

# Aggregate Distributed Generation and Island Operations

Focus on MECO and HELCO systems



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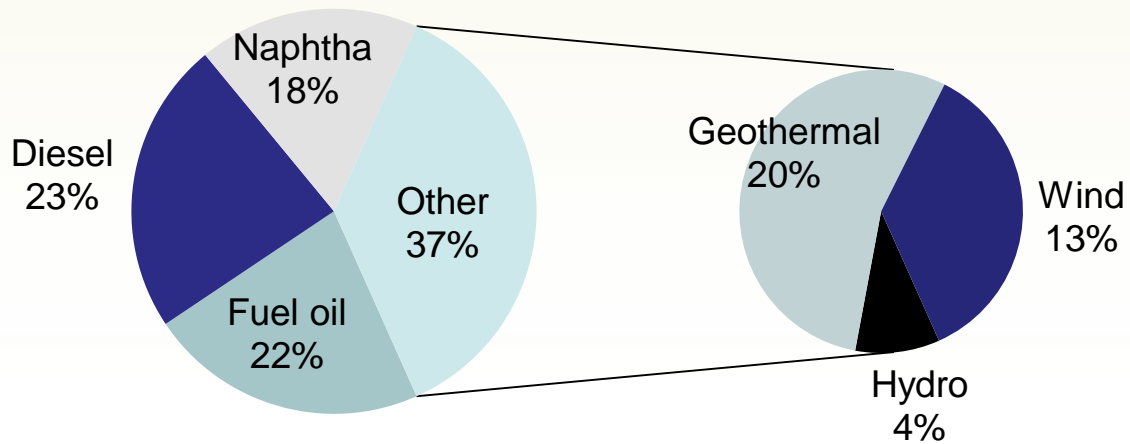
**UWIG Solar User Group**

**October 11, 2011**

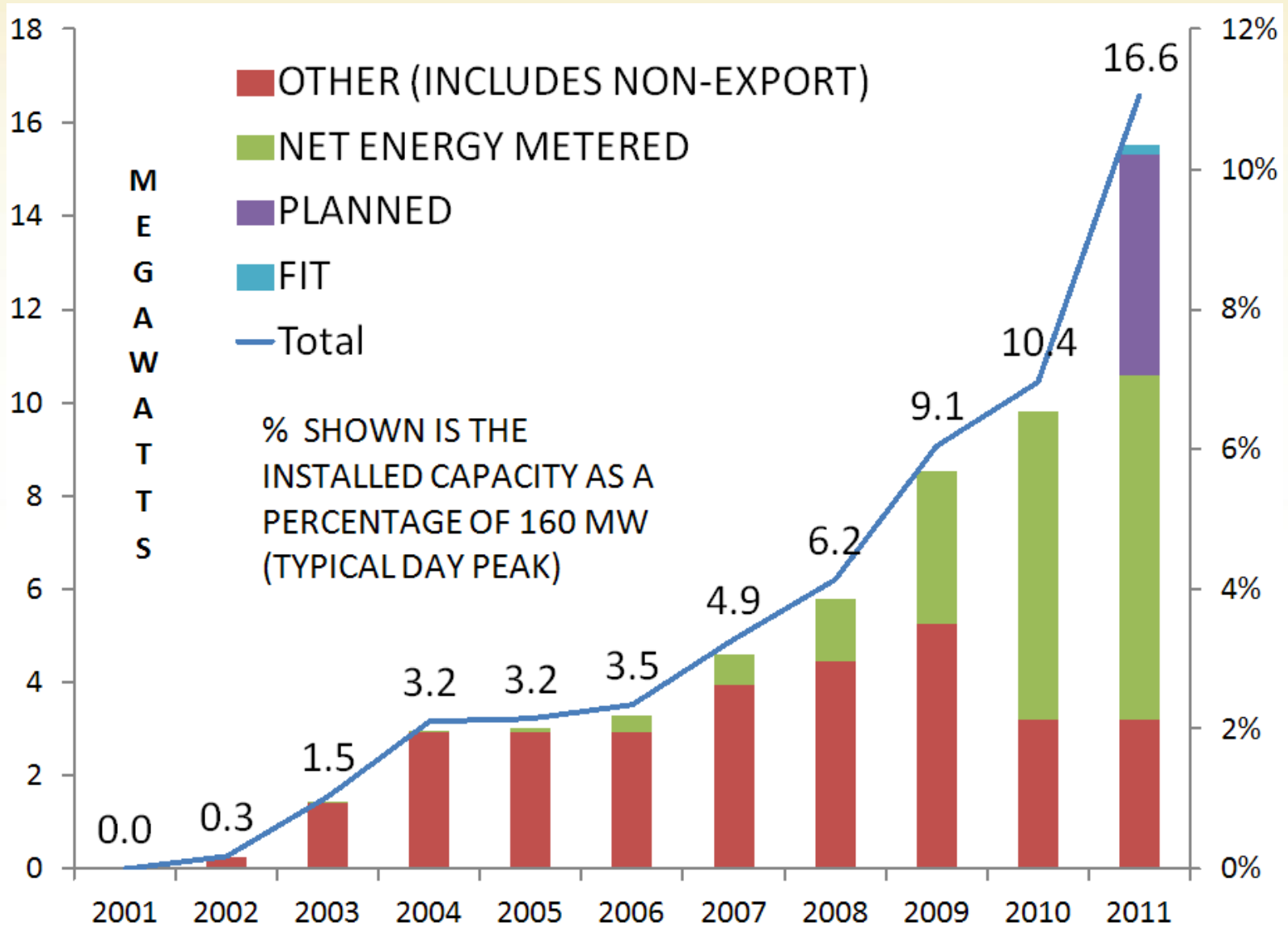
# Overview of HELCO and MECO Systems

- Small autonomous systems (no interconnections)
- High costs
- Close to limits of stable operation
- High penetration of variable generation
- High penetration of distributed generation
- Large amount of renewable energy (wind, hydro, geothermal, biomass and solar)
- Demand is decreasing at HELCO
- Excess Energy problems
- MECO and HELCO systems very similar in size, issues

# HELCO NET-TO-SYSTEM GENERATION THROUGH SEPT 2011 (EXCLUSIVE OF UNMONITORED DISTRIBUTED GENERATION)



# HELCO Variable DG



# Operational Concerns

- Monitoring, control, and forecasting are not available
  - Apparent load (demand – distributed PV) difficult to forecast, unit commitment
  - Impact on intra-hour variability is not known
  - Frequency control/balancing already a challenge
  - System restoration concerns

# Operational Concerns

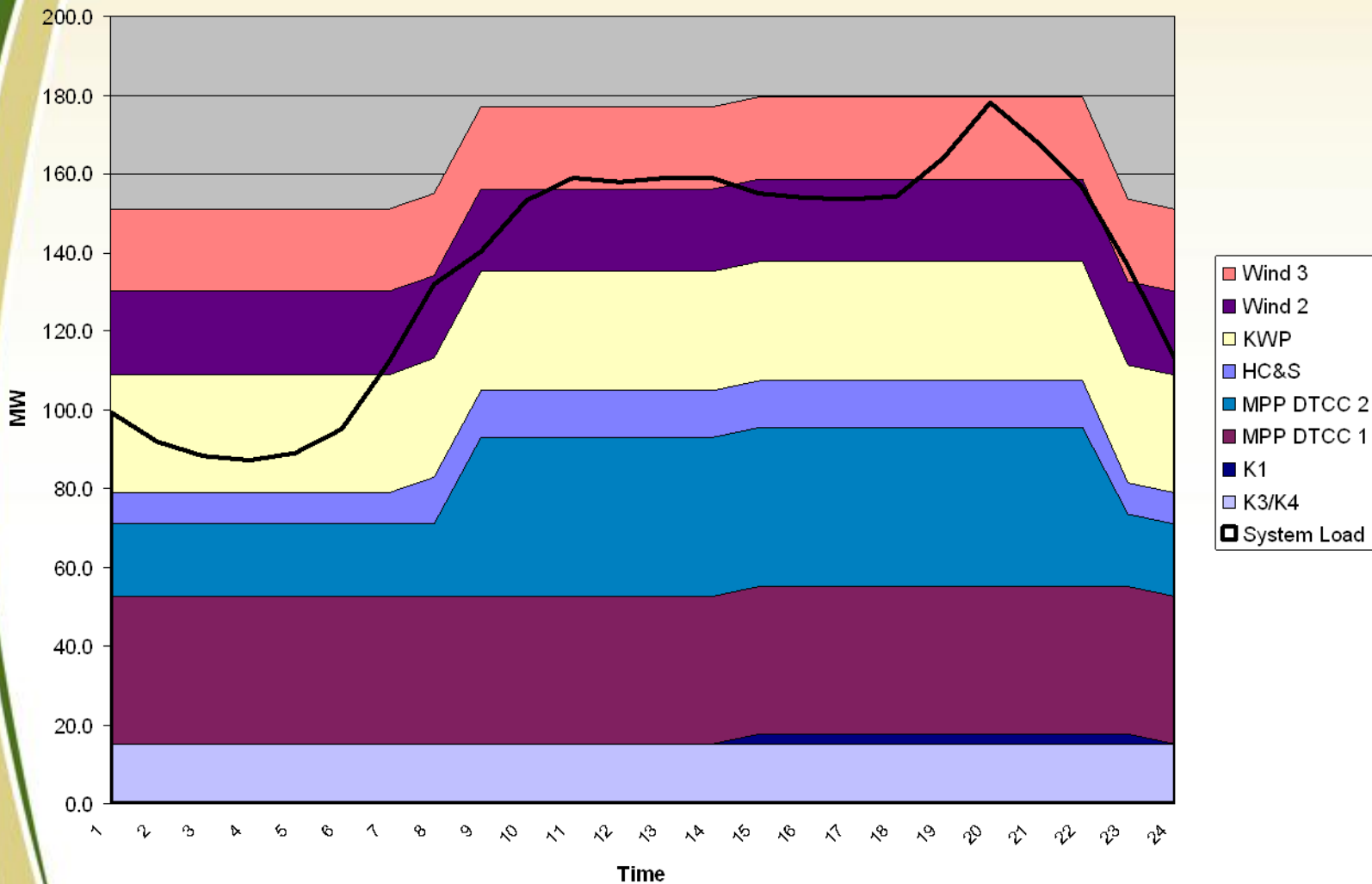
- Displacement of generation performing critical grid services
- Displacement of lower-cost energy
- Contributing to excess energy
- Aggregate loss of distributed PV during faults and contingencies – due to nuisance trips
  - HELCO: First UF stage at 59.3 Hz, Last stage at 57.7 Hz

# Excess Energy Mitigation

- Provide monitoring and curtailment capabilities on all generation, including DG
  - System Operator must be able to administer
  - Need clear and equitable rules
- Storage may be technically feasible (centralized or distributed) but at present remains an uneconomic solution given amount of excess energy
- DG on HELCO will displace dispatchable RE, potentially non-dispatchable RE to some extent
- DG on MECO will displace wind to some extent

# DG will Displace Other RE (Maui-Future)

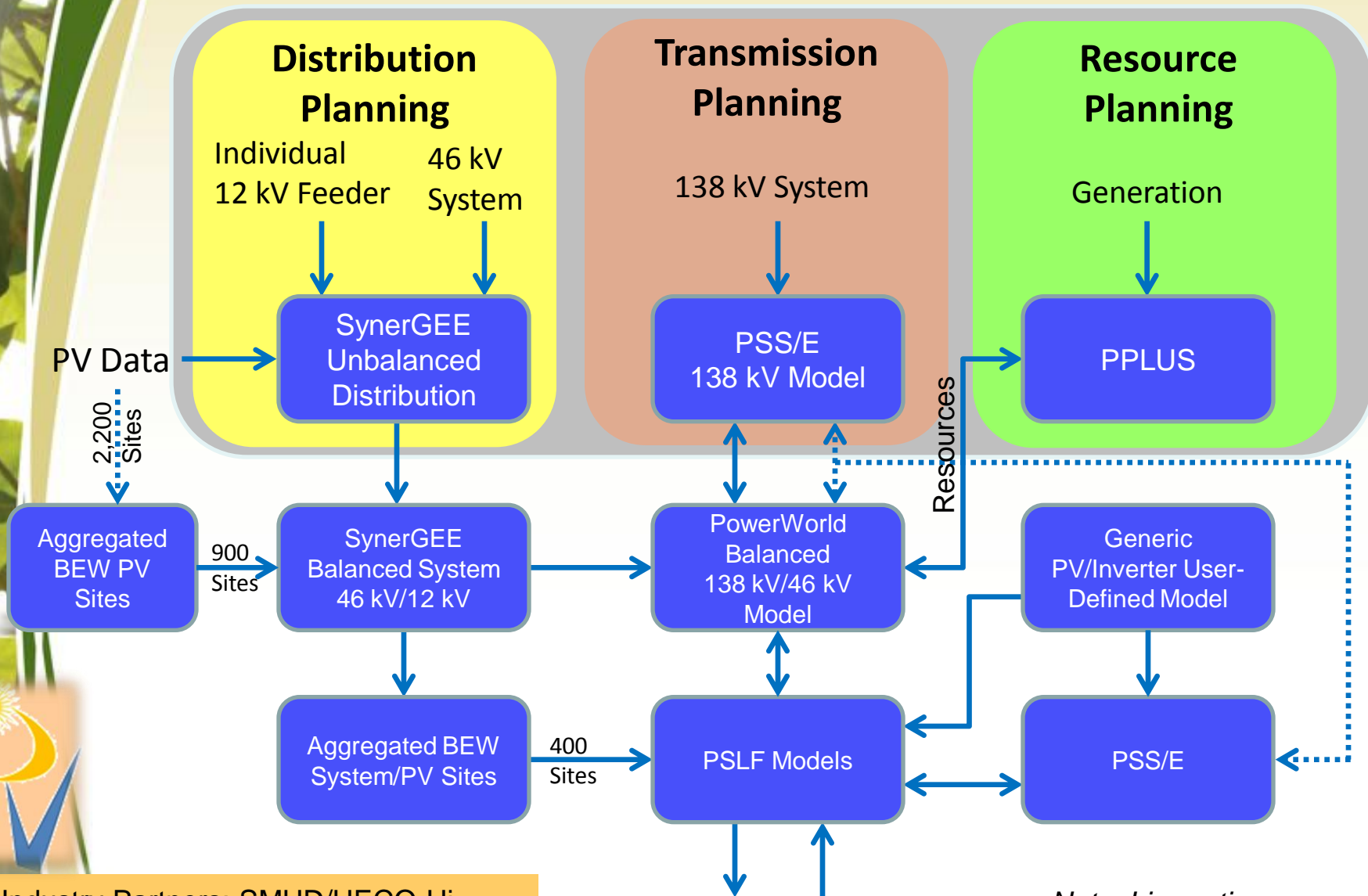
Maui Generation modeled with additional Wind Farms - 02/02/09



# System Studies

- DG interconnection historically focused on individual project and circuit impacts
- Evaluate aggregate impact of DG on system
  - Ensure system operates w/in limits, remains operable through faults and contingencies, can be restored
  - Identify system changes
  - Identify interconnection requirements
  - Identify changes in existing operational policies
- Incorporate into DG technical requirements in standard interconnection (Rule 14H) such as these identified :
  - Remote monitoring and control
  - Off-normal voltage and frequency trip settings to remain connected through disturbances

# Linking Data to Models



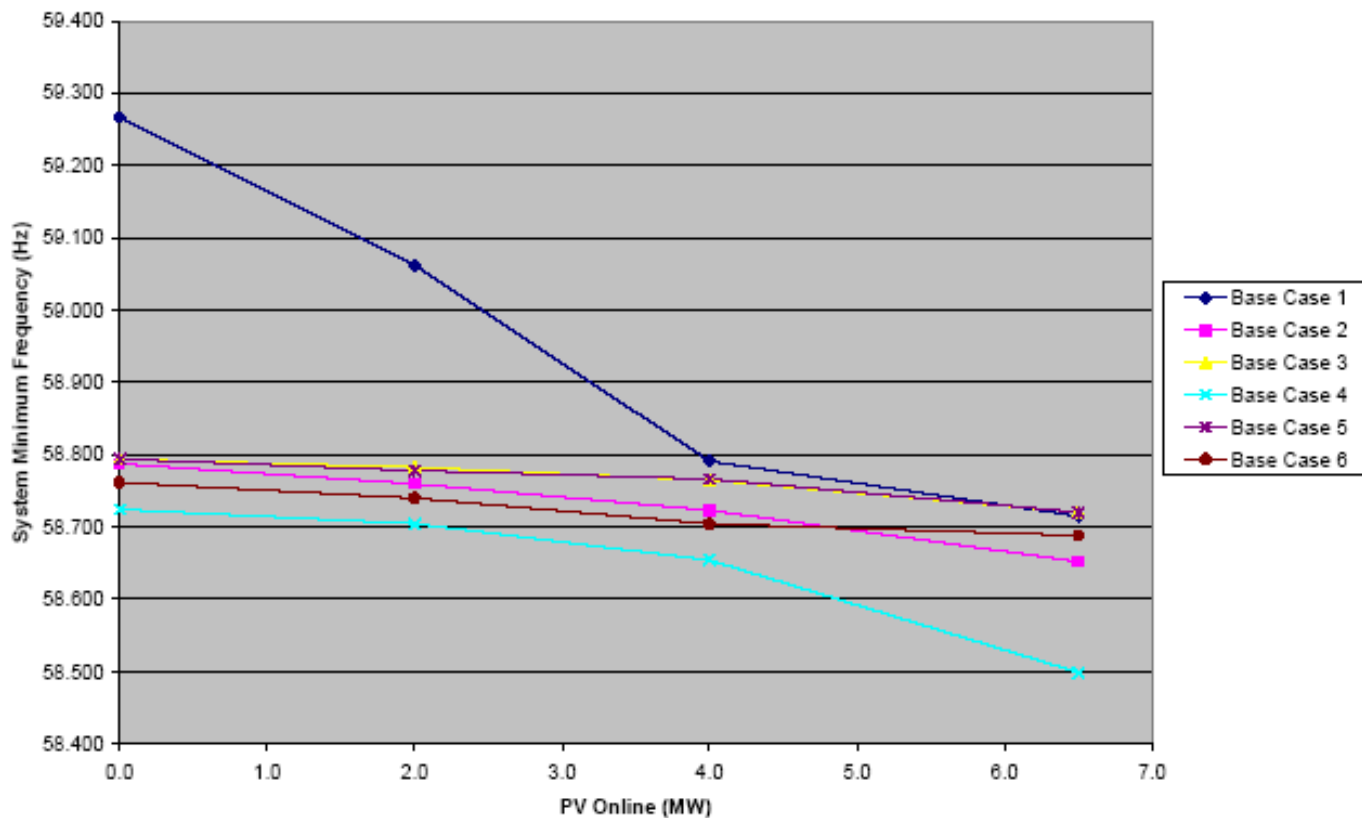
Industry Partners: SMUD/HECO Hi-Penetration Initiative, BEW Engineering, GL Noble Denton, GIS & EMS providers

Note: Line ratings shown for Oahu system for illustration

# Example Completed PV Study – Impact of Aggregate Loss during Unit Trip

Figure 2 – Minimum Frequency vs. PV Penetration

Trip Puna, EPS Load Shed Scheme



## Other Work...

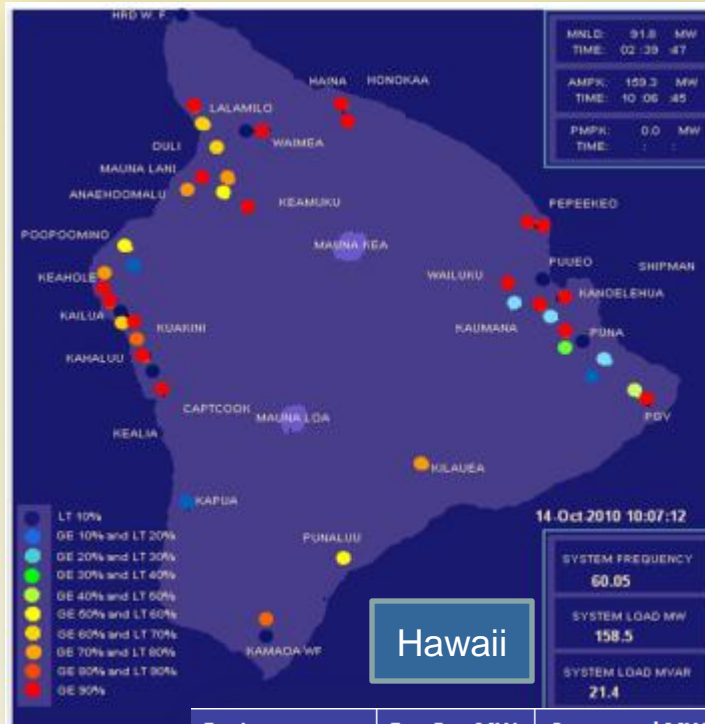
- Real-time stability data captured through use of synchrophasor data
- Investigating alternative communications/controls measures for low-cost monitoring and control of DG (Interested in EDF French Islands solution)
- System models to incorporate distr. load and gen
- Incorporate lessons learned from other high penetration areas (Europe, other islands)
- Operator tools: Visualization and estimation of island PV production
- Other projects to study/mitigate circuit-level issues

# Provide Real-time Operational Visibility to PV Availability

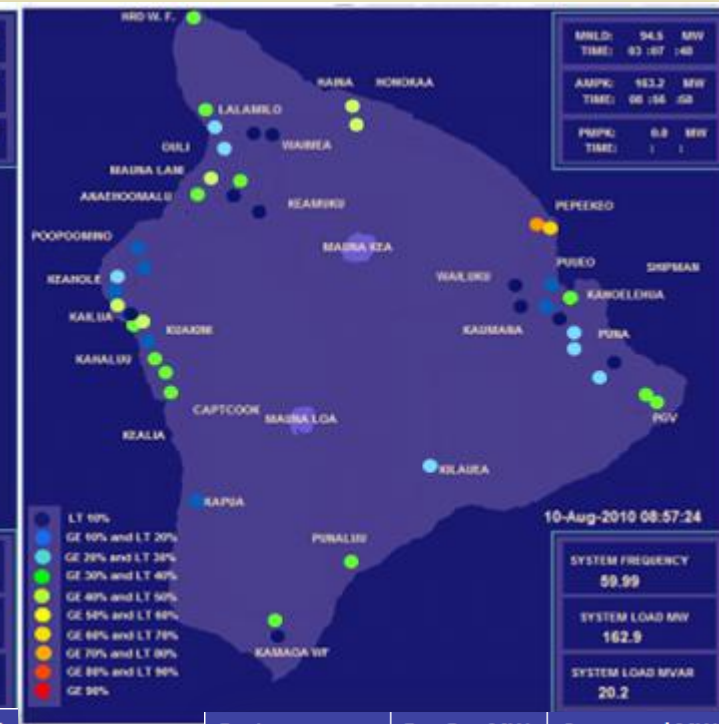


LM-1 solar availability sensors

Ability to visually monitor and plan for “behind the meter” production on the system



Region	Est. Gen MW	Connected MW
North Hawaii	1.3	1.7
East Hawaii	2.9	4.1
West Hawaii	2.6	3.7
South Hawaii	0.0	0.1
<b>Total PV (MW)</b>	<b>6.8</b>	<b>9.6</b>



Region	Est. Gen MW	Connected MW
North Hawaii	0.5	1.7
East Hawaii	0.8	4.1
West Hawaii	1.3	3.7
South Hawaii	0.0	0.1
<b>Total PV (MW)</b>	<b>2.6</b>	<b>9.6</b>

# Real-time Irradiance and Estimated PV

- The estimates are based on measured solar irradiance, converted to available per unit energy
- The per unit energy is used to estimate area PV production based on neighboring installed capacity
  - Manual update process
- EPRI project to evaluate data and, if verified, analyze effect on frequency control
- Operators have seen aggregate decline in irradiance (dots turn blue) correlate to reduction in apparent demand

**SOLAR SATURATION**

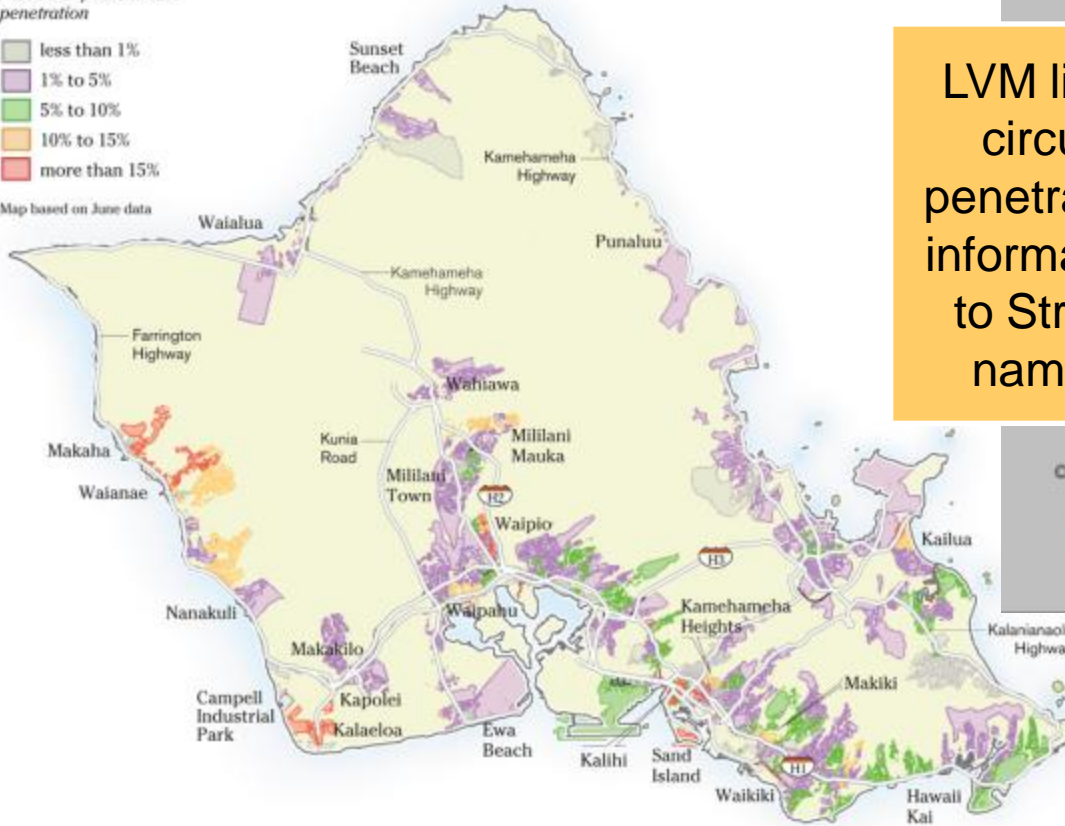
Hawaiian Electric Co. says 15 of the utility's 465 distribution circuits on Oahu have customer-owned photovoltaic systems that account for more than 15 percent of the peak load on that circuit. Once the 15 percent threshold is reached, customers on the circuit who want to install additional PV capacity may be required to undertake an expensive interconnection study.

# Developed LVM to Help Everyone See Areas of High Circuit Penetration

Percent of photovoltaic penetration

- less than 1%
- 1% to 5%
- 5% to 10%
- 10% to 15%
- more than 15%

Map based on June data



10% < DG - 15%  
DG > 15%

LVM links circuit penetration information to Street names

Street Name	Zip Code	Island
ANJANU ST	96789	OAHU
APAKU ST	96817	OAHU
APAKU ST	96817	OAHU
APOWALE ST	96797	OAHU
AURO ST	96819	OAHU
ALUNA PL	96789	OAHU
ALUNA ST	96789	OAHU
AULA ST	96817	OAHU
AUMAKA PL	96797	OAHU
AUPUNI ST	96817	OAHU
AUPUNI ST	96817	OAHU
AWAKUMOKU ST	96797	OAHU
AWALAU ST	96797	OAHU
AWAKO PL	96797	OAHU
AWAKO ST	96797	OAHU
AWARD ST	96797	OAHU
BANNISTER PL	96819	OAHU
BANNISTER ST	96819	OAHU
CHAMBERLAIN ST	96822	OAHU
CLARK ST	96822	OAHU
CLEMENT ST	96822	OAHU
COLUMB ST	96819	OAHU
DEMOCRAT ST	96819	OAHU
DEMOCRAT ST	96819	OAHU
DILLINGHAM BLVD	96817	OAHU

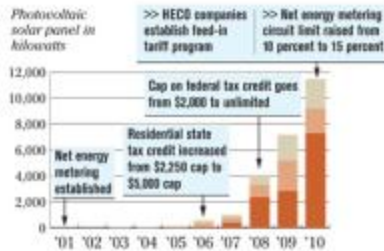
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Home Map

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**POWERING UP**

The amount of solar electricity generating capacity installed by homeowners and businesses has grown dramatically since the net energy metering program was launched 10 years ago, allowing such systems to hook into the HECO, MECO and HELCO grids.



HECO MECO HELCO

Sources: HECO and Rising Sun Solar

Recent article in Hawaii local news on Sun Screening by Alan Yonan of Star Advertiser 7/24/2011 captured current levels of penetration and ongoing needs to manage increasing penetration levels.



**PAU**