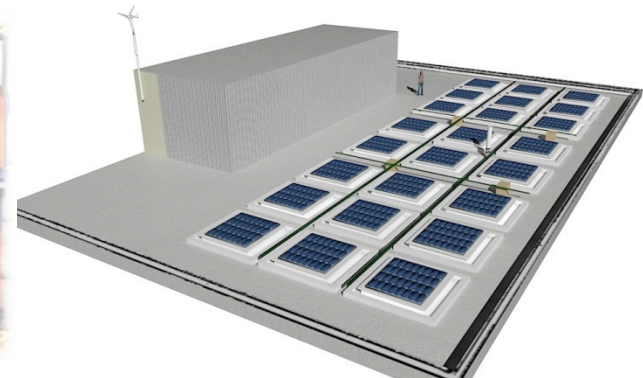
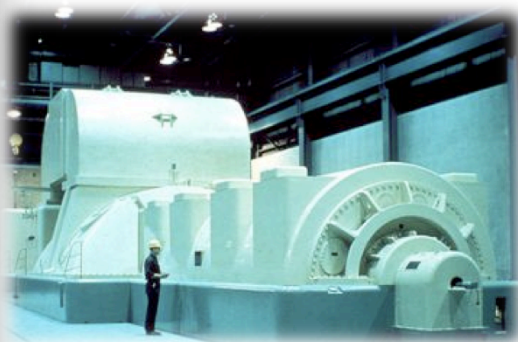


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Foundational & Rapid Workforce Training Concepts

- Utility/academia partnerships
 - Reinstate foundational electrical power generation curriculum
 - Provide hands-on training and internship
 - Build workforce pipeline to sustain green energy workforce for the islands
- Conduct research on new technologies and gain operating experience via demonstration pilots
- Non-traditional short-course offerings to provide existing workforce continuing education, retooling and retraining opportunities



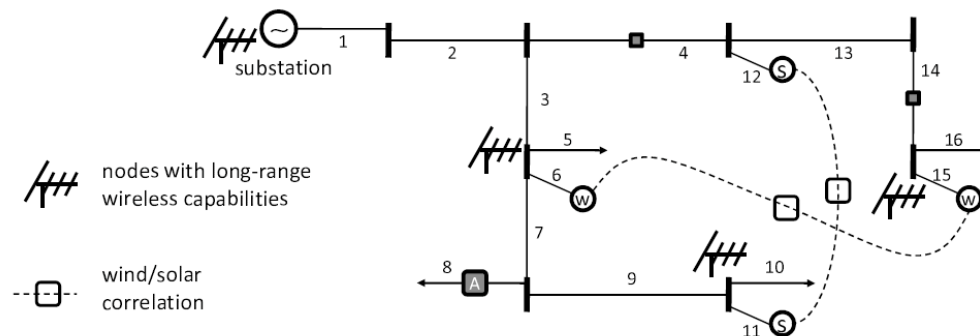


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Micro-grid Research

- **Joint UH-HECO-CMU research project**
- **Study micro-grids**
 - **Model using signal processing**
(probabilistic models use factor graphs)
 - **Estimation: distributed sources, parameters**
 - **Control and optimization**
 - **Security: Privacy and attacks**
 - **Hardware: Embedded systems**
 - **Software: Smart Homes**





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Questions/Comments??



Mahalo

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