

# Challenges and Solutions for Low Carbon Future

Northeast Asia Economic Forum  
12<sup>th</sup> Expert Working Group Meeting on  
Energy and Environment  
March 20, 2012



Hawaii can substitute renewable sources of energy to substitute, in total, for the use of fossil fuels in the generation of electricity.

# Three areas of challenge

- Schedule/Timing
- Technical (Grid) challenges
- Financial issues

# Schedule/Timing

- Available now:
  - Solar
  - Wind
  - Biomass/waste
  - Geothermal – Maui and Hawaii only
- Available near term (10 yrs. or less):
  - Geothermal – large volume
  - Biofuels
- Available longer term (10 yrs. or more):
  - Wave energy
  - OTEC

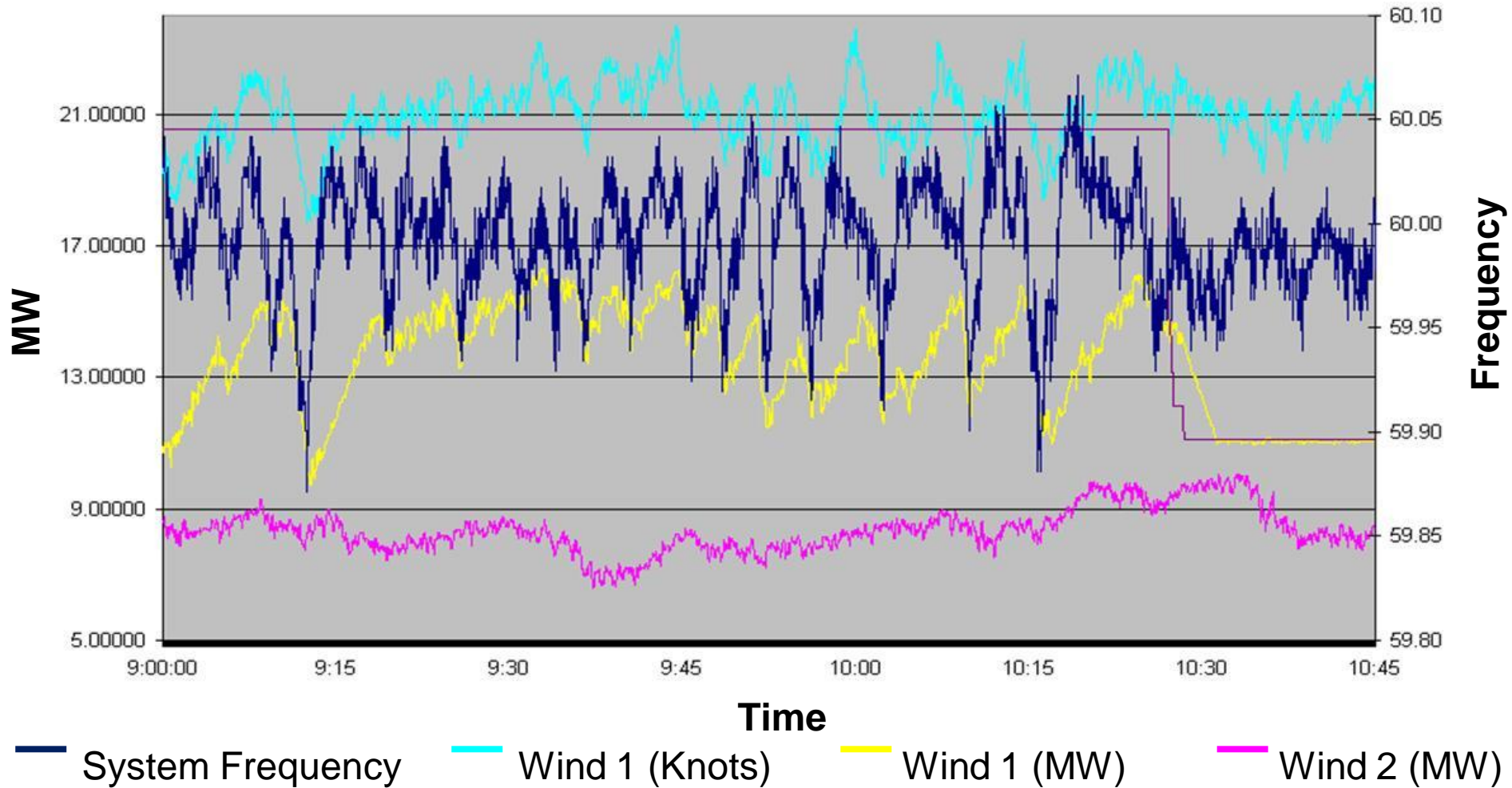
# Grid challenges

- Frequency management
  - System frequency
  - Dynamic response (inertia, droop, etc.)
- Voltage management
  - Voltage regulation – maintaining service within tariff requirements
  - Flicker
  - Ground fault overvoltage
- Circuit protection schemes – fault current

# And the impact (and challenges) vary by generator technologies

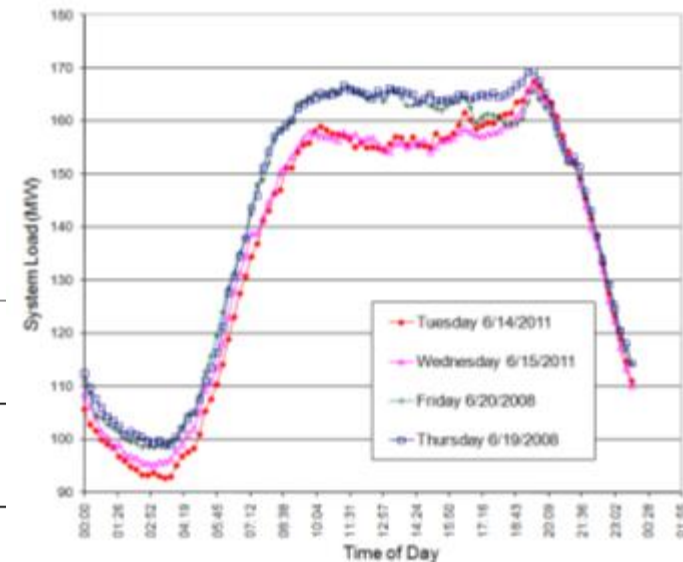
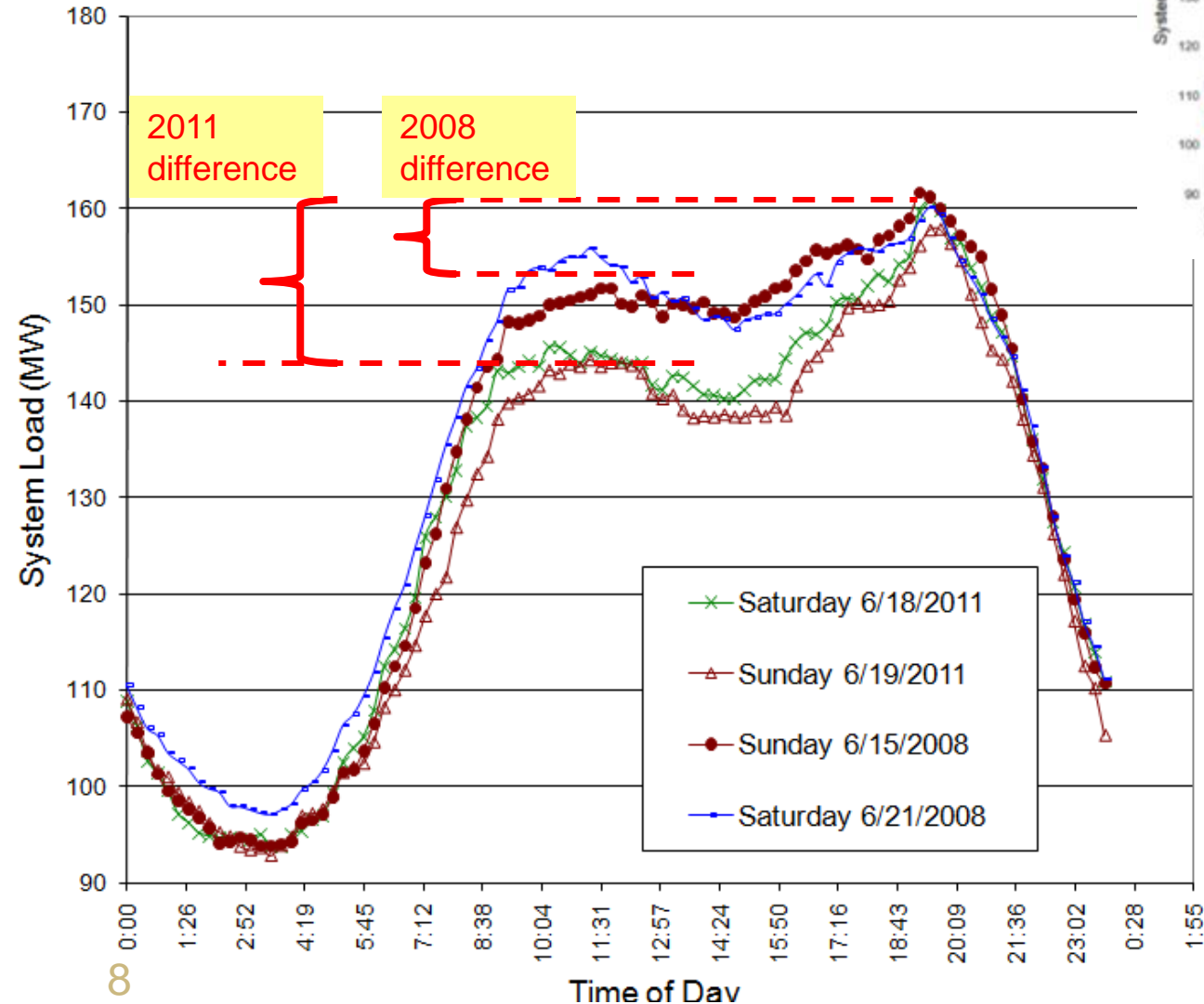
- Wind
  - Generation potential 24/7 – excess energy
  - Ramping
- Solar
  - Generation potential during daylight only but tends to match load curve
  - Ramping considerably faster than wind

# Impacts on System Frequency



# Distributed PV impacts on system load

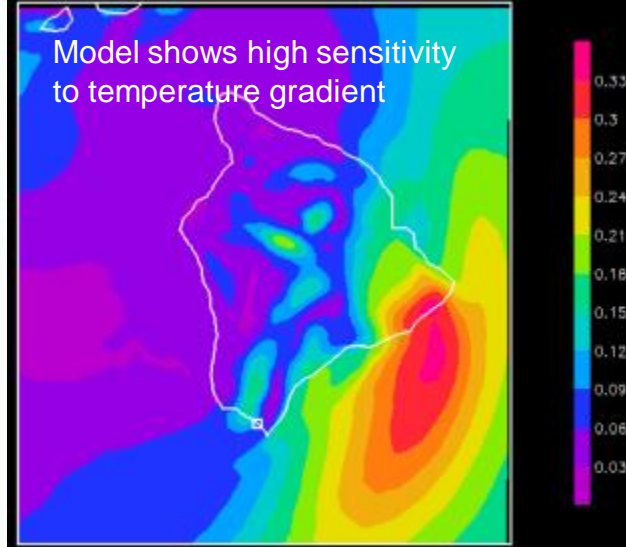
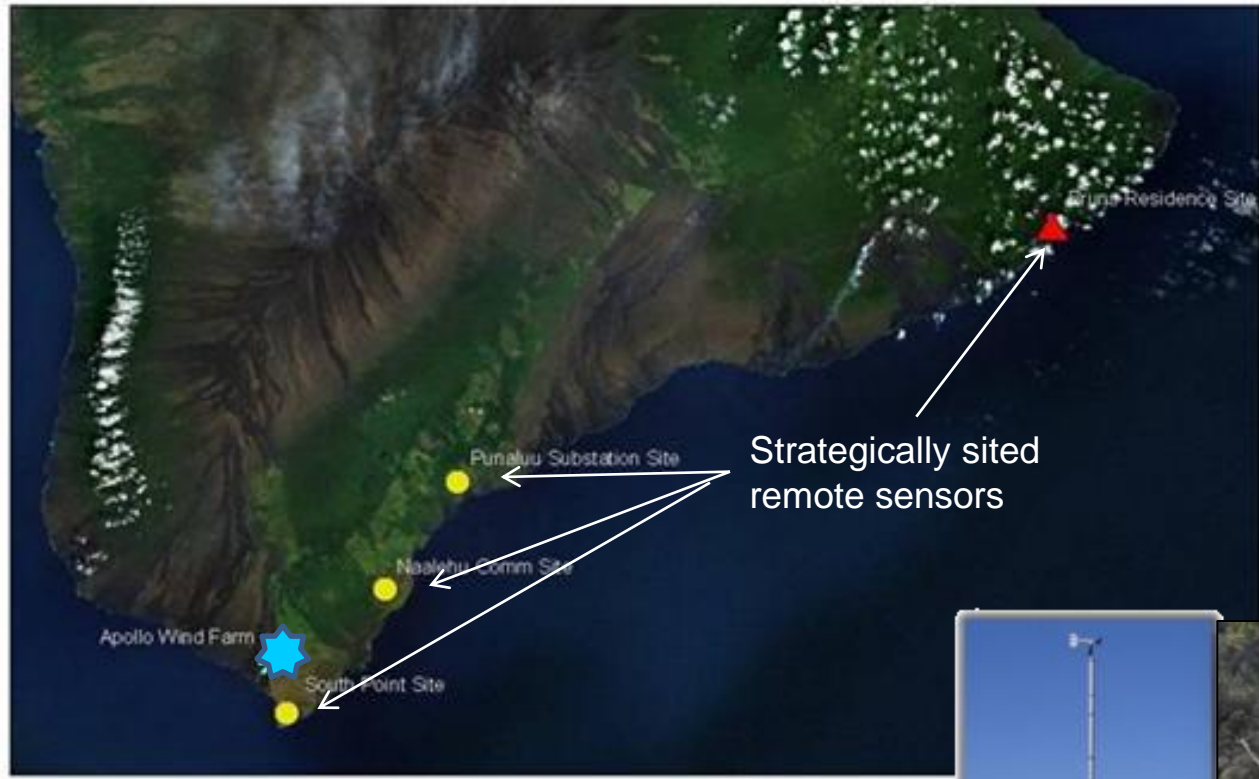
Source: HELCO



- Weekday comparison: evening peak has not significantly changed between 2008 and 2011 but daytime demand has.
- Weekend comparison (light load day): difference between daytime peak and evening peak has increased.



# Developing & Operationalizing “Heads-up” Wind & Solar Forecasting Capabilities



**WINDNET EQUIPMENT LOCATIONS**

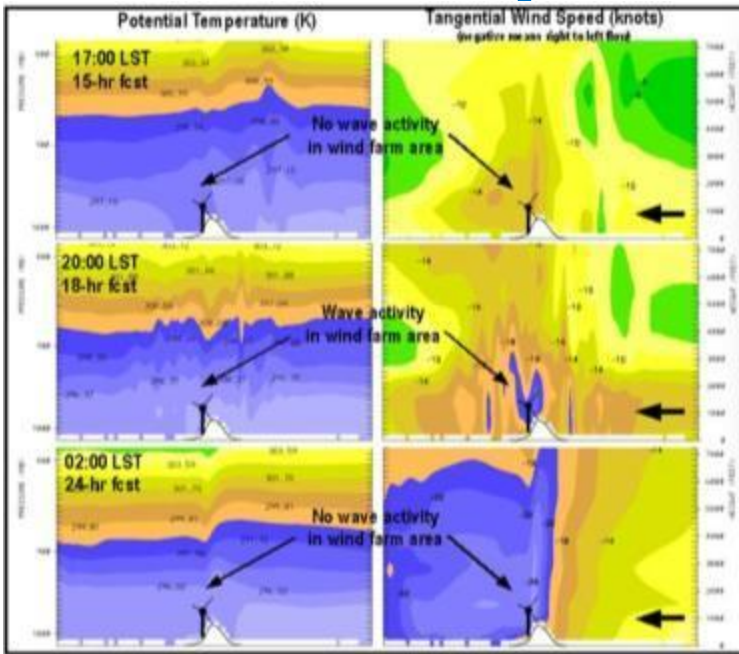
|  |                     |
|--|---------------------|
|  | Sodar Location      |
|  | Radiometer Location |
|  | Wind Farm Location  |



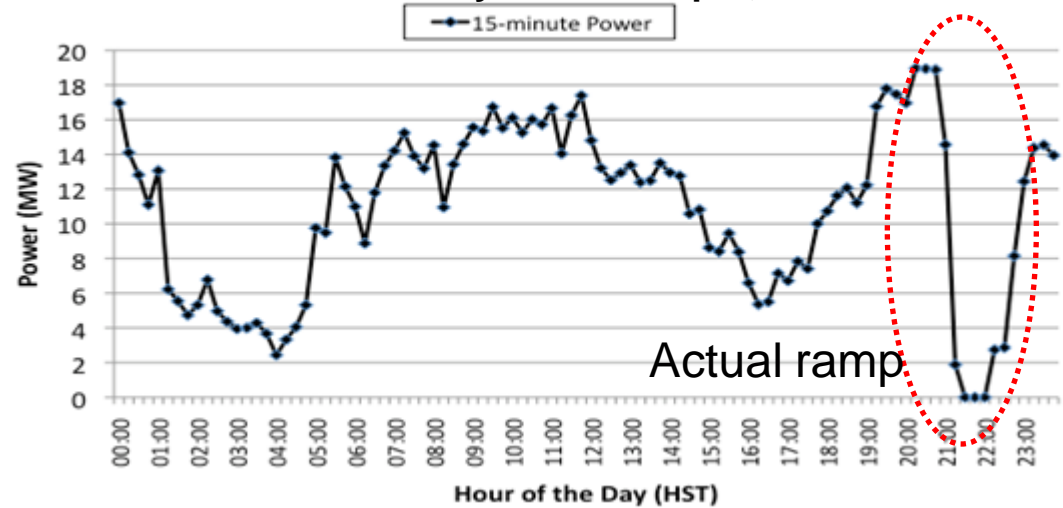
Using state-of-the-art forecasting models and remote sensors (SODAR, radiometer) ahead of wind facility to provide operators 30 min to 1 hr “heads-up” on potential ramp events.



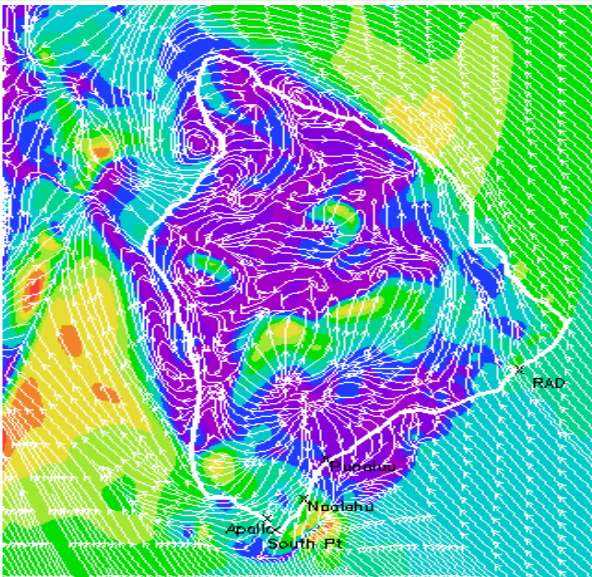
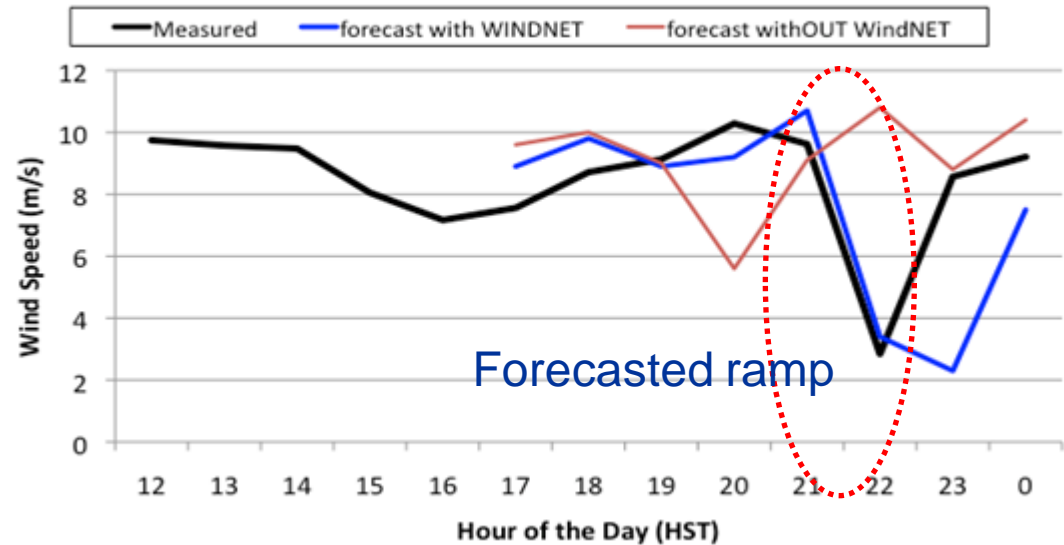
# Wind Ramp Event Forecasting



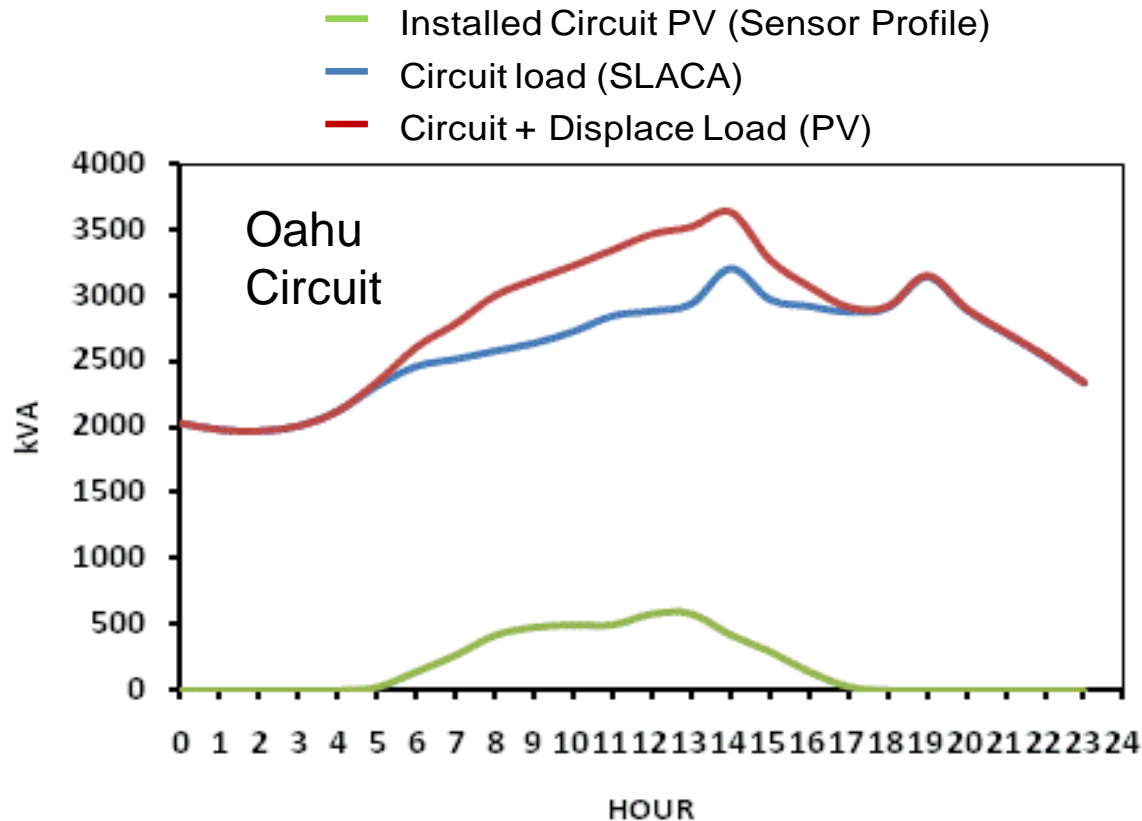
## Wind Facility Power Output, 12/19/10



## NWP Wind Speed Forecast, 12/19/10



# Hi-Pen PV Impact on the Grid - Substation Circuit Monitoring & Analysis (Operations)



- Low-cost capability to account for PV load and actual load for forecasting, operations & planning
- Correlate grid conditions with solar variability to assess impacts (operations, protection, contingencies, reserve plans)



TJD-1 mobile solar irradiance sensors



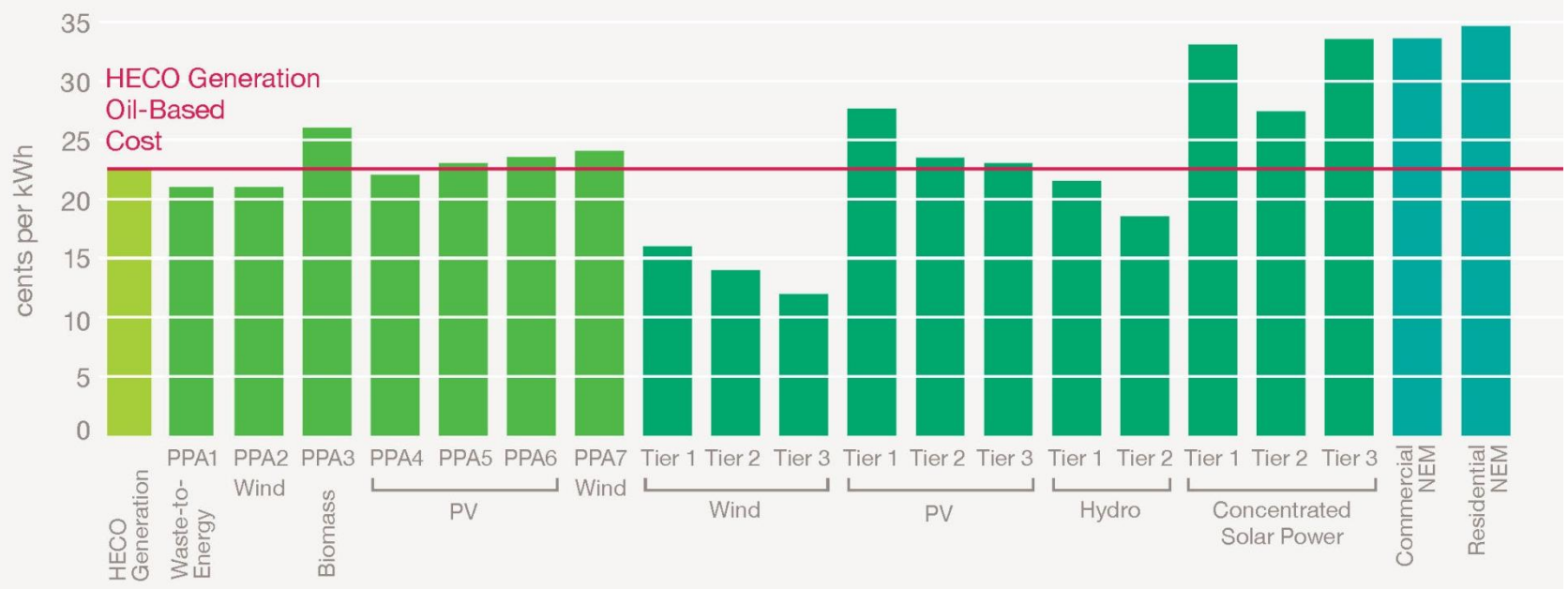
LM-1 solar availability sensors



# Oahu Generation Cost

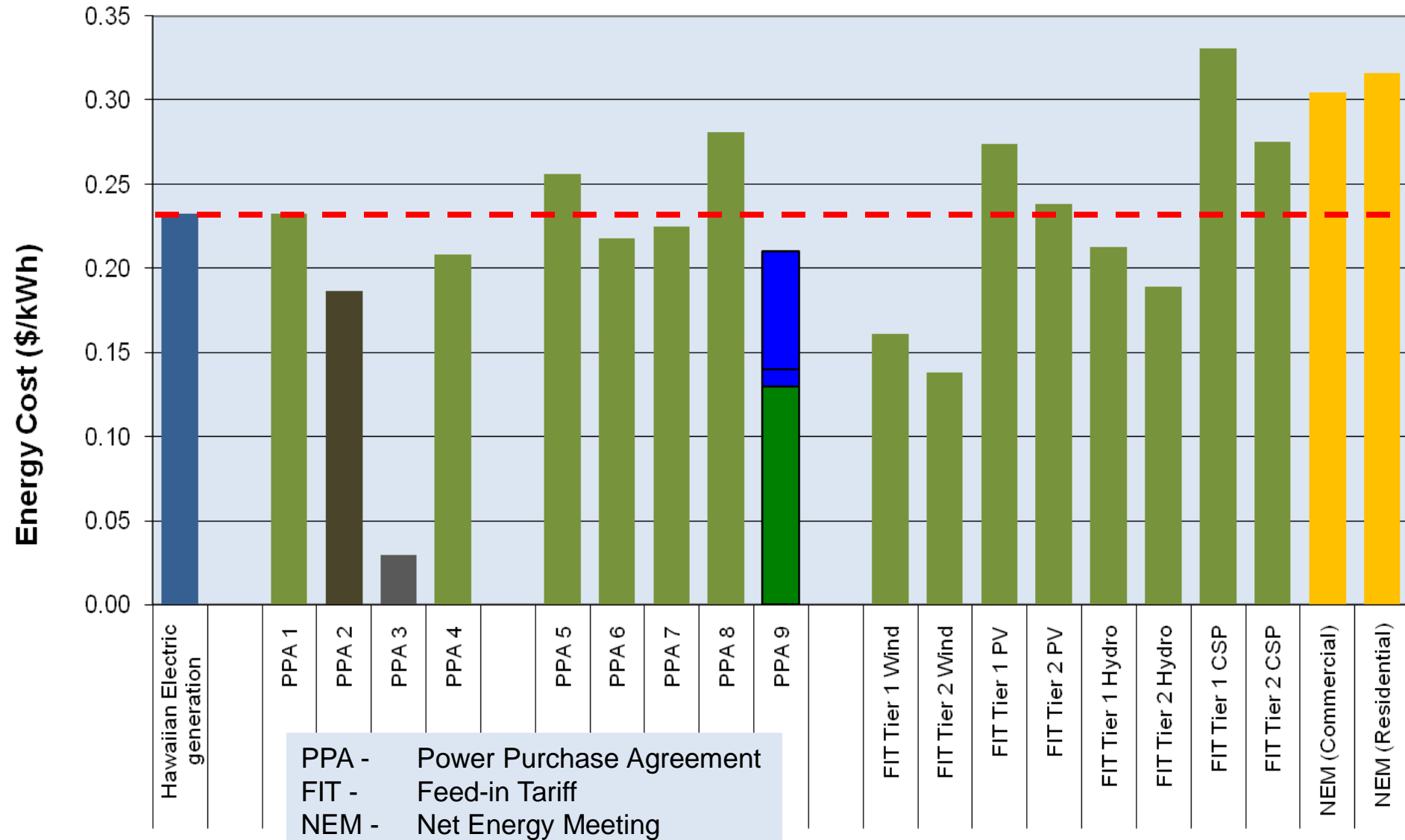
Low Sulfur Fuel Oil (LSFO) at \$132/BBL

■ Power Purchase Agreement (PPA)
 ■ Feed-In Tariff (FIT)
 ■ Net Energy Metering (NEM)



# Oahu Energy Cost

Fuel oil at \$132/BBL

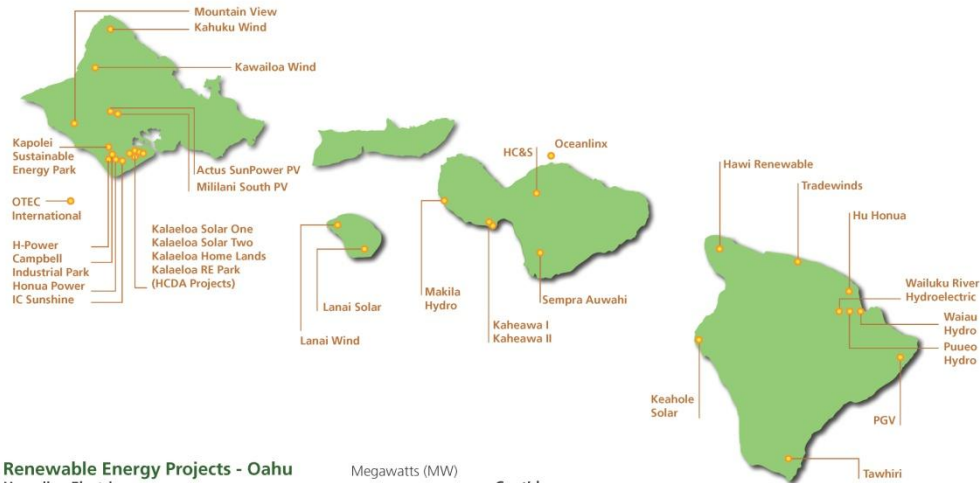




Hawaiian Electric Company  
Maui Electric Company  
Hawaii Electric Light Company

# Renewable Energy Projects

(Projects in service, under construction or in active negotiation as of 1/7/2012)



## Renewable Energy Projects - Oahu

| Hawaiian Electric                 |                                 | Megawatts (MW) |
|-----------------------------------|---------------------------------|----------------|
| • Campbell Industrial Park        | Biofuels                        | 110            |
| <b>Existing, Approved PPAs</b>    |                                 |                |
| • H-Power                         | Waste-to-energy                 | 46             |
| • Kahuku Wind                     | Wind                            | 30             |
| • Kapolei Sustainable Energy Park | PV                              | 1              |
| • Kawaiioa Wind                   | Wind; Under construction        | 69             |
| • Honua Power                     | Biomass; Construction to come   | 6              |
| • IC Sunshine                     | PV; Construction to come        | 5              |
| • Kalaela Solar Two               | PV; Construction to come        | 5              |
| <b>Pending PUC Approval</b>       |                                 |                |
| • Kalaela RE Park                 | PV                              | 5              |
| <b>Under Negotiation*</b>         |                                 |                |
| • OTEC International              | Ocean thermal energy conversion | 100            |
| • Mountain View                   | PV                              | 5              |
| • H-Power Expansion               | Waste-to-energy                 | 27             |
| • Kalaela Solar One               | Concentrated solar              | 5              |
| • Kalaela Home Lands              | PV                              | AES Solar 5    |
| • Millilani South                 | PV (4 projects)                 | 20             |
| • Actus SunPower                  | PV                              | 5              |
| • (HCDA Projects)                 | PV                              | 5              |

## Renewable Energy Projects - Maui County

|                                |                            |     |
|--------------------------------|----------------------------|-----|
| <b>Existing, Approved PPAs</b> |                            |     |
| • HC&S                         | Biomass                    | 16  |
| • Kaheawa I                    | Wind                       | 30  |
| • Lanai Solar                  | PV                         | 1.2 |
| • Makila Hydro                 | Hydro                      | 0.5 |
| • Kaheawa II                   | Wind; Under construction   | 21  |
| • Sempra Auwahi                | Wind; Construction to come | 21  |
| <b>Under Negotiation*</b>      |                            |     |
| • Lanai Wind                   | Wind                       | 200 |
| • Oceanlinx                    | Wave                       | 0.5 |

## Renewable Energy Projects - Hawaii Island

|                                      |       |      |
|--------------------------------------|-------|------|
| <b>Hawaii Electric Light Company</b> |       |      |
| • Wailuku River Hydroelectric        | Hydro | 12.1 |
| • Waiau Hydro                        | Hydro | 4.35 |
| • Puueo                              | Hydro | 4.35 |

## Cont'd

| Existing, Approved PPAs                 |                    | Megawatts (MW)   |
|---|--------------------|------------------|
| • PGV                                   | Geothermal         | 30               |
| • Tawhiri                               | Wind               | 20               |
| • Hawi Renewable                        | Wind               | 10.5             |
| • Keahole Solar                         | Concentrated solar | 0.5              |
| • PGV expansion                         | Geothermal         | 8                |
| <b>Under Negotiation*</b>               |                    |                  |
| • Hu Honua                              | Biomass            | 22               |
| • Tradewinds                            | Biomass            | 3.6              |
| <b>Renewable Energy Projects Total:</b> |                    | <b>854.60 MW</b> |

## Feed-In Tariff Status (PV) (as of 12/31/2011)

|                               | Installed Capacity | Active Development Queue |
|-------------------------------|--------------------|--------------------------|
| Hawaiian Electric Company     | 1.79               | 55.82                    |
| Maui Electric Company         | 0.33               | 8.99                     |
| Hawaii Electric Light Company | 0.25               | 9.18                     |
| <b>FIT Total:</b>             | <b>2.37 MW</b>     | <b>73.99 MW</b>          |

## Net Energy Metering (NEM) (as of 12/31/2011)

|                               | Installed       |
|-------------------------------|-----------------|
| Hawaiian Electric Company     | 31.11           |
| Maui Electric Company         | 12.56           |
| Hawaii Electric Light Company | 10.24           |
| <b>NEM Total:</b>             | <b>53.91 MW</b> |

## Standard Interconnection Agreements (SIA) Installed

|                   |                 |
|-------------------|-----------------|
| <b>SIA Total:</b> | <b>14.51 MW</b> |
|-------------------|-----------------|

## Other (all islands)

|                       |                |
|-----------------------|----------------|
| <b>Other Total:**</b> | <b>5.95 MW</b> |
|-----------------------|----------------|

## Renewable Energy Projects Total: 1005.33 MW

(Renewable Energy Projects, FIT, NEM, SIA, Other)

\* Projects listed as under negotiation are projects that have been publicly disclosed.  
\*\* Small RE projects such as Sun Power for Schools.

**Mahalo!**