EESAT TECHNICAL CONFERENCE, Portland, OR

Implementation of the NELHA Energy Storage Test Bed

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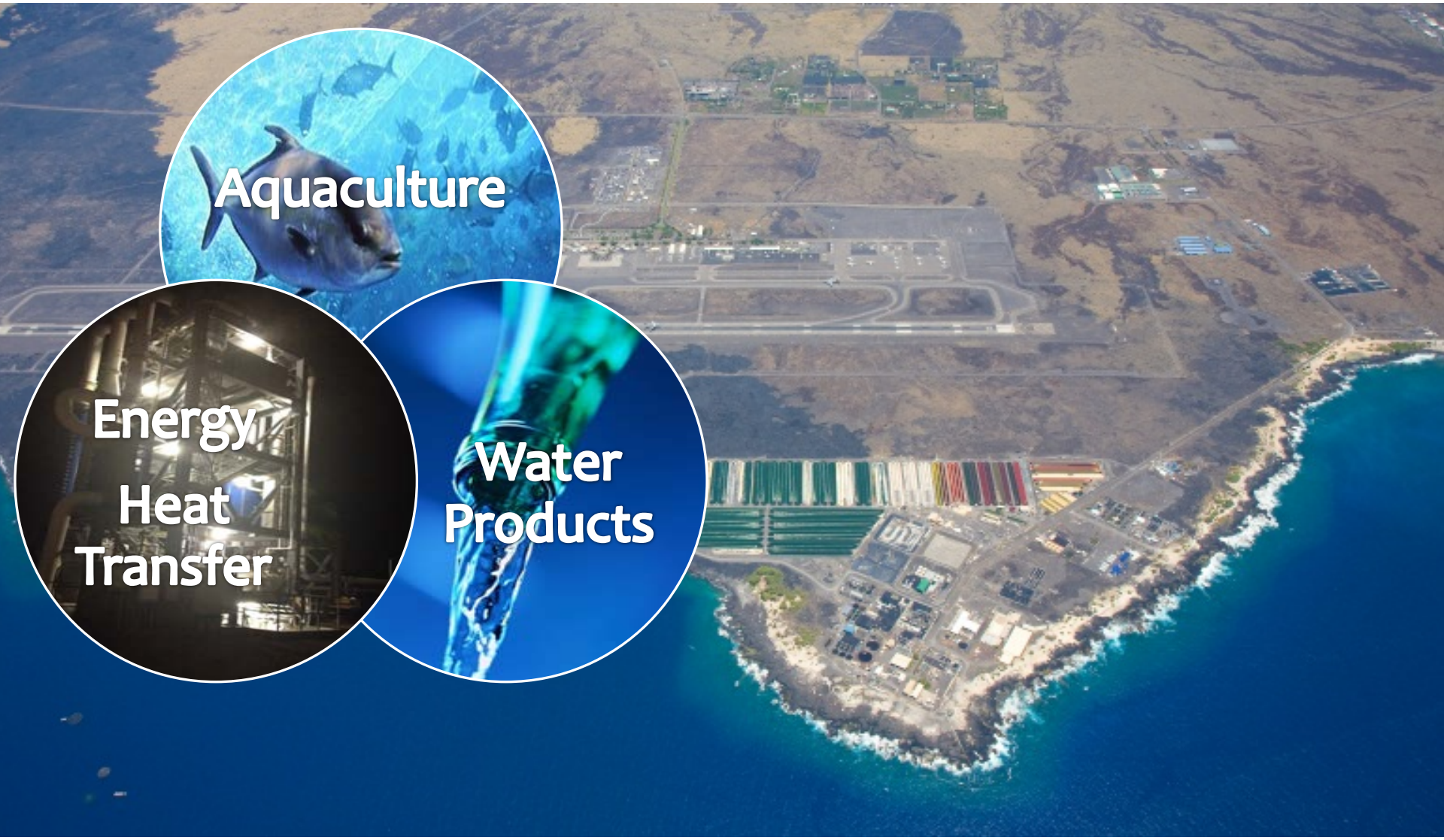


Hawaii Ocean and Science Technology Park
administered by the Natural Energy Laboratory of Hawaii Authority

ENERGY PROJECTS at NELHA

- Ocean Thermal Energy Conversion (OTEC)
- Solar (PV and CSP)
- Biofuels from Microalgae
- Sea Water Air Conditioning
- Energy Storage Test Bed

Why an Energy Storage Test Bed at NELHA?

Hawaii Policy

- State's overdependence on oil
- Aggressive Clean Energy Policy – 100% by 2045
- Based on abundance of natural renewable resources (sun, wind, bio, geo, hydro, ocean)

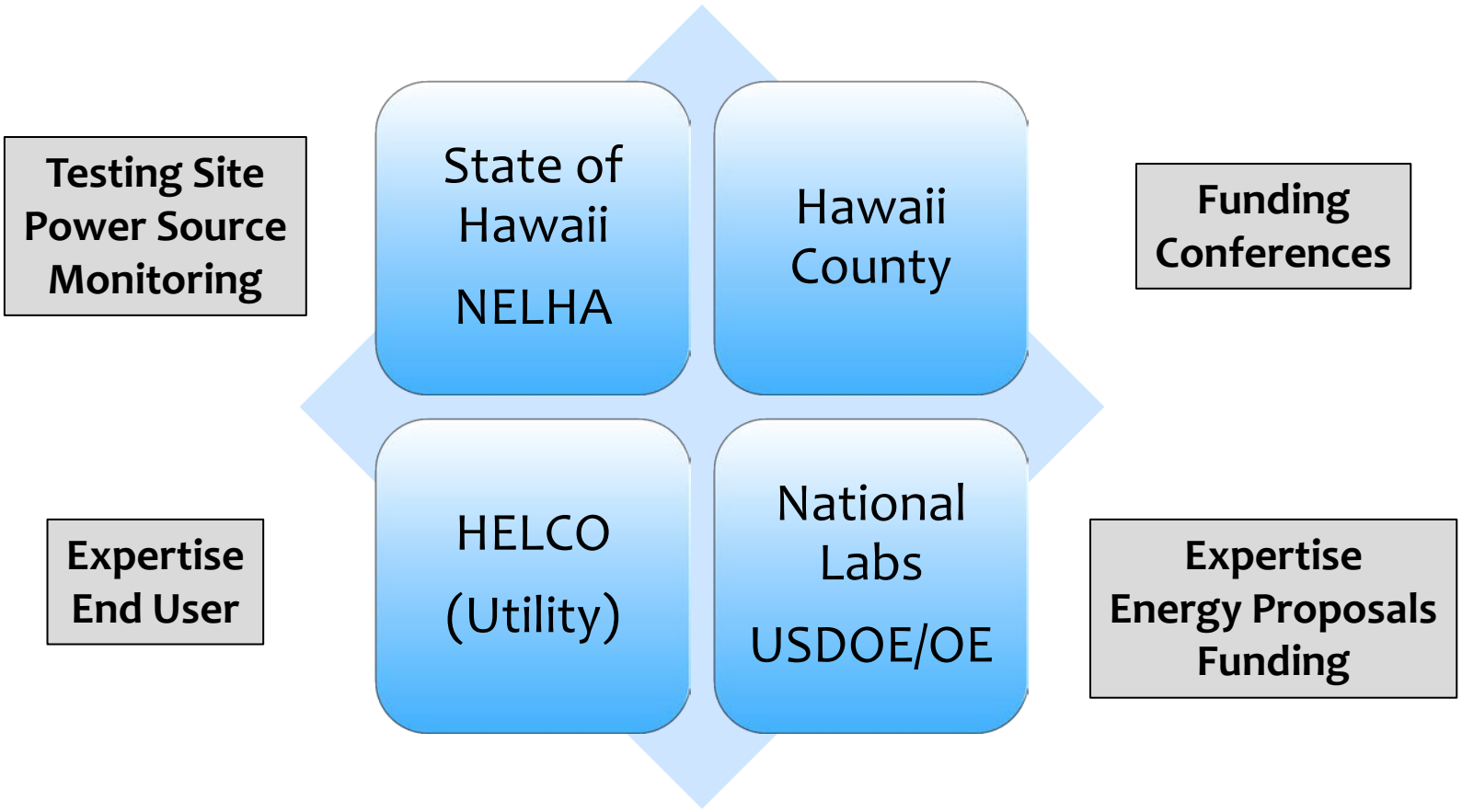
Demonstration Needs

- Motivated customers
- User Demand (Utility, Commercial, Residential, Military) for real world demonstrations in industrial setting
- 100-150 MW storage deployment needed in next few years
- High percentage of renewables needing to be integrated on grids

Roll Out

- High electrical rates between $0.30 and $0.40/kWh
- Government private partnerships
- Master permit

Real World Testing and Validation of Pre-Commercial Energy Storage



Initial Partners 2014/2015

Government	National Labs	Private
• State of Hawaii • County of Hawaii • US DOE – Office of Electricity	• Sandia National Laboratories • National Renewable Energy Laboratory	• Hawaiian Electric Company • Makai Ocean Engineering • Aquion Energy Inc.

Energy Storage Test Bed Short List

- Aquion Energy

Pre-commercial aqueous hybrid ion battery (1.7 kWh)

- Imergy Power Systems

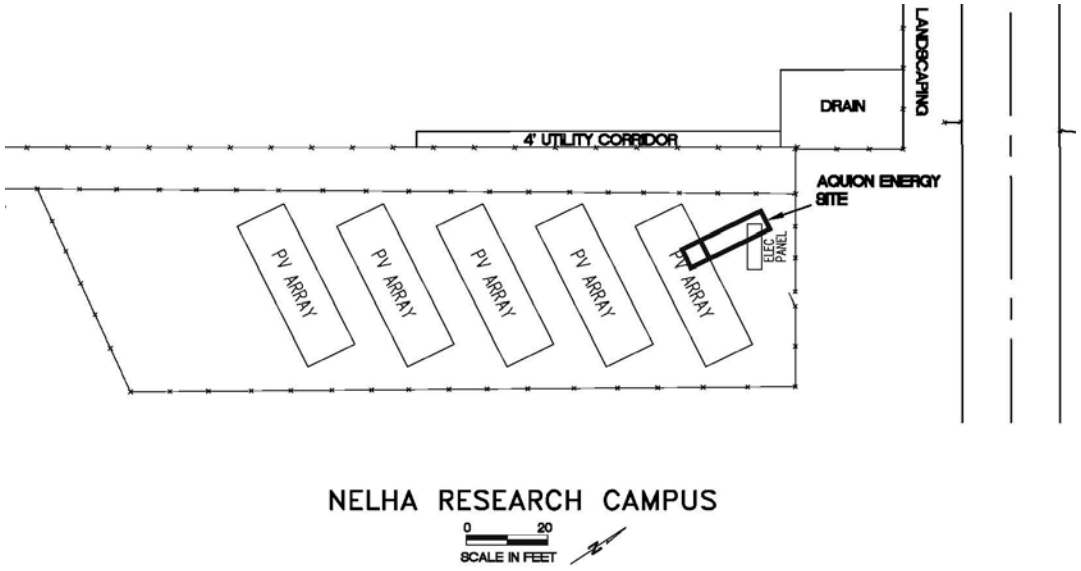
Vanadium flow battery

- JuiceBox

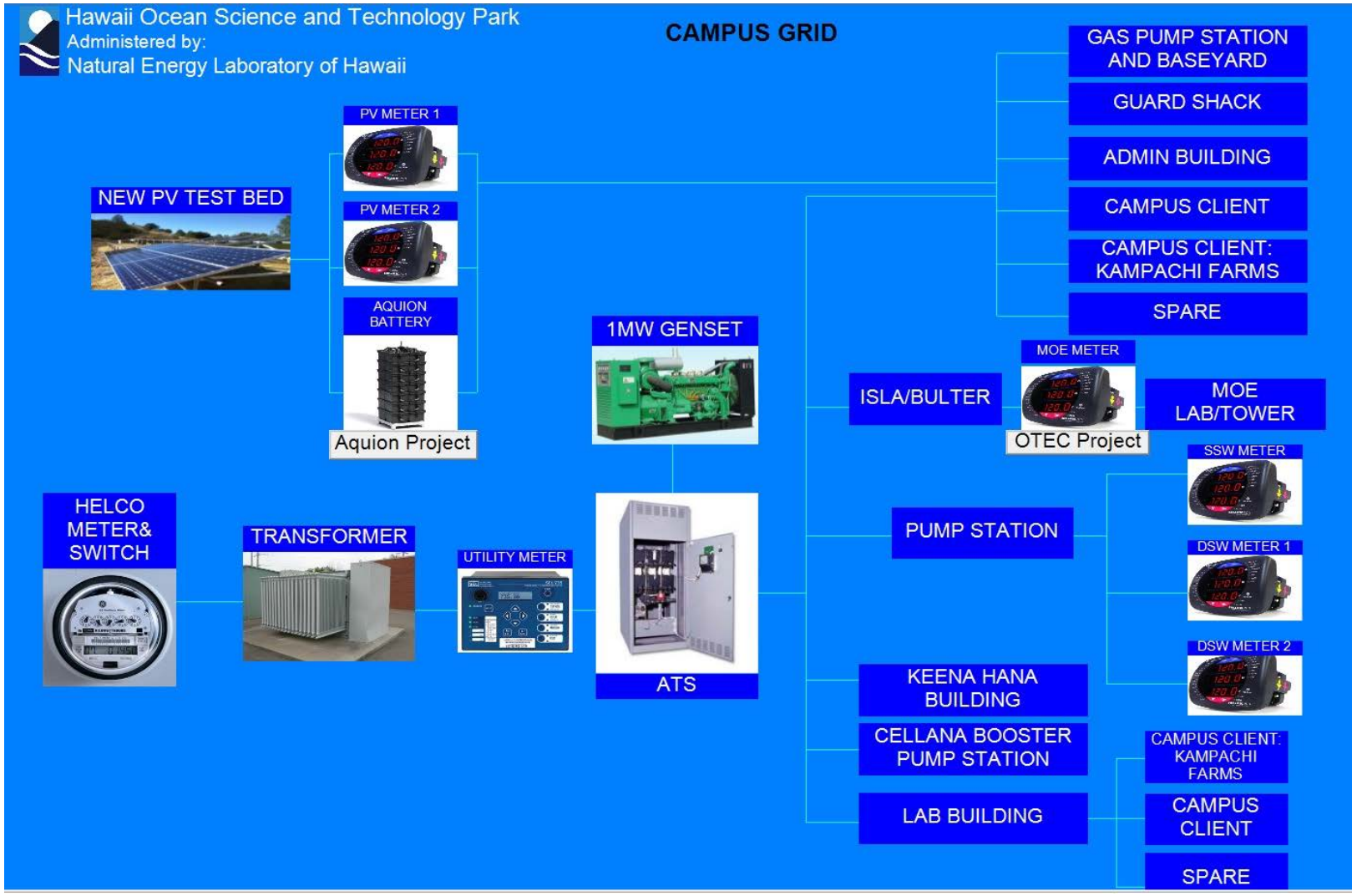
Integrator of small scale <60kW lithium-ion storage

First Installation: Aquion Battery (Generation 1)

- Lease and Evaluation Agreement – Executed Oct 15, 2014
- Installation March 2015
- One M100 Battery Module
- Minimum 21.9kWh based on C/20 standard discharge rate
- Local Partner: Renewable Energy Services

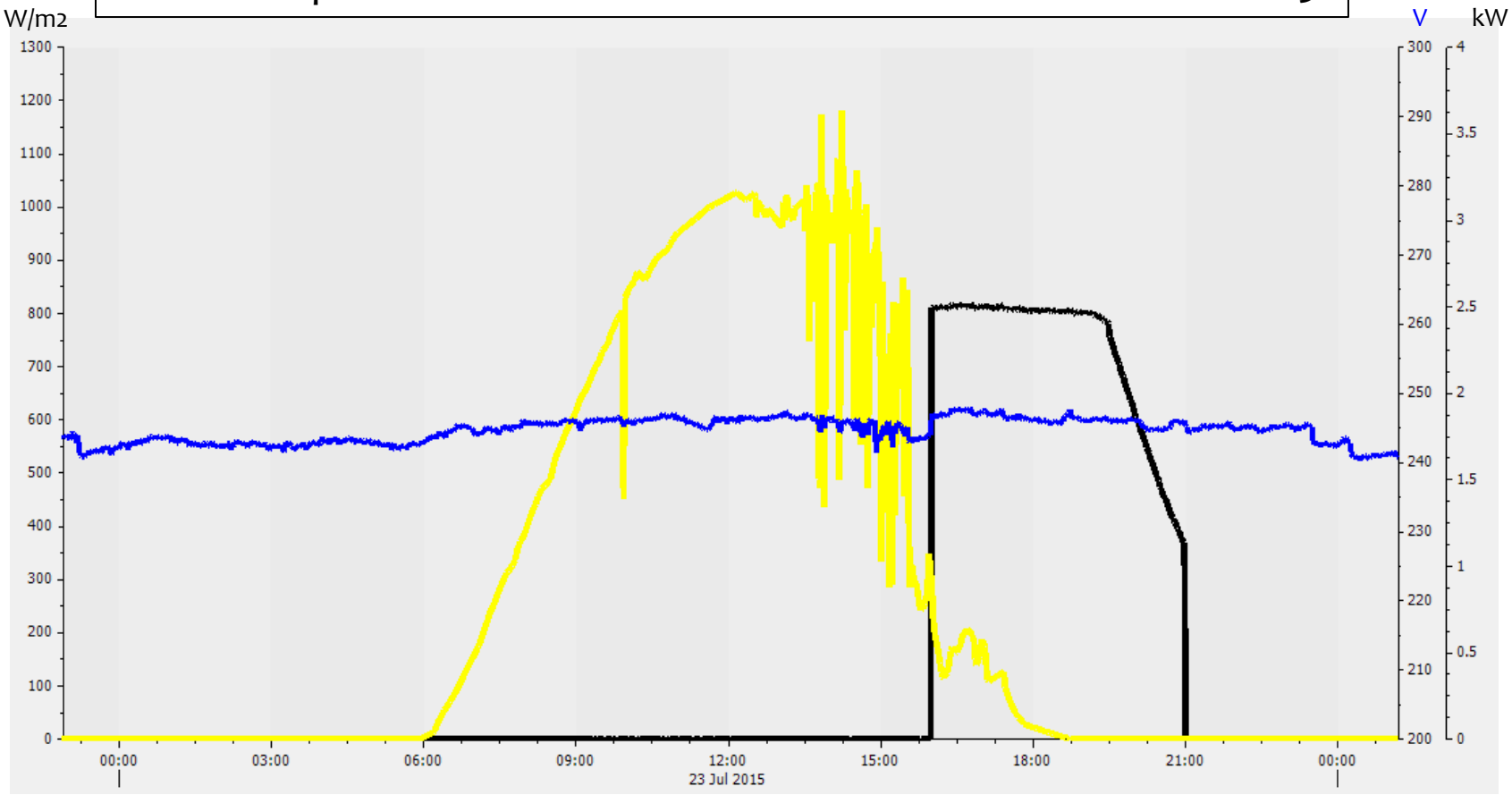


Research Campus Microgrid

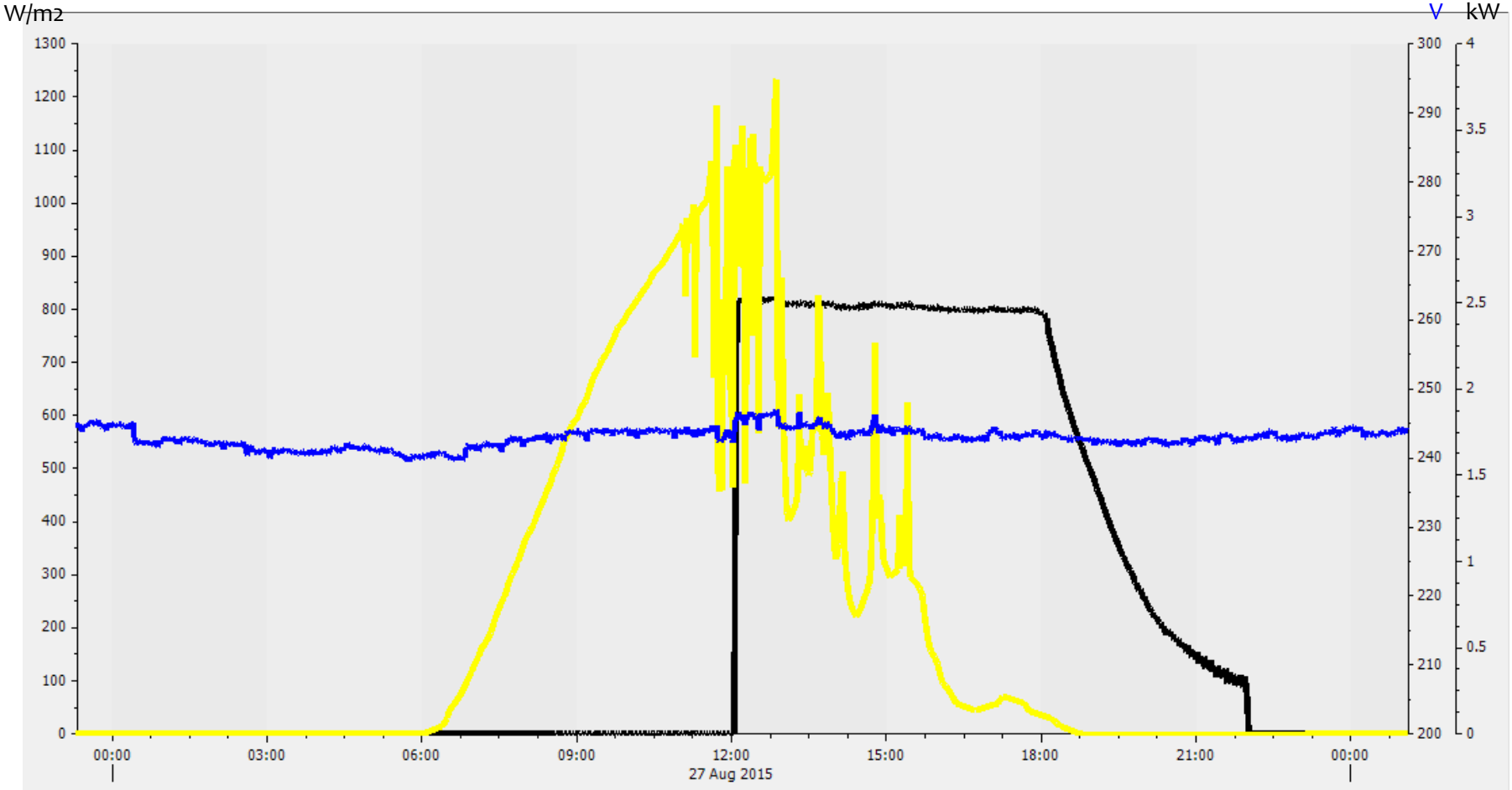


Aquion Battery (Generation 1) – Initial Duty Cycle (HELCO preferred)

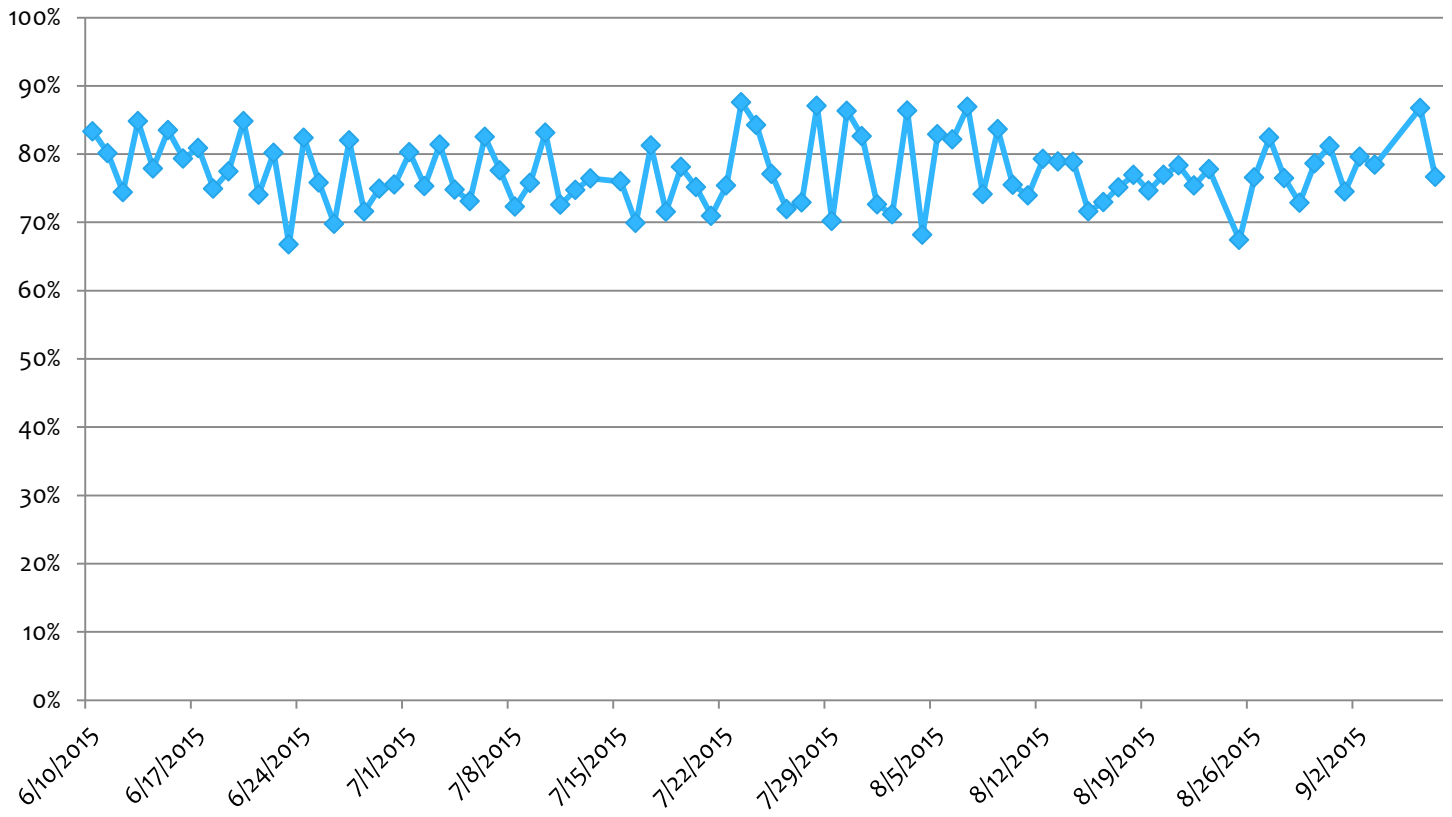
- Full data collection started June 10, 2015
- Sandia to perform evaluation on 6 months data in November 2015



Aquion Battery (Generation 1) - Duty Cycle (Compromise)



Aquion Gen 1 Battery Efficiency (Daily) from June 10 to September 7, 2015



Developing an ESS Test Bed – Lessons Learned

- ***Consumer vs industrial*** – integration challenges
- ***Rapidly moving field*** - permitting process must be streamlined
- ***Value of partnerships*** – utility in particular
- ***Data Accessibility*** – central, user friendly, web accessible

Future Work and Projects

- **Oct 2015 (in progress):** Hawaii Natural Energy Institute (HNEI) Hydrogen production and fueling station (65 kg/day)
- **Jan 2016:** 200kW PV and energy storage installation at Research Campus – Microgrid
- **Feb 2016:** Use of reconditioned Prius hybrid vehicle batteries as potential energy storage solution
- **2016 (?):** Ocean Compressed Air Energy Storage (OCAES)
- **2016 (?):** Modular Pumped Hydro Demonstration
- **2016(?):** Wave Energy/Desalination Demonstration

NELHA

Acknowledgments:

- DOE Office of Electricity, Dr. Imre Gyuk
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- Aquion Energy, Tim Wood
- Renewable Energy Systems, Roland Shackelford

NELHA/HOST Park

Explore the possibilities…

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