

Molokai Island Initiatives



Grid System Technologies Advanced Research Team

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Island Power Systems Connect 2018

Hawaii Initiatives

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Maui, Hawaii

Established to develop and test advanced grid architectures, new technologies and methods for the integration of renewable energy resources, power system optimization and enabling policies.

- Diverse staff includes engineers, scientists, lawyers; students and postdoctoral fellows; visiting scholars
- Serves to integrate into the operating power grid other HNEI technology areas: biomass and biofuels, fuel cells and hydrogen, energy efficiency, renewable power generation
- Strong and growing partnerships with national and international organizations including Asia-Pacific nations.



Lead for many public-private demonstration projects



Moloka'i Island 100% RE Grid Initiative

- HECO Set Goal to be 100% Renewable by 2030
- HNEI RDTE Support

- System Data Collection
- Load Flow & Midterm Dynamics Modeling
- Production Modeling
- Battery Storage
 - 2MW, 375kWh
- Dynamic Load Bank
- PV Forecasting



- Peak Load: 5.8 MW
- Daytime Min Load: 2.7 MW
- PV Installed: 1.07 MW (with 59.3Hz drop-out)
- PV Installed: 1.21 MW (with 57Hz drop-out)
- PV Planned: 0.6 MW in que

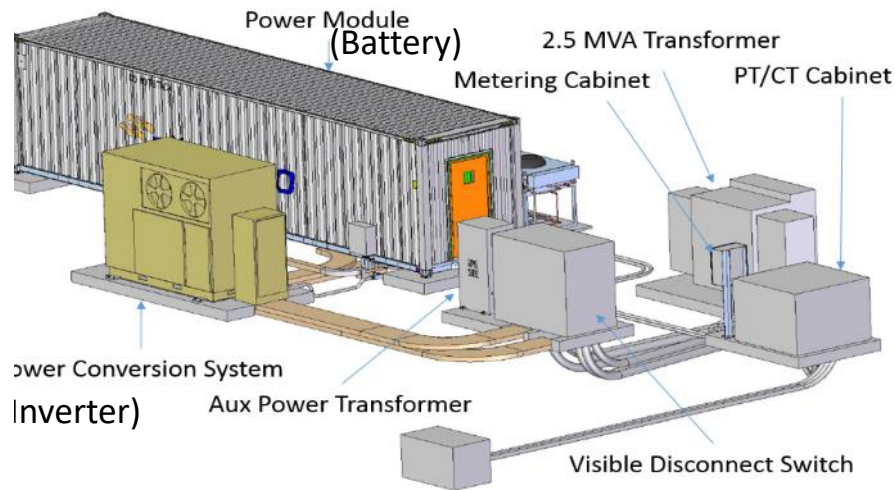
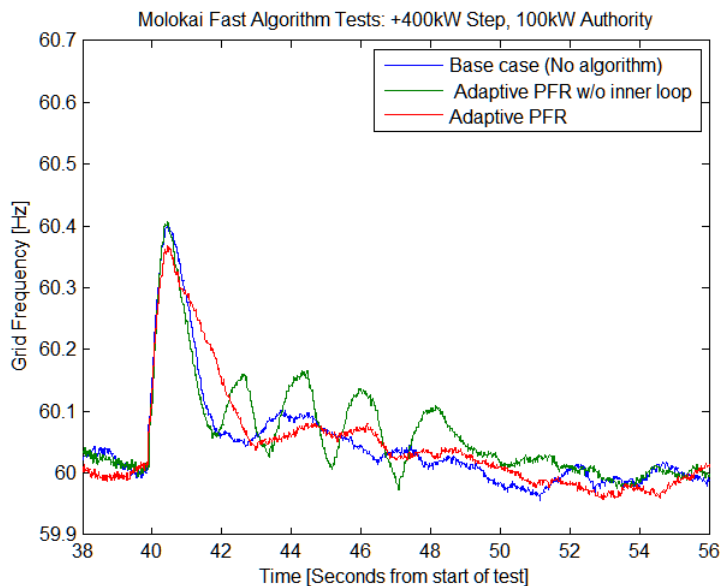
Hawaii ranks #1 in U.S. electric energy costs:

35.6 cents/kWh	Molokai
35.9 cents/kWh	Lanai
34.2 cents/kWh	Hawaii
30.6 cents/kWh	Maui
28.22 cents/kWh	Oahu
(Avg. residential rates for 2017)	
11 - 12 cents/kWh	U.S. avg.

Opportunity to extend this initiative as a scalable model to other Asia-Pacific regional sites

Molokai Grid Stability

- Even relatively small disturbances can trip PV units, increasing automatic load shedding customer outages on the system
- **Proposed solution** to increase grid reliability: a 2MW/375KWh fast-acting BESS.
- **The challenge:** standard 250 ms response destabilizing to grid (models)
- **The solution:** re-engineer the way the BESS and the inverter computers collaborate to share computational burden in control and reduce response time

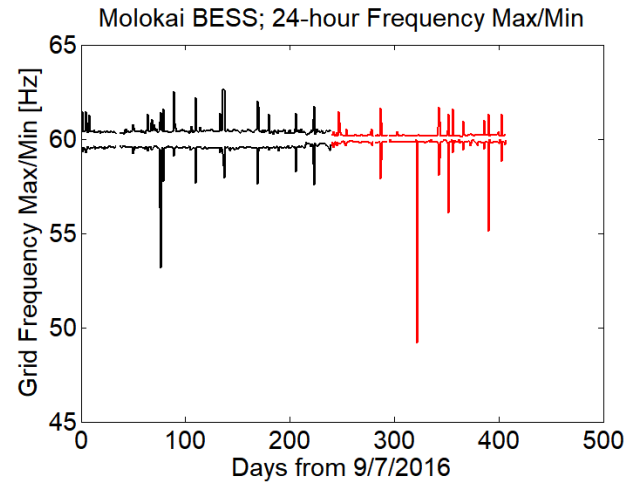
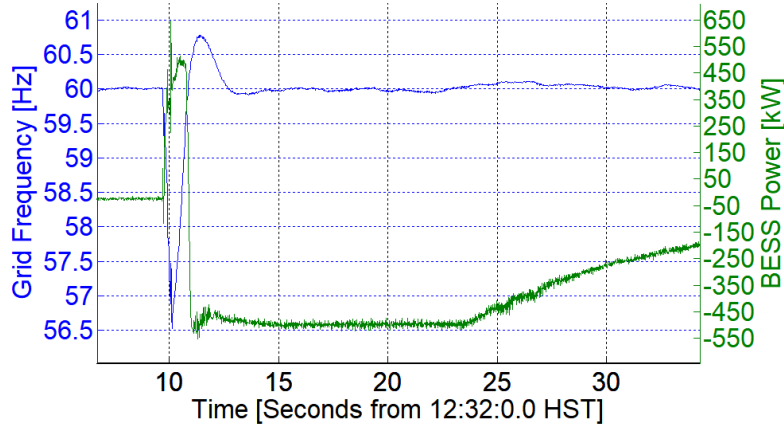


Performance of BESS with 500kW Authority and Fast Response

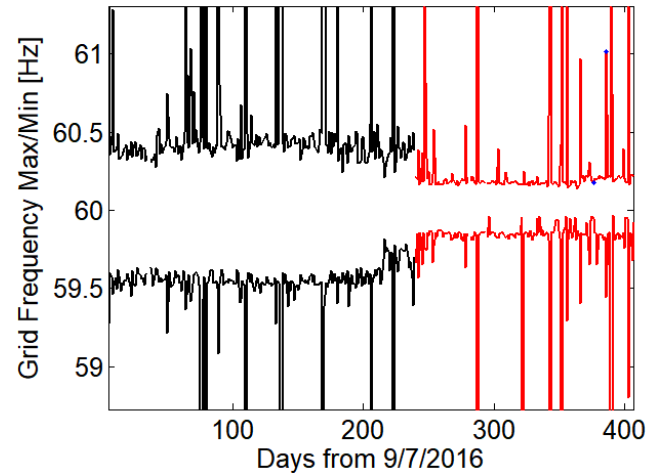
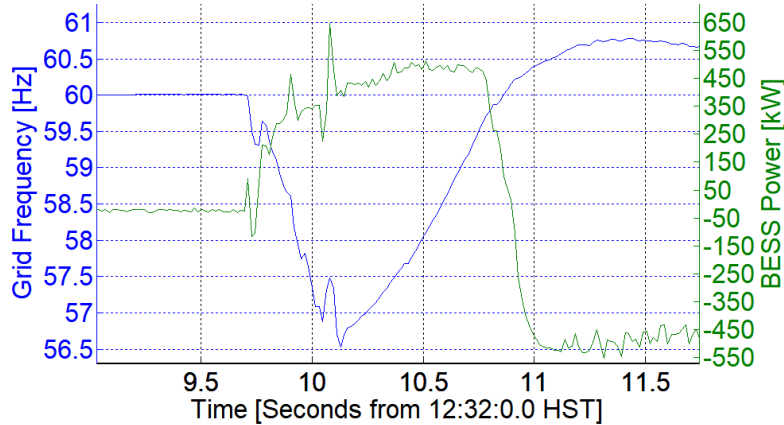
Expansions (bottom) show Down-Step

BESS Authority = 500kW

1/16/2018

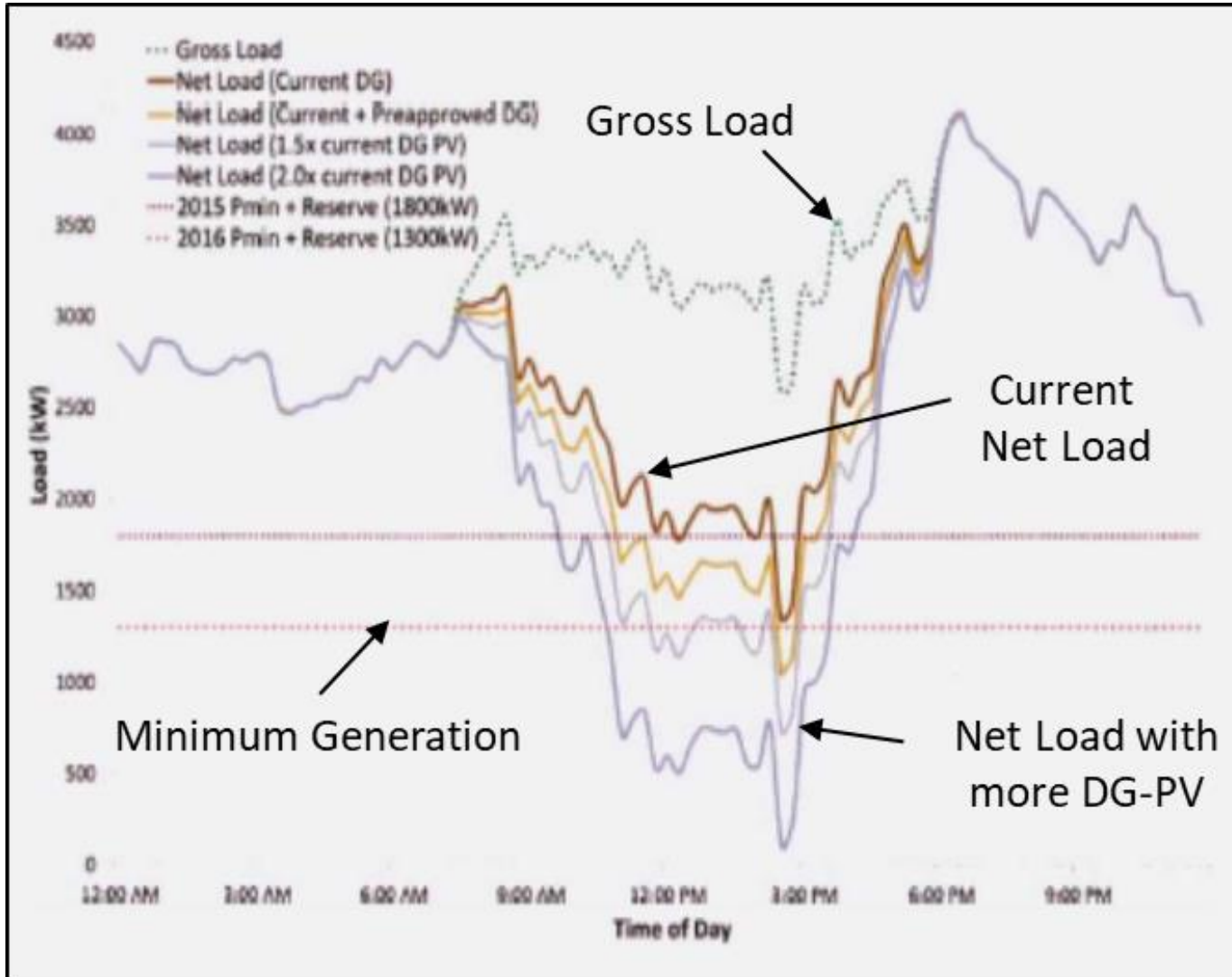


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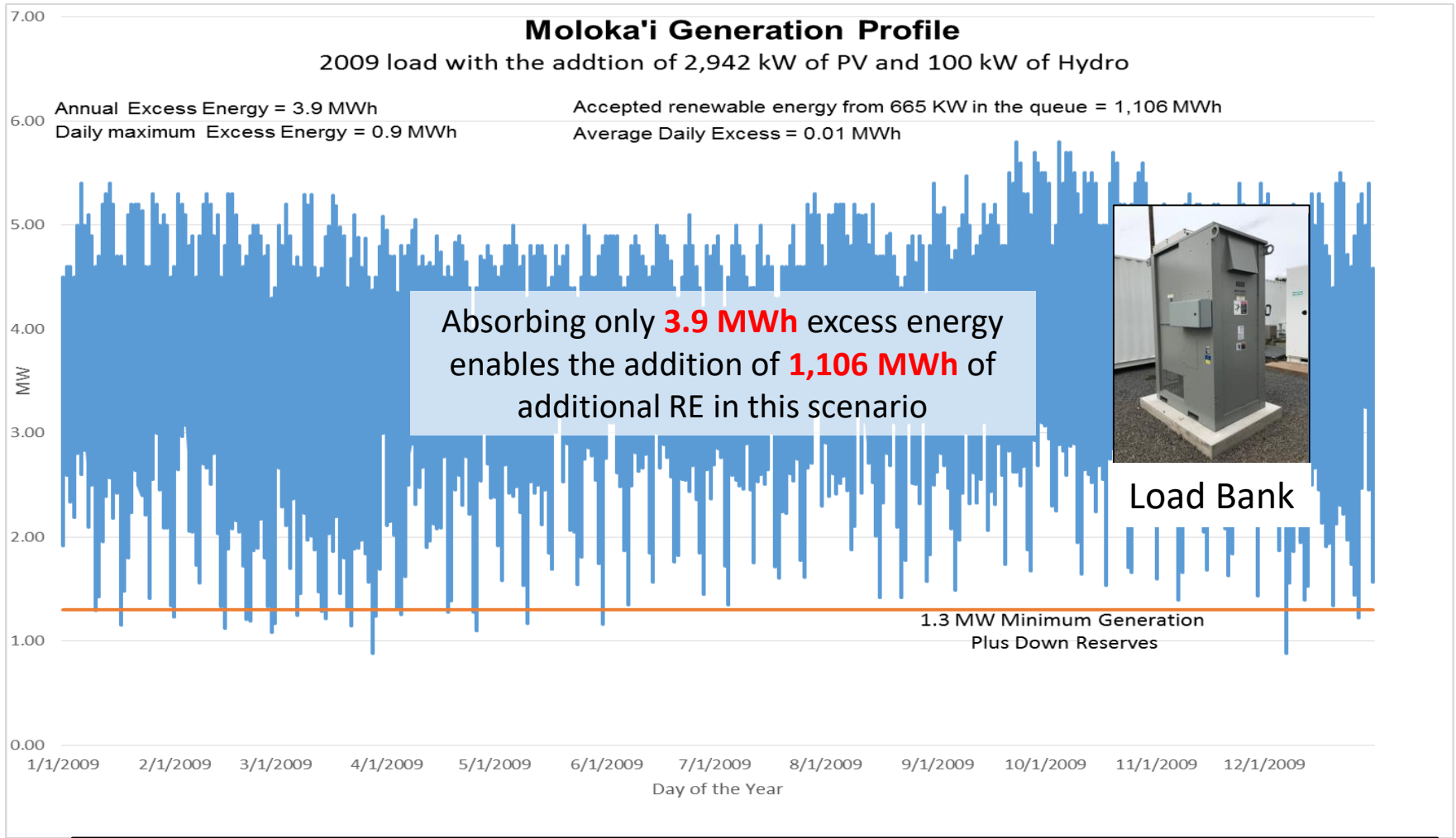
500kW Authority provides a significant benefit
750kW is the next test level

Excess Energy Potential Low Load Day



Alternatives to Storage

Dynamic Load Bank (Energy Safety Valve)

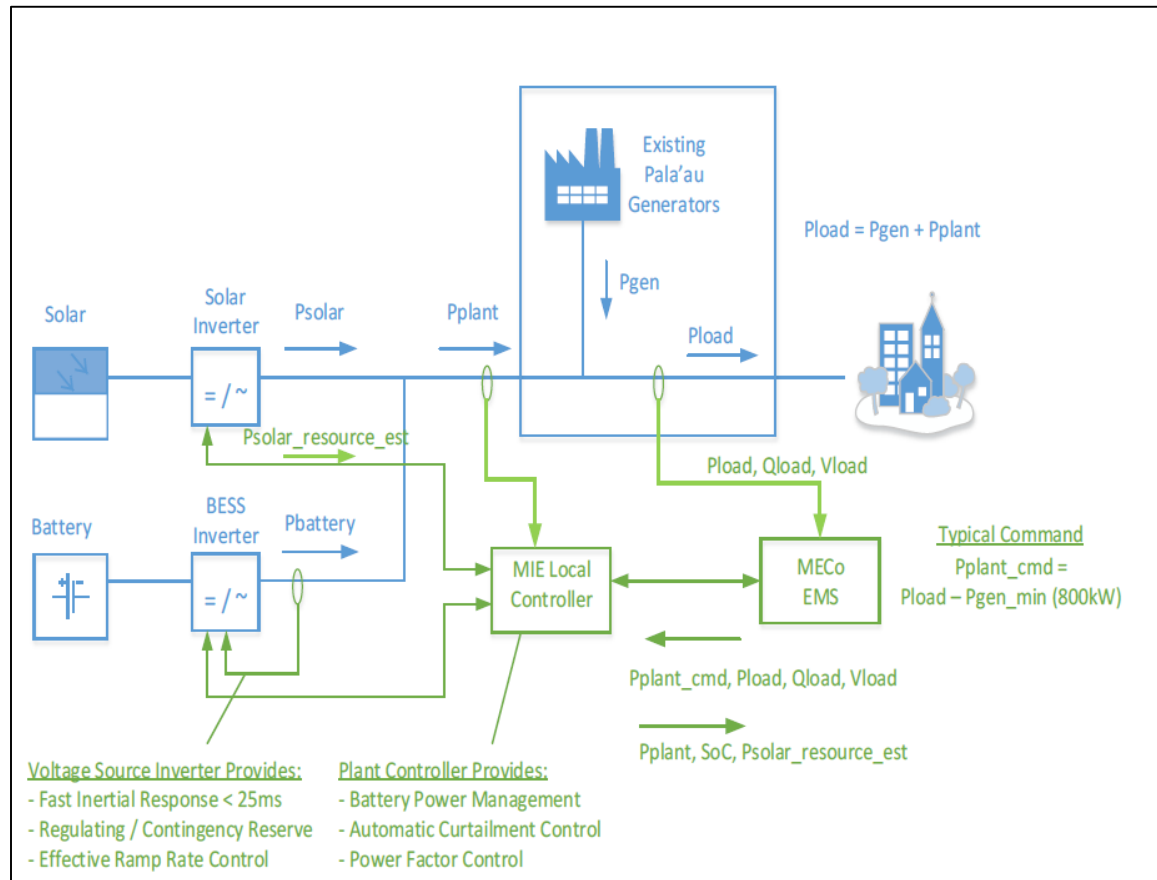


Small to moderate amount of excess RE curtailment is a sound integration strategy



Molokai New Energy Partners

- 2.64 MW Export
- 4.88 MW Solar
- 3MW/15MWh BESS
- 22 Year term
- 5.211 cents/kwh (initial and stored)
- 2.246 cents/kwh (post initial)
- \$101,083.50/month BESS Services
- Levelized cost 18 cents/kwh



HNEI Solar Forecasting System - Overview

System provides solar resource and PV production estimates at a range of timescales from minutes to days ahead

Day ahead forecasts

- Regional numerical weather prediction model
- Regional forecasts - hours to days ahead
- **Unit commitment planning**

Hour ahead forecasts

- Satellite imagery
- Regional forecasts – 10 minutes to hours ahead
- **Unit dispatch and operational reserve management**

Minute ahead forecasts

- **Ground-based cameras**
- Local forecast - seconds to minutes ahead
- **Grid stability and short ramp identification**

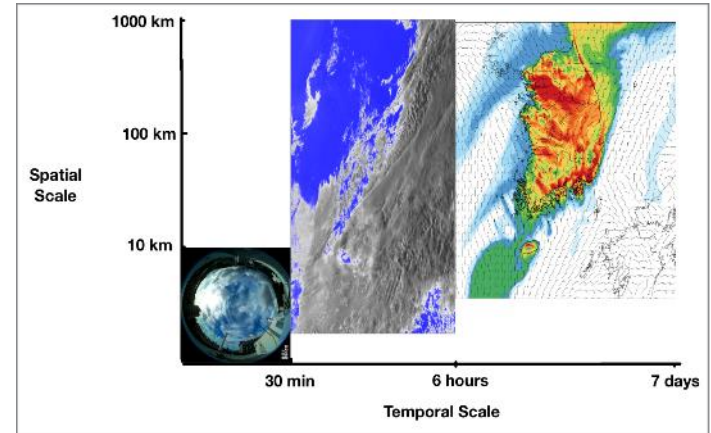
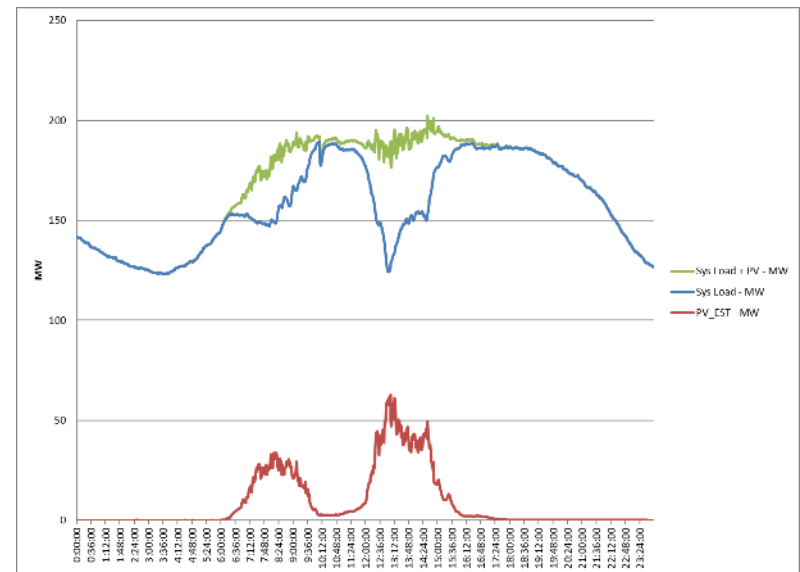
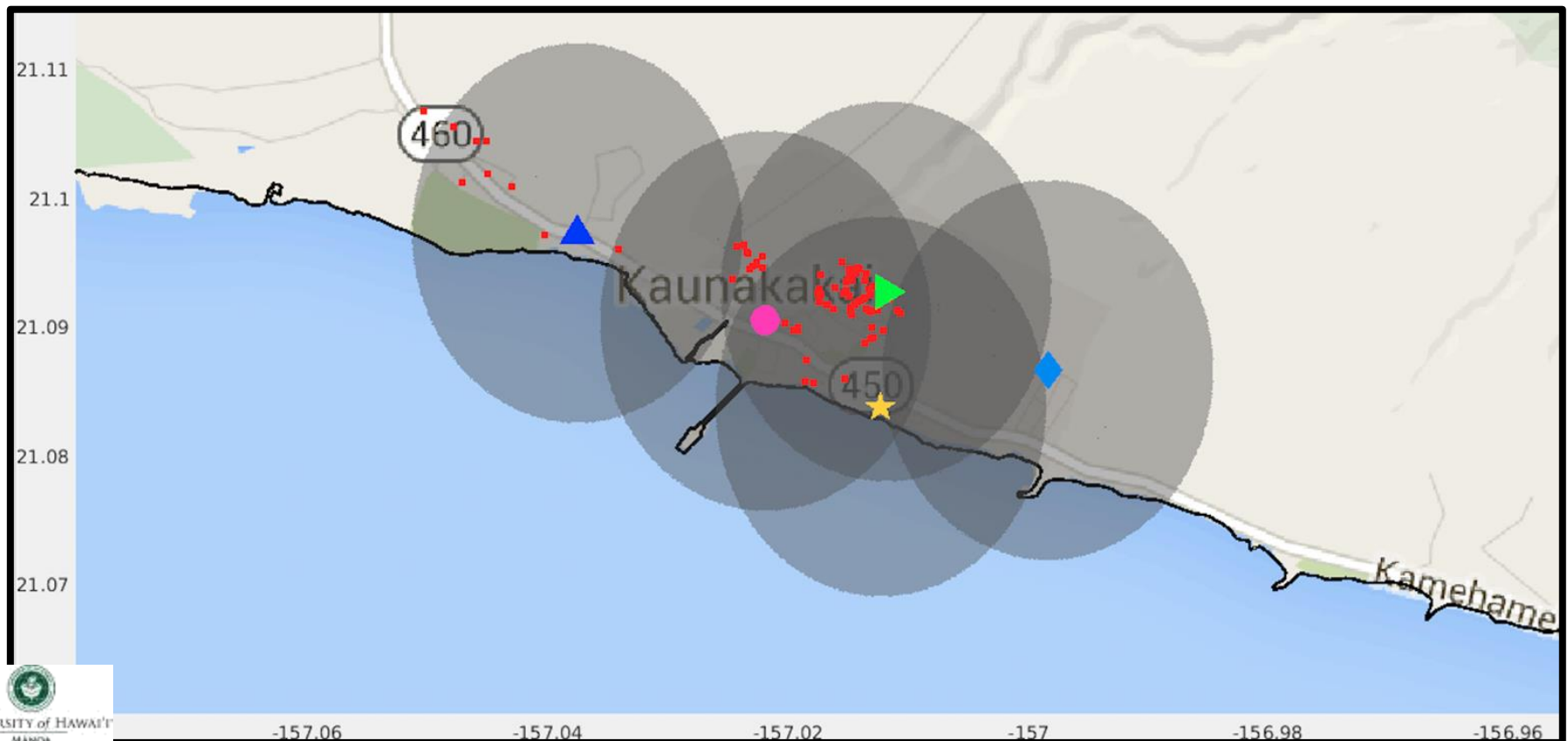


Figure: Forecasting time and space scales of the different components that make up the solar forecasting system.



Potential Moloka'i Field Deployment

- Proposed initial deployment focuses on high penetration PV circuit using 5 camera systems mounted on secondary utility poles
- Predominant cloud movement driven by trade winds
- Camera placement to have 1 upwind camera, 3 cameras in triangle pattern covering majority of PV devices, 1 leeward camera
- Camera FOVs (shown by grey circles) are related to the cloud base height (CBH) - below, we use the regional mean atmospheric inversion height (900 m) to calculate FOV



Manual & Autonomous Control

Manual start/Stop
Autonomous Regulation



Utility Generation



Manual Disconnect

ConnectDER

Autonomous Regulation
or
Manual Set point



Forecast

SCADA

Scheduled Energy



Distributed Storage



BESS

Autonomous Regulation
and
Manual Set point/Curtailment



Large Energy Projects



Load Bank

Manual Set point

Automated & Autonomous Control

Automated start/Stop
Autonomous Regulation



Utility Generation



Automated Disconnect

ConnectDER

Autonomous Regulation and Automated Dispatch

Forecast



SCADA

Automated Dispatch



Distributed Storage



BESS

Autonomous Regulation and Automated Dispatch/Curtailment



Large Energy Projects



Automated Dispatch

Load Bank

Mahalo!

(Thank you)



For more information, contact:



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