
# Integrating Distributed Generation on Lanai

**Ben Kroposki and Jamie Keller**
**National Renewable Energy Laboratory**

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NREL National Renewable Energy Laboratory
*Innovation for Our Energy Future*

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# Presentation Overview

- Island Overview
- Renewables Study #1 -RE100%
- Renewables Study #2 - RE 88%
- Renewables Study #3 - New PV
- Conclusions


Island of Lanai
0
1
2
4
Miles
Maui Electric Company, Ltd.
Lanai City
The Lodge at Koele Resort
Lanai Airport
Miki Basin Power Plant
Manele Bay Resort
S
P
C
S - 3sec. Solar sensors
P - 1.2MW PV system
C - 900kW CHP plant

# Lanai 100% RE Study #1

- Purpose is to define a pathway to help Lanai reach 100% Renewable Energy
- Study Partners: Castle & Cooke, MECO, NREL, Sandia, and Sentech
- Focused on how to develop a pathway to reach 100% renewable energy on Lanai

# Study #1 Methodology

- Collected and evaluated load and existing generation data
- Used Homer to evaluate potential RE scenarios based on resource and cost data
- Compared base case with planned renewable energy scenarios
- Describe path forward for 100% RE

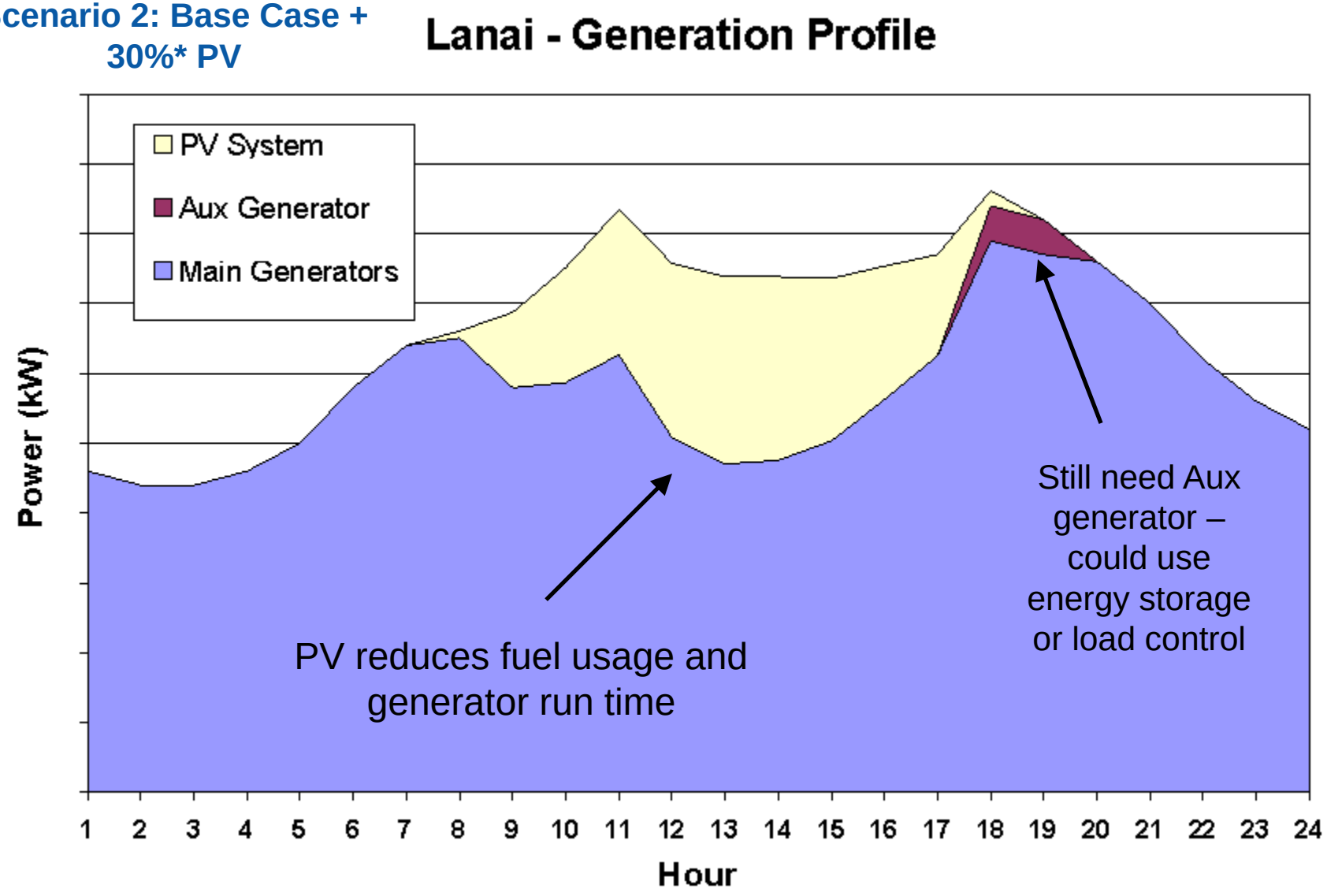
# Analysis of Lanai – Using HOMER

- **Case 1** – Base Case – No Renewables, No CHP

- **Case 2** – Base Case + PV
- Examined 2 PV costs, 3 PV sizes, and 2 Diesel prices

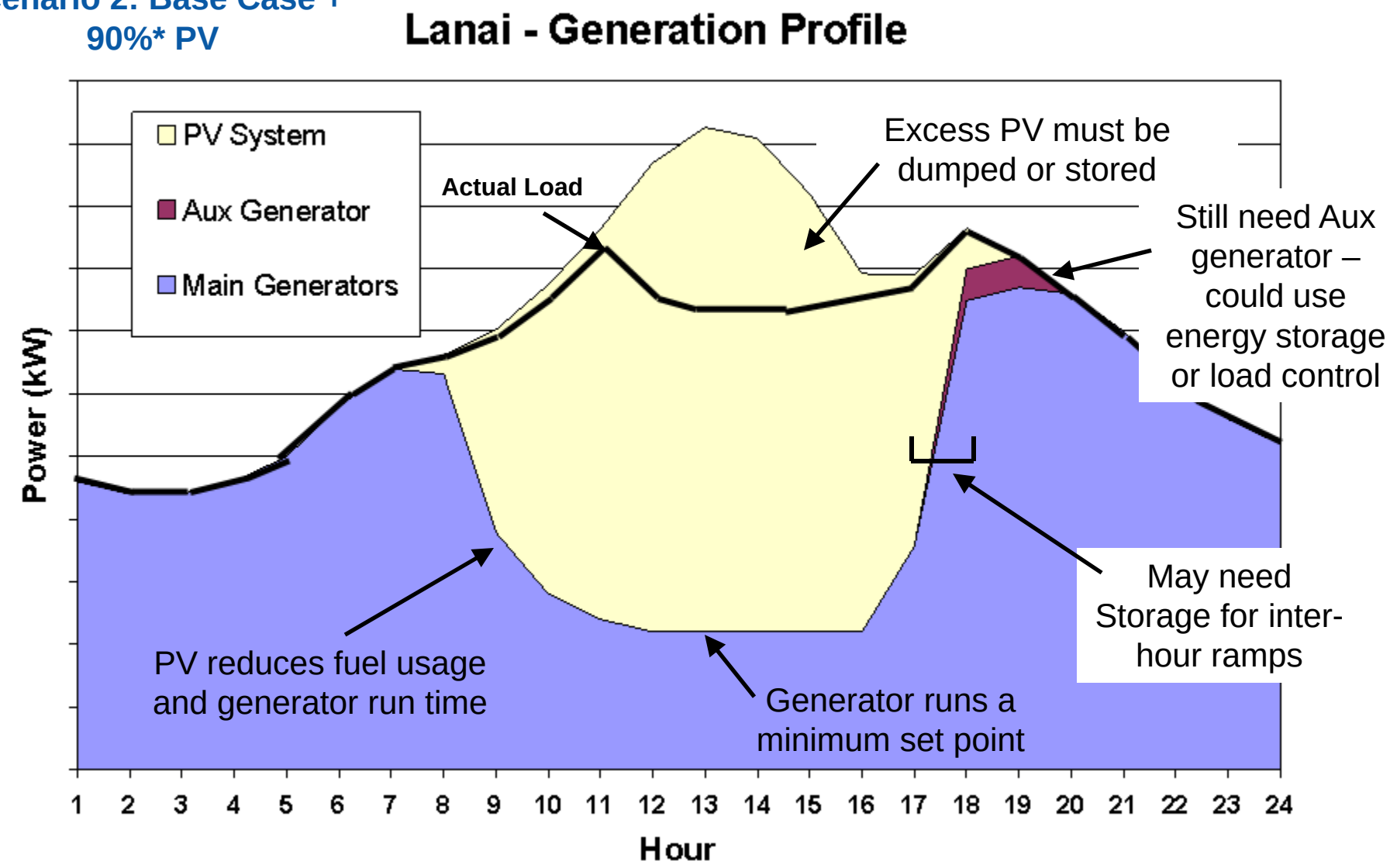
- **Case 3** – Base Case + PV +Battery +Wind
- Optimize System mix based on LCOE
- Examined several costs and sizes of equipment
- 1408 combinations

## Scenario 2: Base Case + 30%* PV




*** 30% of Peak Load not Energy**

## Scenario 2: Base Case + 90%* PV




*** 90% of Peak Load not Energy**

# Lanai Study #1 Summary

- Optimized use of wind turbines in conjunction with existing generators can result in significant fuel usage reductions (56%) and reduce levelized cost of energy by 28%
  - Consider installing wind turbines into grid and using different dispatch strategies as Variable RE penetration increases
  - Optimal RE fraction was 56%

- High PV costs increase overall levelized cost of energy
  - Consider less expensive fixed-tilt PV systems
  - Consider distributing PV systems to reduce impact of clouds and locating them near loads to reduce losses

- Batteries are not cost effective for long-term energy balancing with small renewable fractions or low diesel prices
  - Energy storage may be necessary for short term grid stability
  - Consider large kW rating and smaller kWh

# Renewables Study #2

- Look at effect of new combined heat and power (CHP)  plant
- Evaluate wind and solar scenarios to reach near 100% RE (88% RE)
- Examine next steps for more renewables

# Analysis for Study #2

- **Scenario Adjusted Base Case:**
  - Updated load for 2008 to include reduction from following projects:
    - 850 kW Combined Heat and Power (CHP)
    - 1.5 MW PV system
- **Scenario A**: Adjusted Base Case + CSP w/thermal storage
  - Analysis done using Solar Advisor Model
- **Scenario B**: Adjusted Base Case + PV + NaS Batteries
  - Analysis done using HOMER Optimization tool
- **Scenario C**: Adjusted Base Case + Wind Turbine + NaS Batteries
  - Analysis done using HOMER Optimization tool
- **For Scenarios A, B, and C we are trying to provide 88% of the adjusted based case load with renewable energy**

# Study #2 Summary

- **PV can reduce the use of diesel fuel but COE is higher**
  - PV can provide 88% of the remaining load with RE with 16 MW of PV and 10 battery modules (1.2MWx8hrs)
  - LCOE at 2.95 x Base Case electricity
- **Concentrating Solar Power**
  - Can provide up to 88% of the remaining load with RE
  - CSP = 4MW Generator/ 28MW CSP array
  - LCOE at 1.86 x Base Case electricity
- **Wind resource is significant**
  - Wind can provide 88% of the remaining load with RE with 7 (1.5MW) MW wind turbines and 6 (1.2MW) battery modules
  - LCOE = 1.1 x Base Case
- **Getting to 100% RE with Solar or Wind & batteries alone is difficult**
  - Should consider biodiesel generator in the system mix
- **Examining Wind Options and Solar/Wind Hybrid Options**

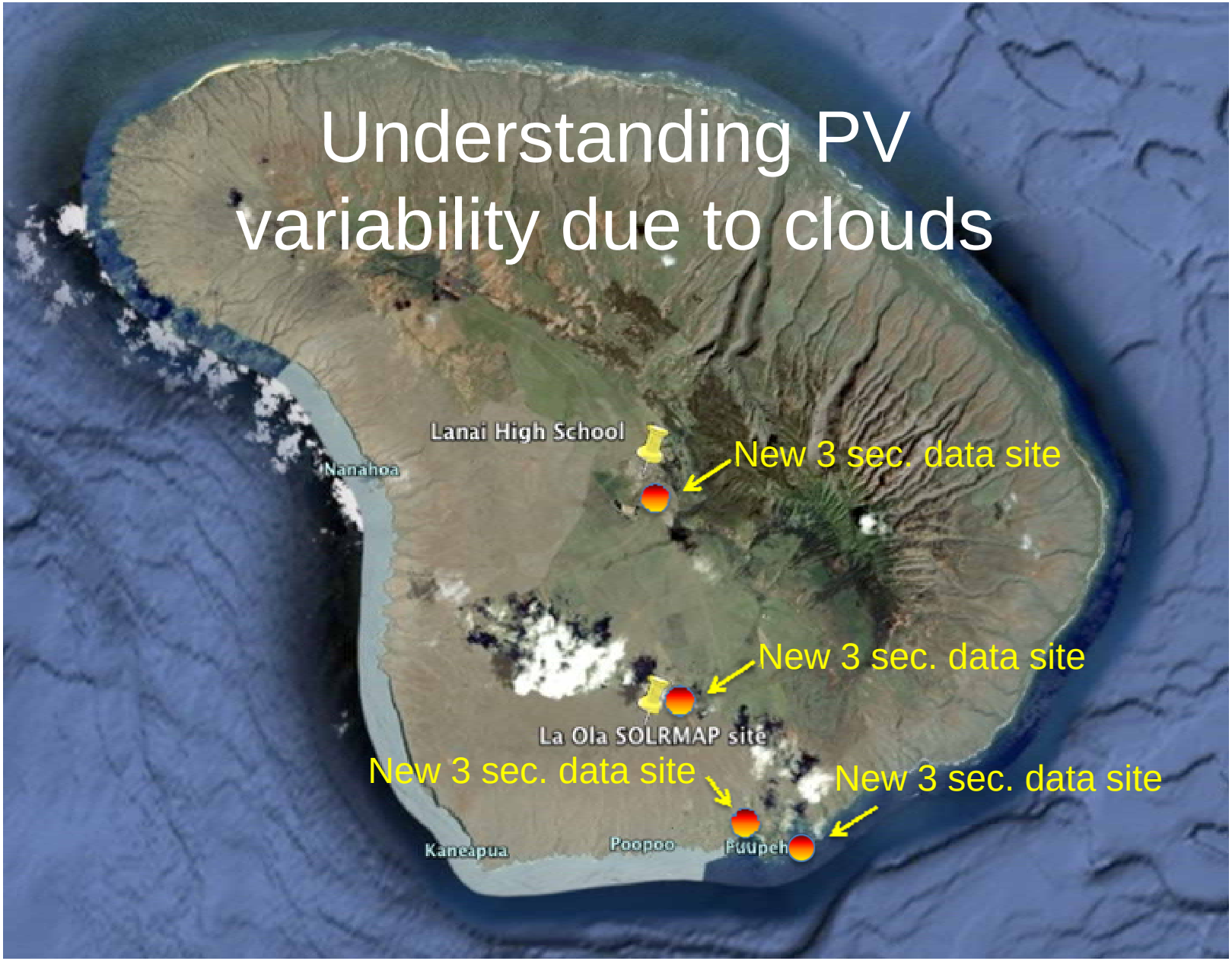
# Next Steps

# Integrating more PV

# Renewables Study #3

- Evaluate if more PV can be added to system without storage
- Look at new load with CHP and 1.5MW PV system running – compare with minimum loading of existing generators
- Look at geographic diversity of PV systems
- Examine sites without export to rest of grid at PCC

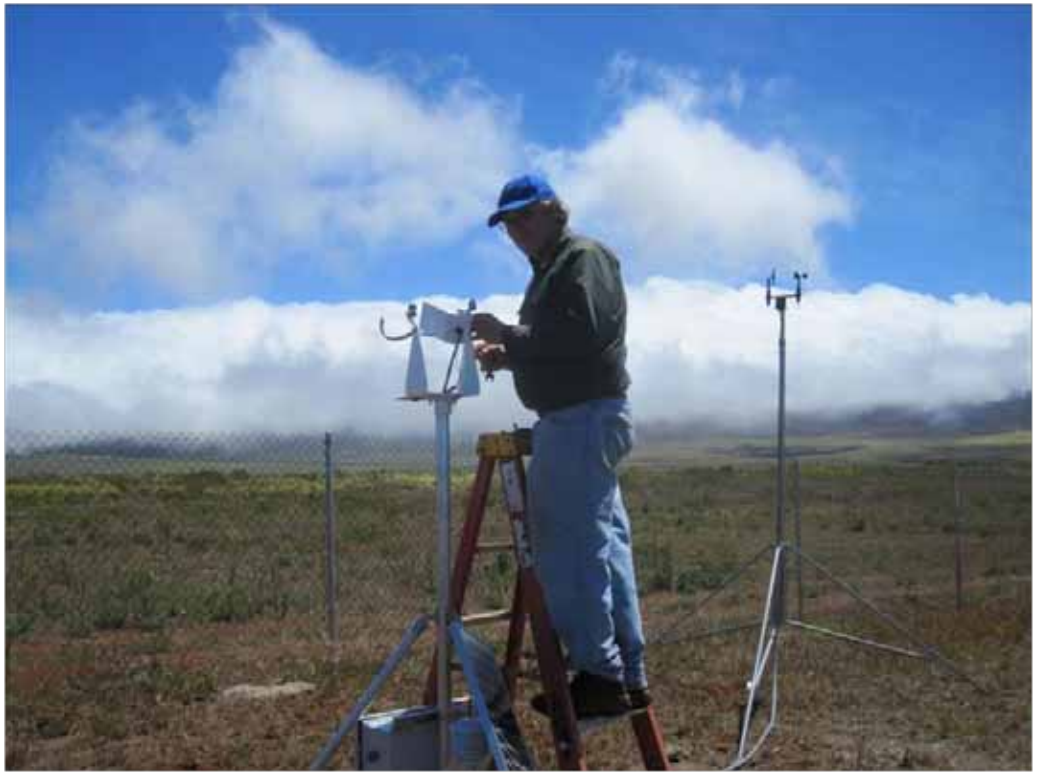
# Understanding PV variability due to clouds



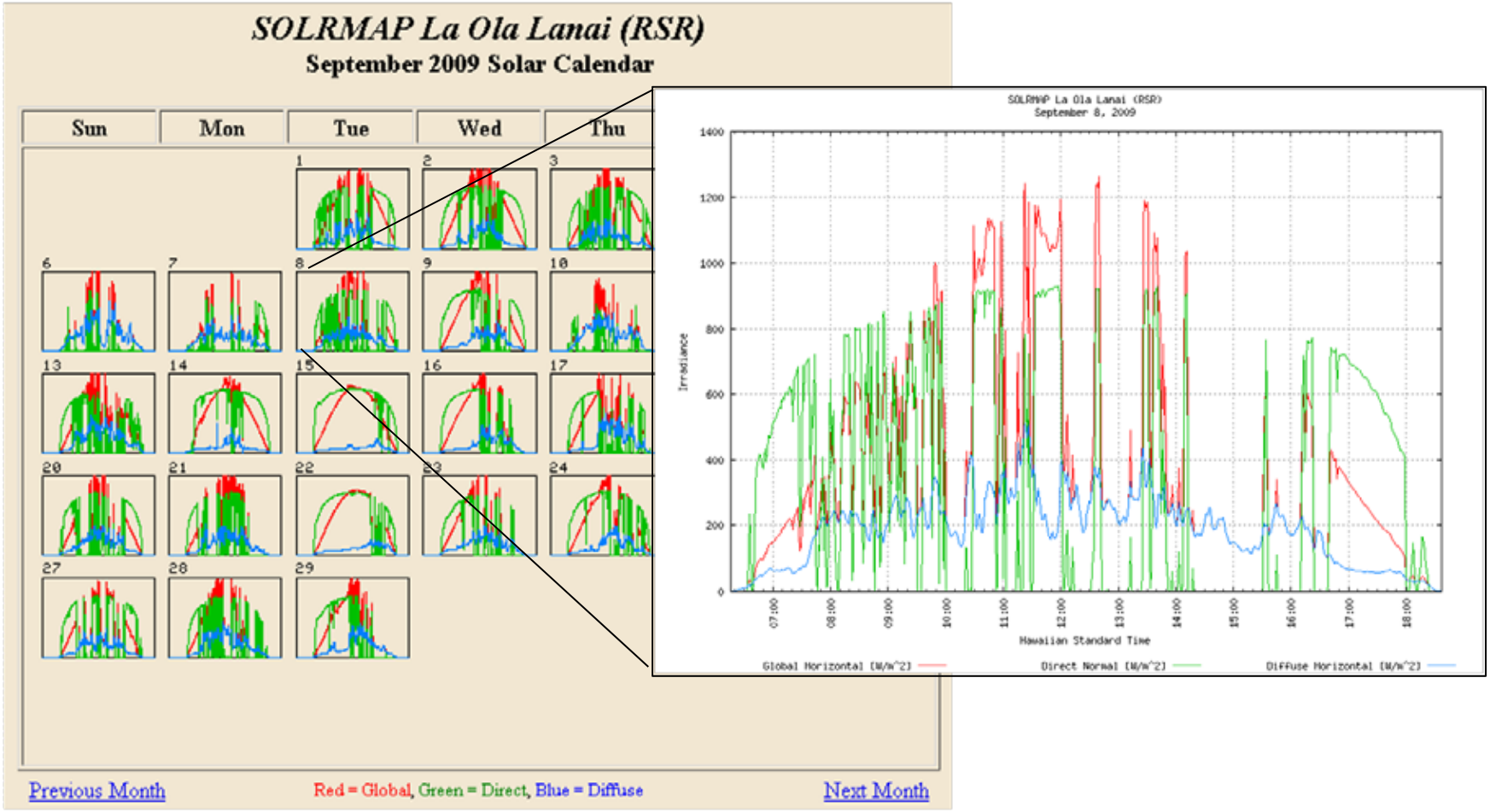
## Solar Monitoring Station

- Installed La Ola Lanai solar monitoring system – July 2009
- 1 min. data available at:

http://www.nrel.gov/midc/la_ola_lanai

# Close look at 1 min. Solar data from La Ola



# C & C Central Service Buildings


PV size estimates according to IMBY

Installed March 2010

# Manele Waste Water Treatment Plant (WWTP)

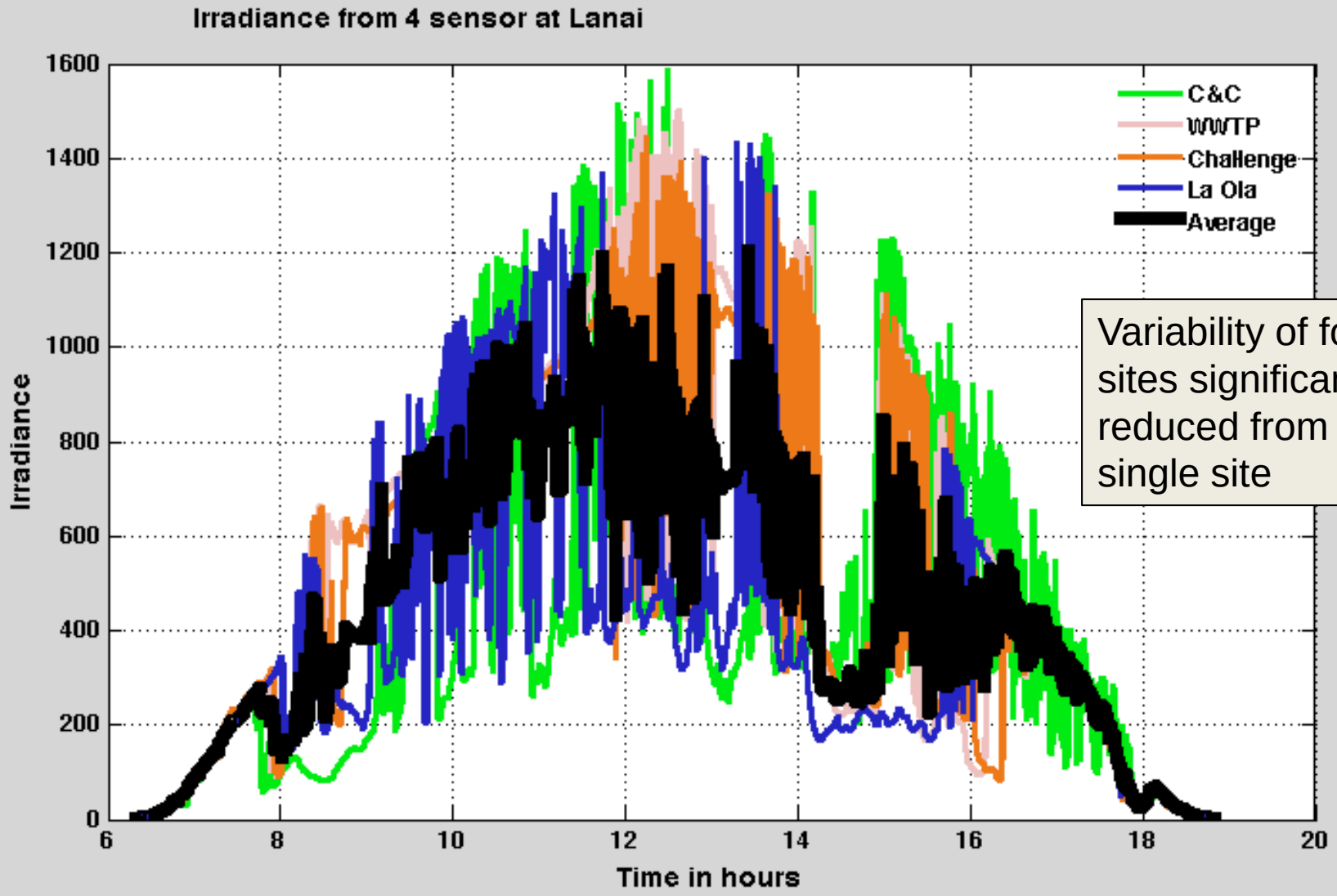

PV size estimate according to IMBY

Installed March 2010

# "The Challenge at Manele" Golf Course Parking Lot


PV size estimate according to IMBY

Installed March 2010




Variability of four sites significantly reduced from single site

# Integrating more PV - Conclusions

- 400 - 500kW could be integrated without storage
  - The more geographically spread the systems are, the better to reduce variability due to clouds
  - PV system operational windows would need to be widened past IEEE 1547 voltage/frequency limits
  - Best to co-locate PV with loads - Examine sites that could be no-export back to grid and Net Energy Meter sites
  - Plans are to conduct an Island-wide Interconnection study for more PV

# Greetings from Lanai

Questions?