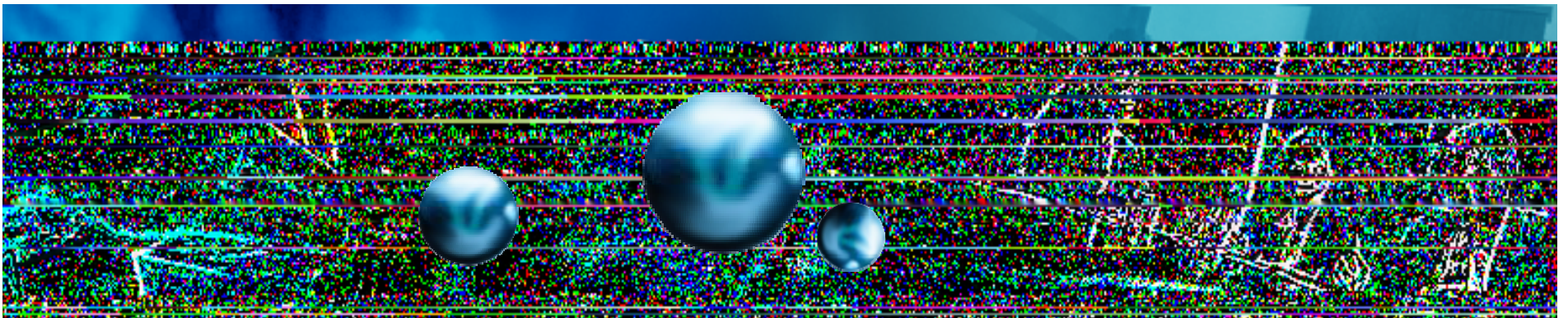


Hawaii Case Study



"Commitment to Innovation"

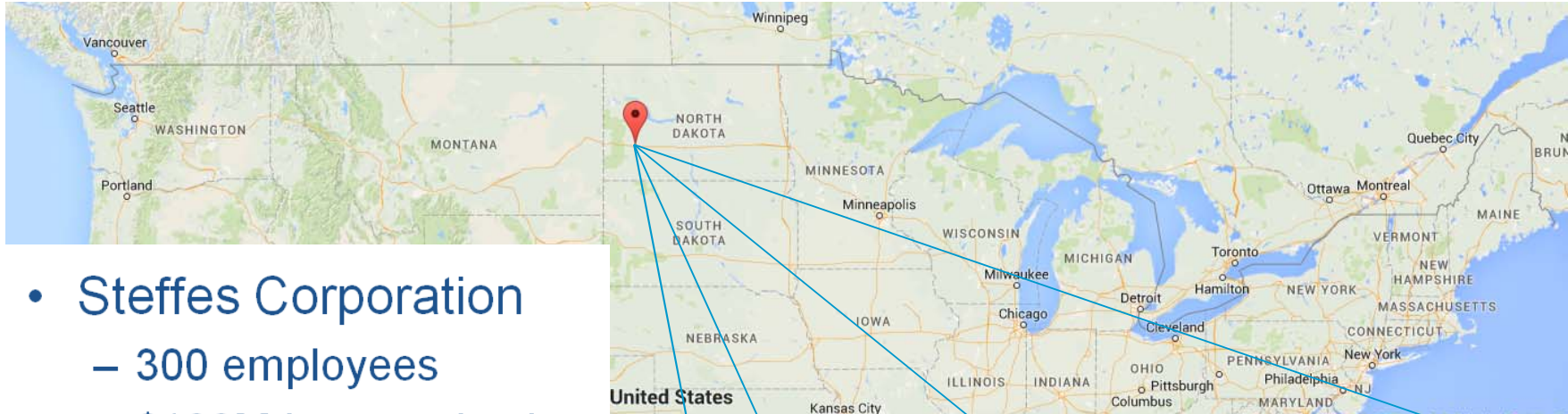
Austin Zeller
Steffes Corporation
azeller@steffes.com
888-783-3337

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INTRO SLIDE



- Steffes Corporation
 - 300 employees
 - \$100M in annual sales
 - 30 years of experience in energy
 - Work with 200 utilities
 - Certified UL test lab





Space Heating Products

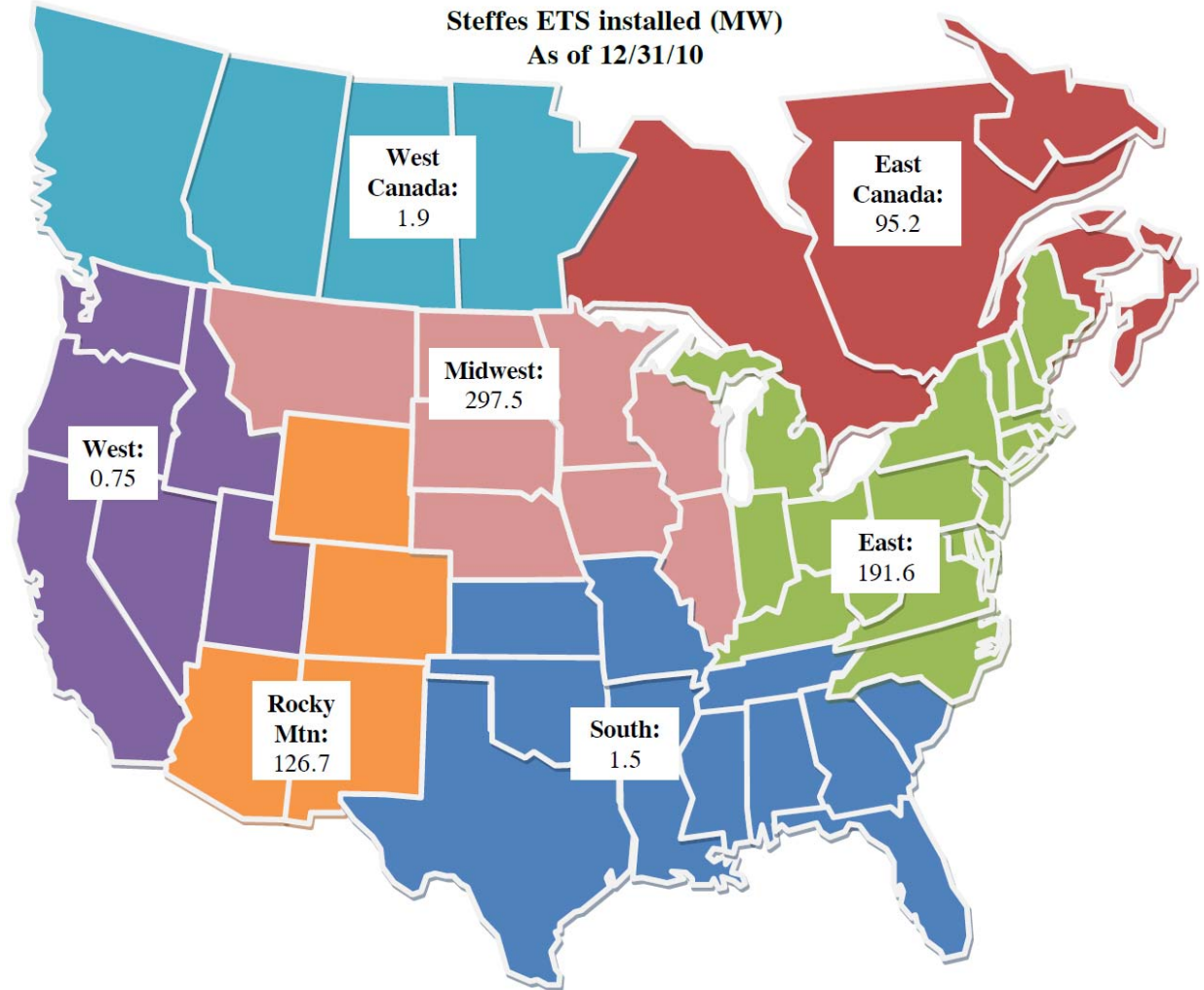
- Room Units
 - Up to 10.8 kW
 - Up to 40 kW·h
- Residential
 - Up to 45.6 kW
 - Up to 240 kW·h
- Commercial
 - Up to 80 kW
 - Up to 1 MW·h





Product Footprint

- 700 MW of DR and ToU operating capacity
- 10 GW·h of energy storage





Society for Energy Alternatives

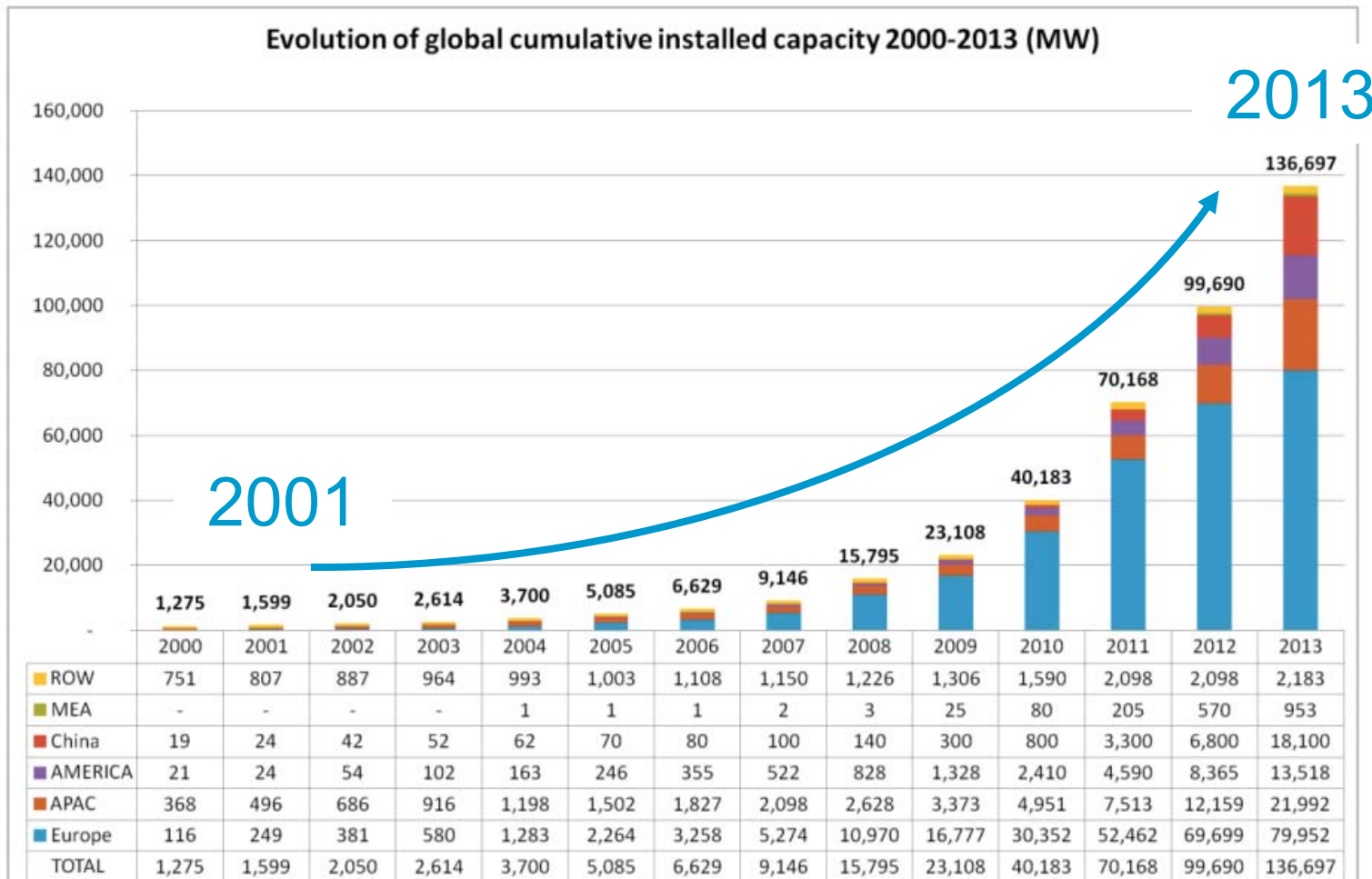


"We were among the fastest teams turning laps out there when the motor was running," said Austin Zeller, Dickinson, N.D., the driver and team president.



Solar Installed Capacity

Evolution of global cumulative installed capacity 2000-2013 (MW)



Source: EPIA



Fast Ramps

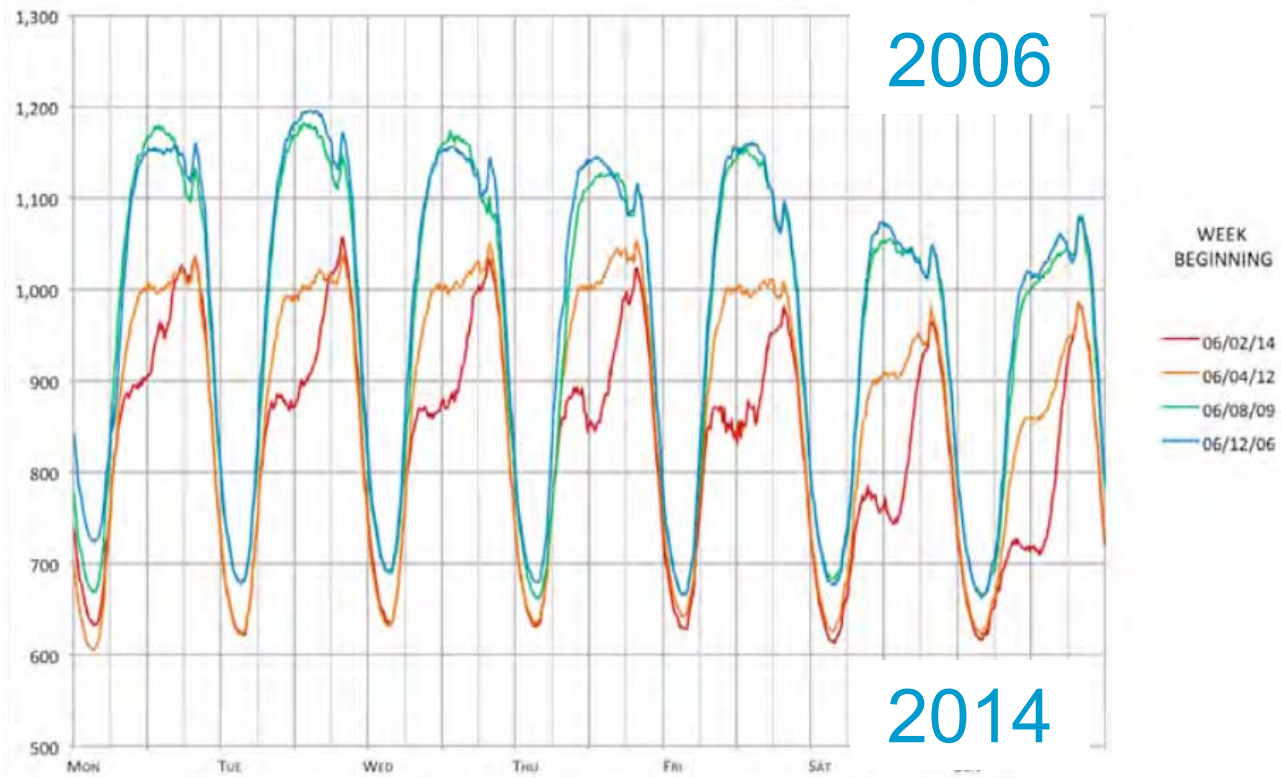
Growing need for flexibility starting 2015

One of the ISO's major concerns is the duck curve that shows how rapidly the amount of renewables available to meet demand can change. It also shows that there could be as much as a 13,000-megawatt ramp in demand at the evening peak, just when the sun sets, Greenlee said. "With higher levels of variable generation, there is an increasing need for flexible technologies like energy storage and rapid ramp natural gas plants."



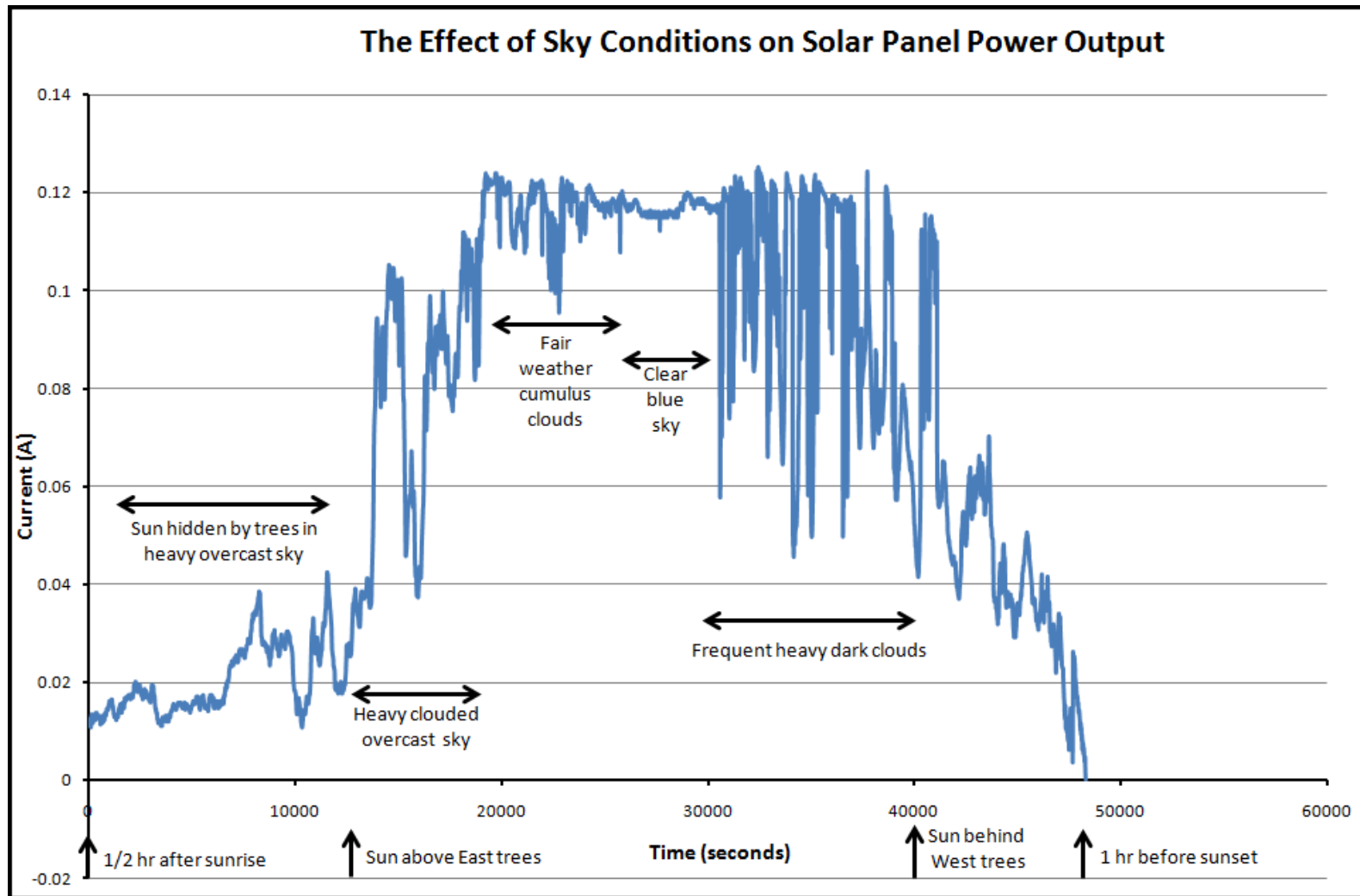
HECO System Load

HAWAIIAN ELECTRIC COMPANY, INC.
HISTORICAL COMPARISON OF SYSTEM LOAD
TYPICAL WEEK IN JUNE





Generation Variability



Source: <http://www.vernier.com/innovate/the-effect-of-sky-conditions-on-solar-panel-power-output/>



Options

- Fast-ramp generation
- Hydro
- Pumped Storage
- Flywheels
- Battery Systems
- And . . .



GETS Water Heater

- Specifications
 - 4.5 kW
 - 15-25 kW·h
 - Multipoint temperature sensing
 - High-speed, real-time, communications
 - Sub-second solid-state switching
 - Accurate real-time energy metering



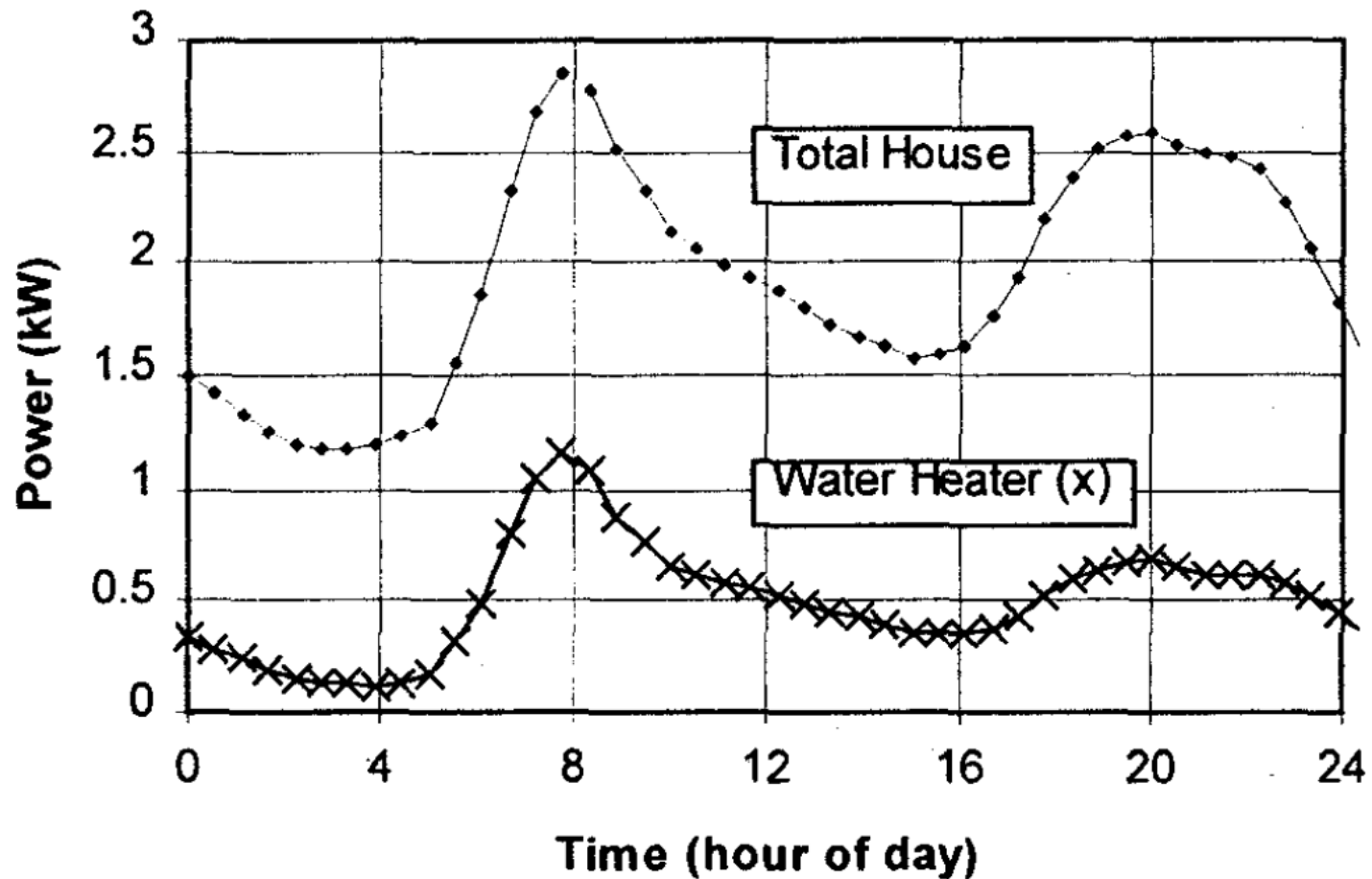


Dynamic Dispatch

- So, how can the lowly water heater help the grid?
- Aggregation.



Average Daily Energy Use

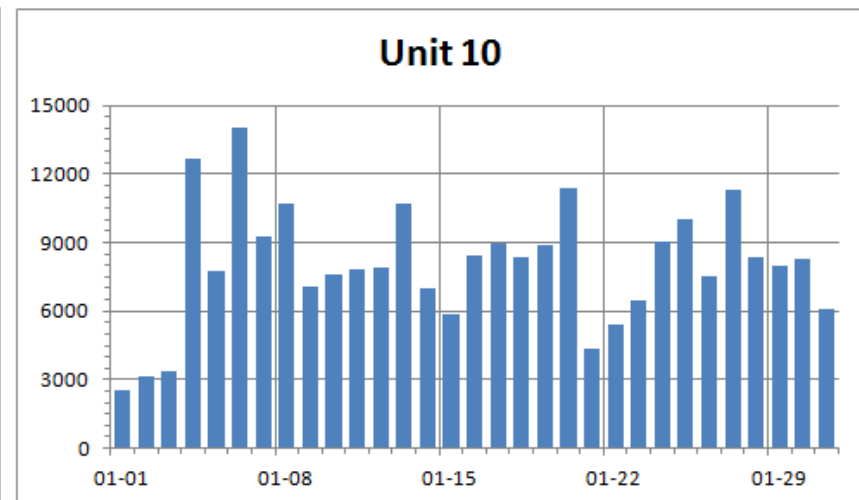
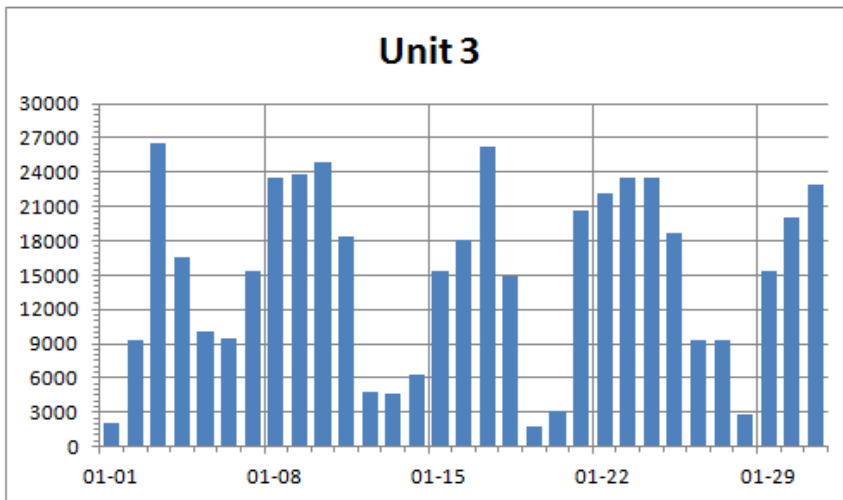
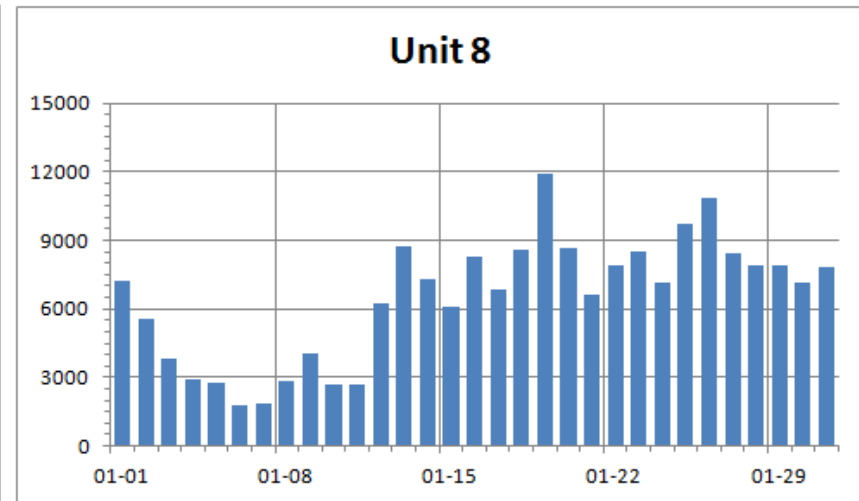
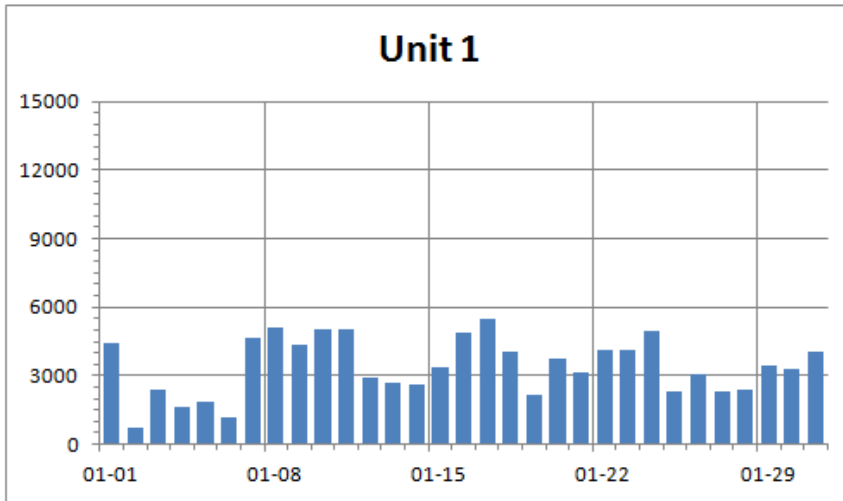


A CUSTOMER-INTERACTIVE ELECTRIC WATER HEATER
DEMAND-SIDE MANAGEMENT STRATEGY USING FUZZY LOGIC

M.H. Nehrir, B.J. LaMeres, V. Gerez
Senior Member, IEEE Student Member, IEEE Senior Member, IEEE
Department of Electrical and Computer Engineering
Montana State University
Bozeman, MT 59717

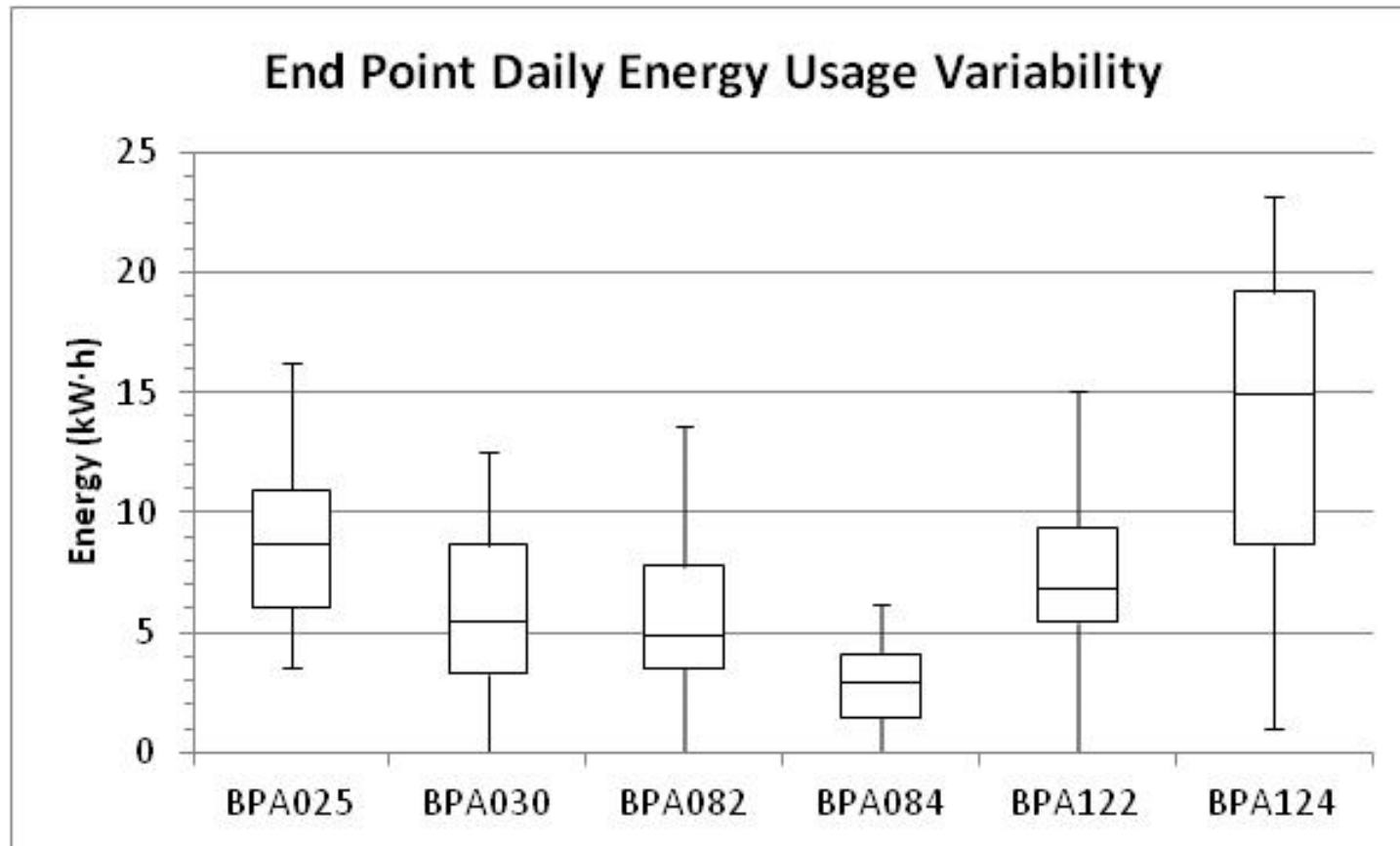


Hawaii Daily Load Variability



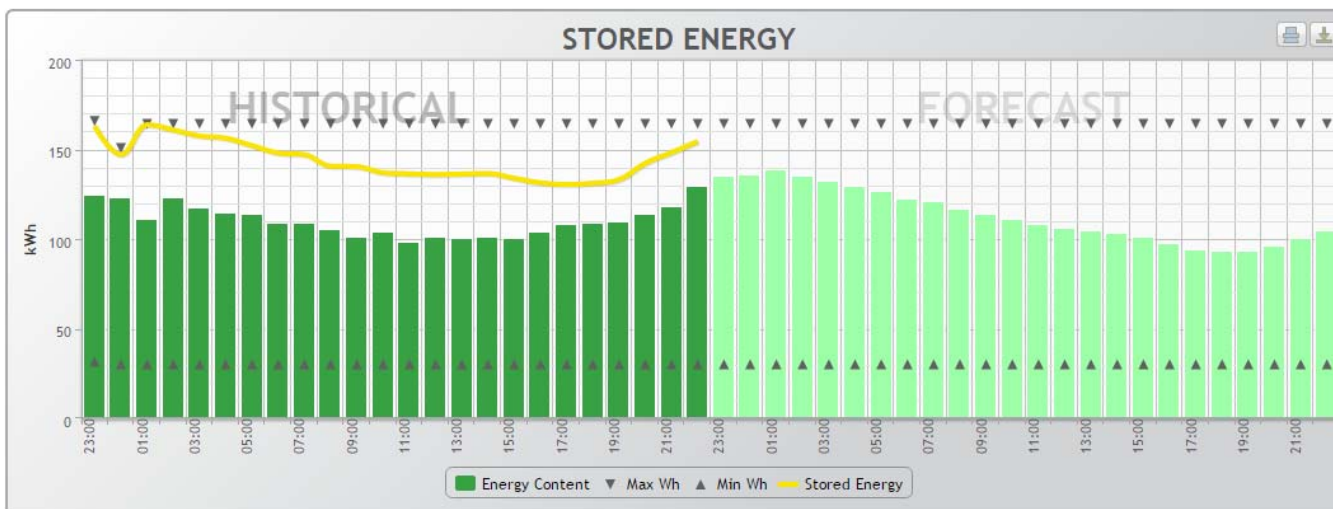
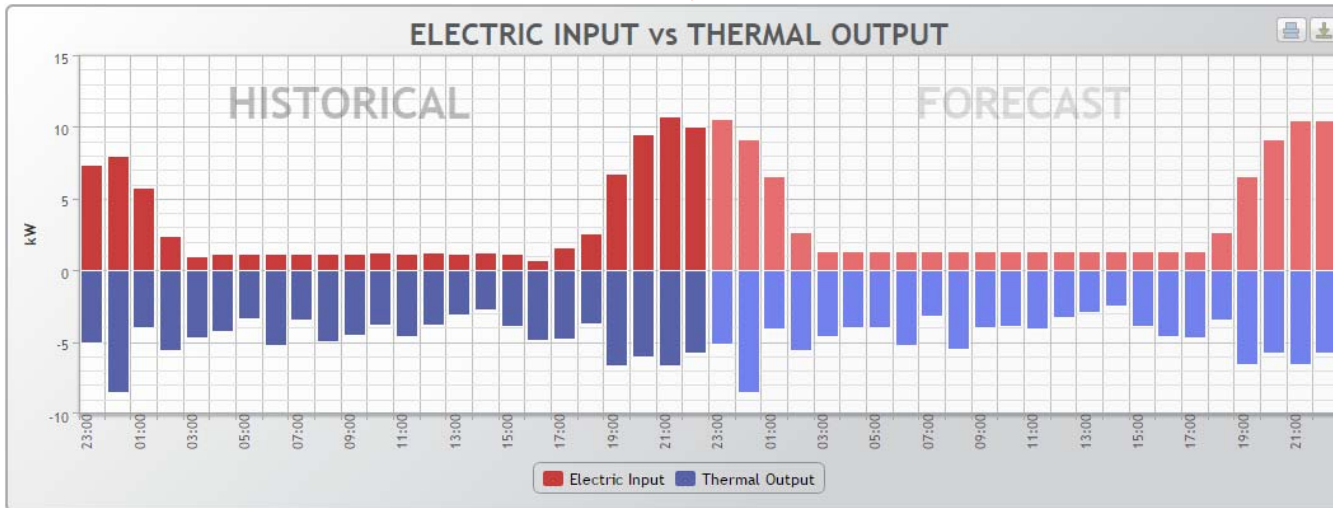


Load Variability



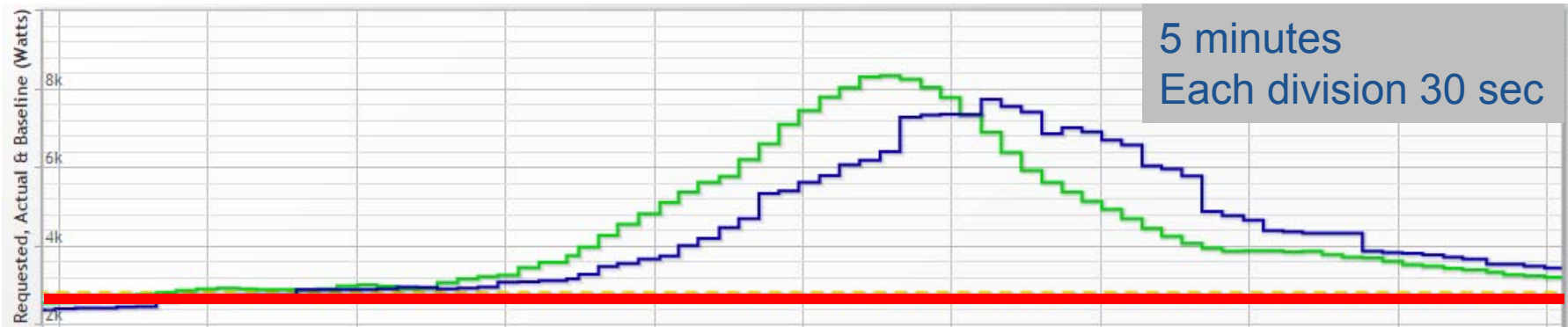
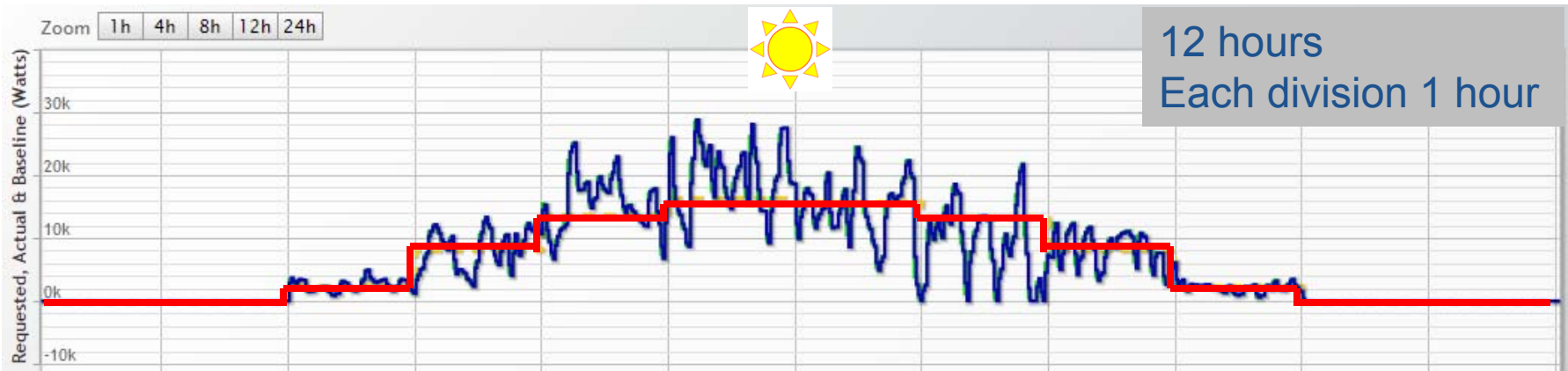


Solar Absorption Profile



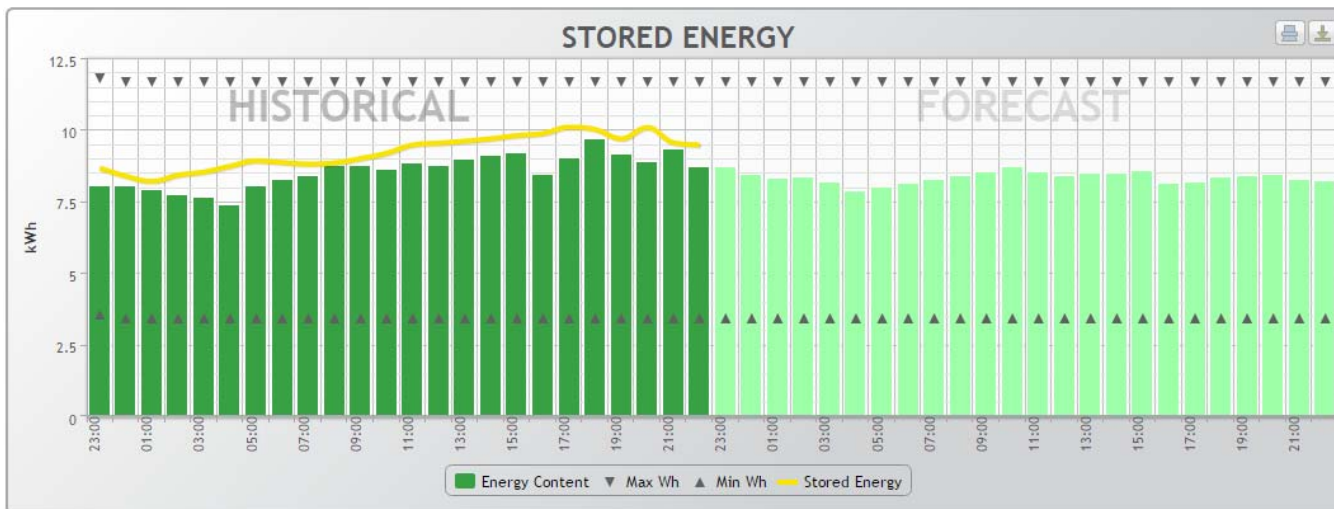
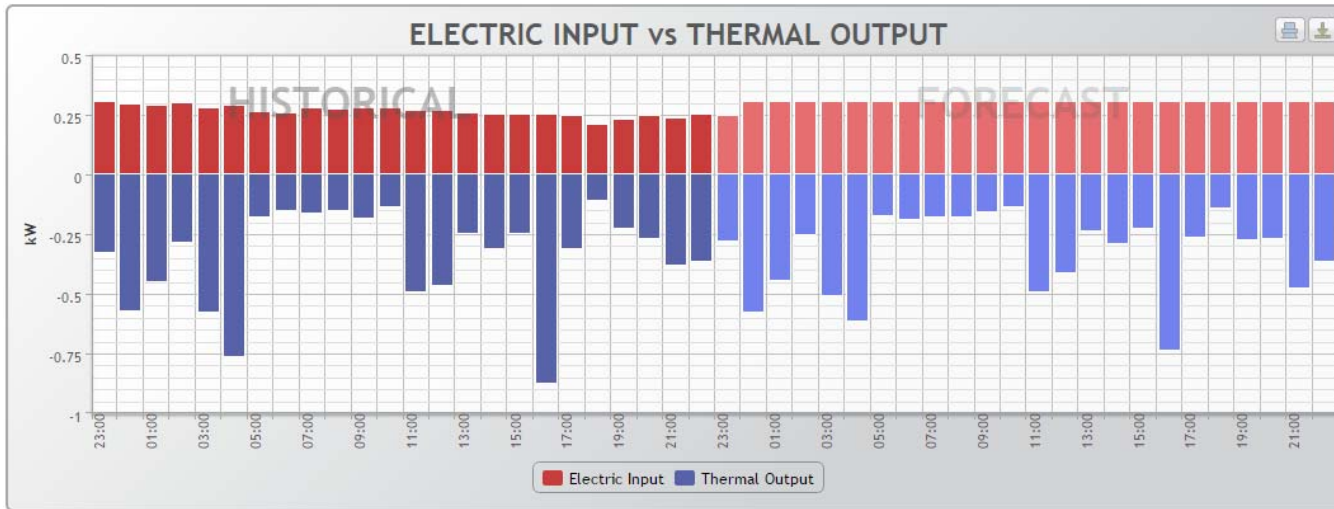


Real-Time Control



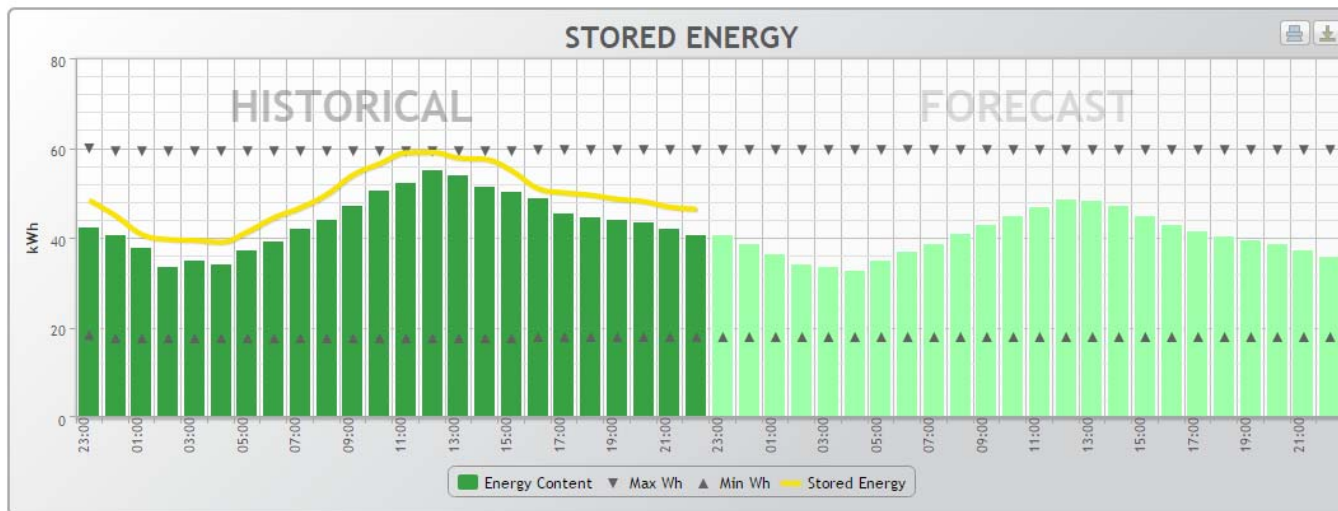
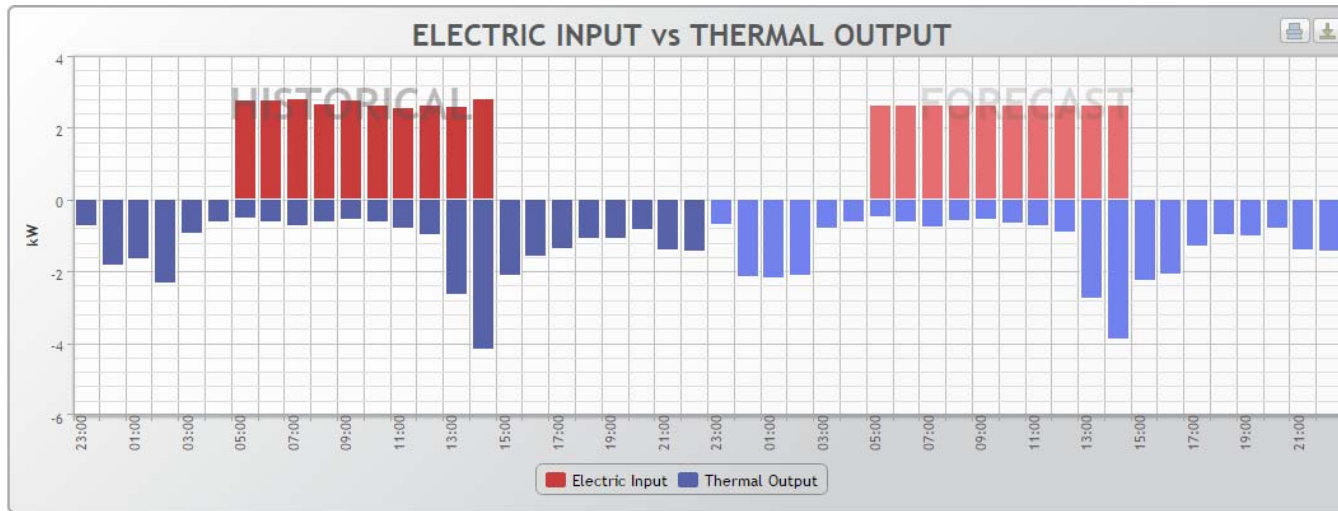


Continuous Availability



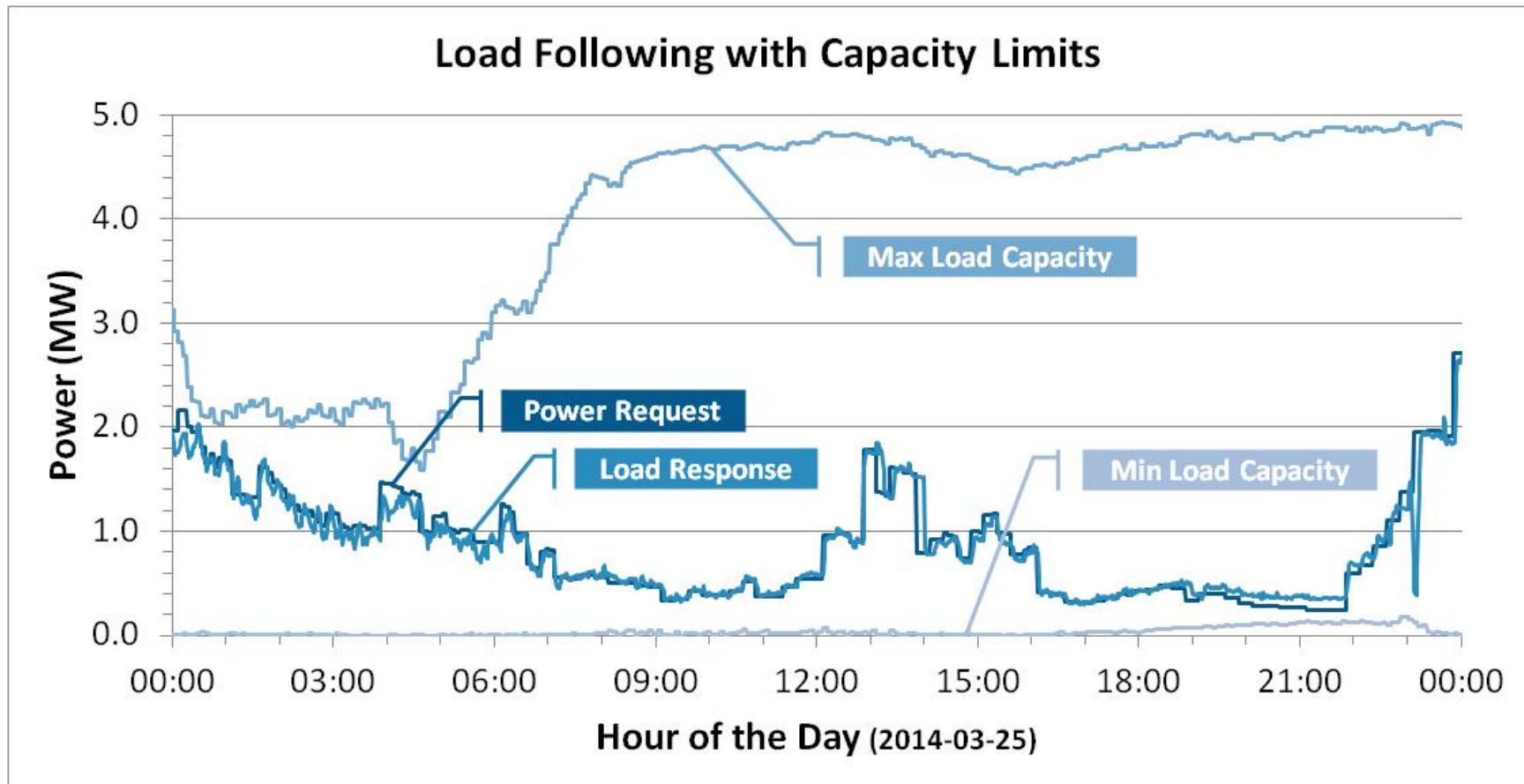


Off-Peak + Real-Time



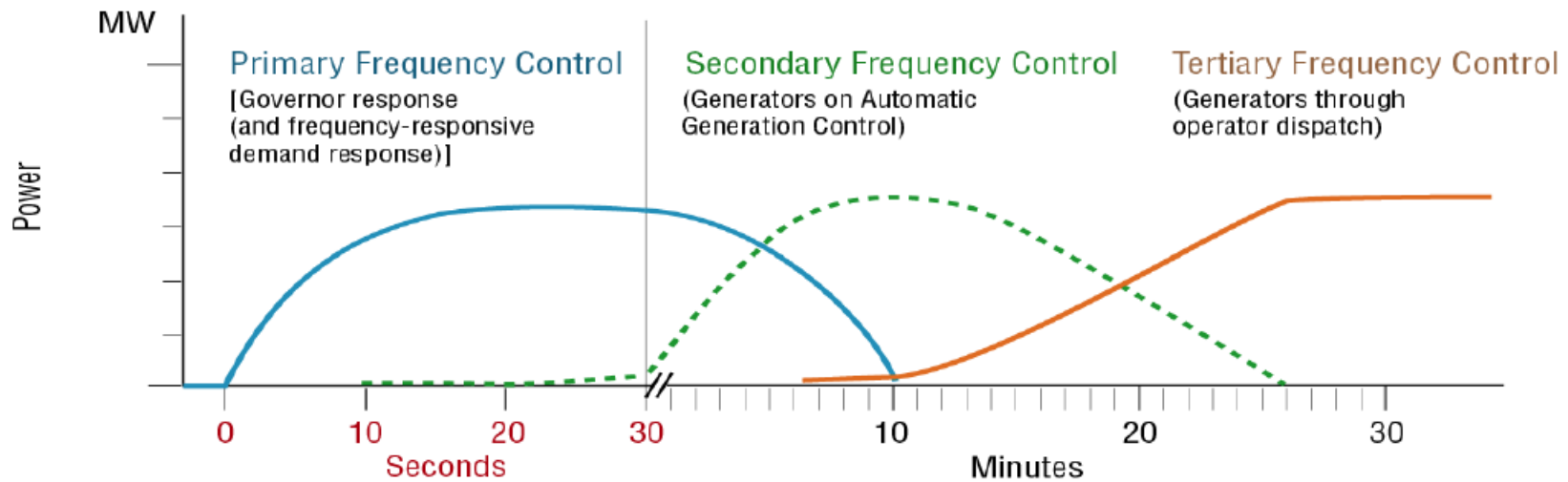


Grid-Scale





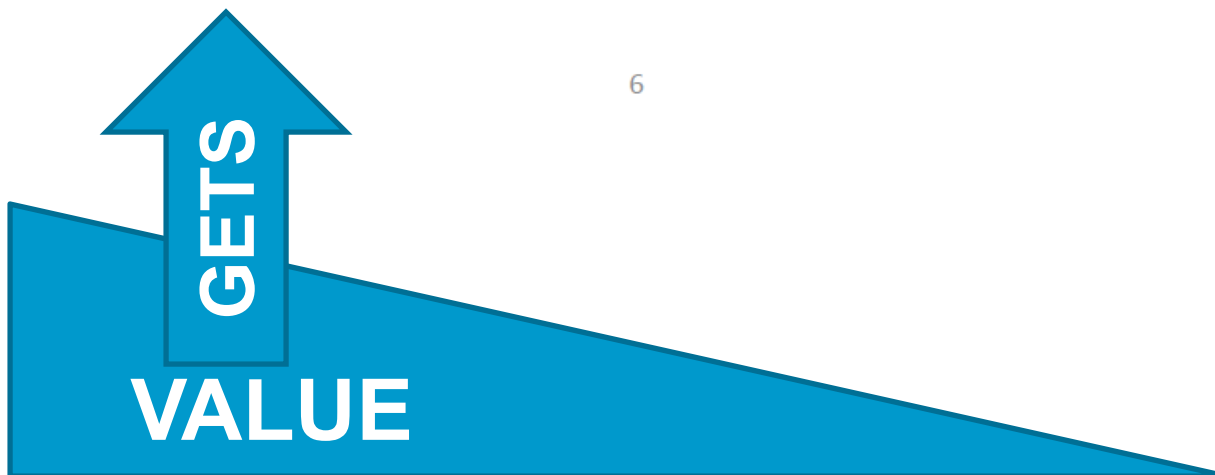
Value of Fast Response



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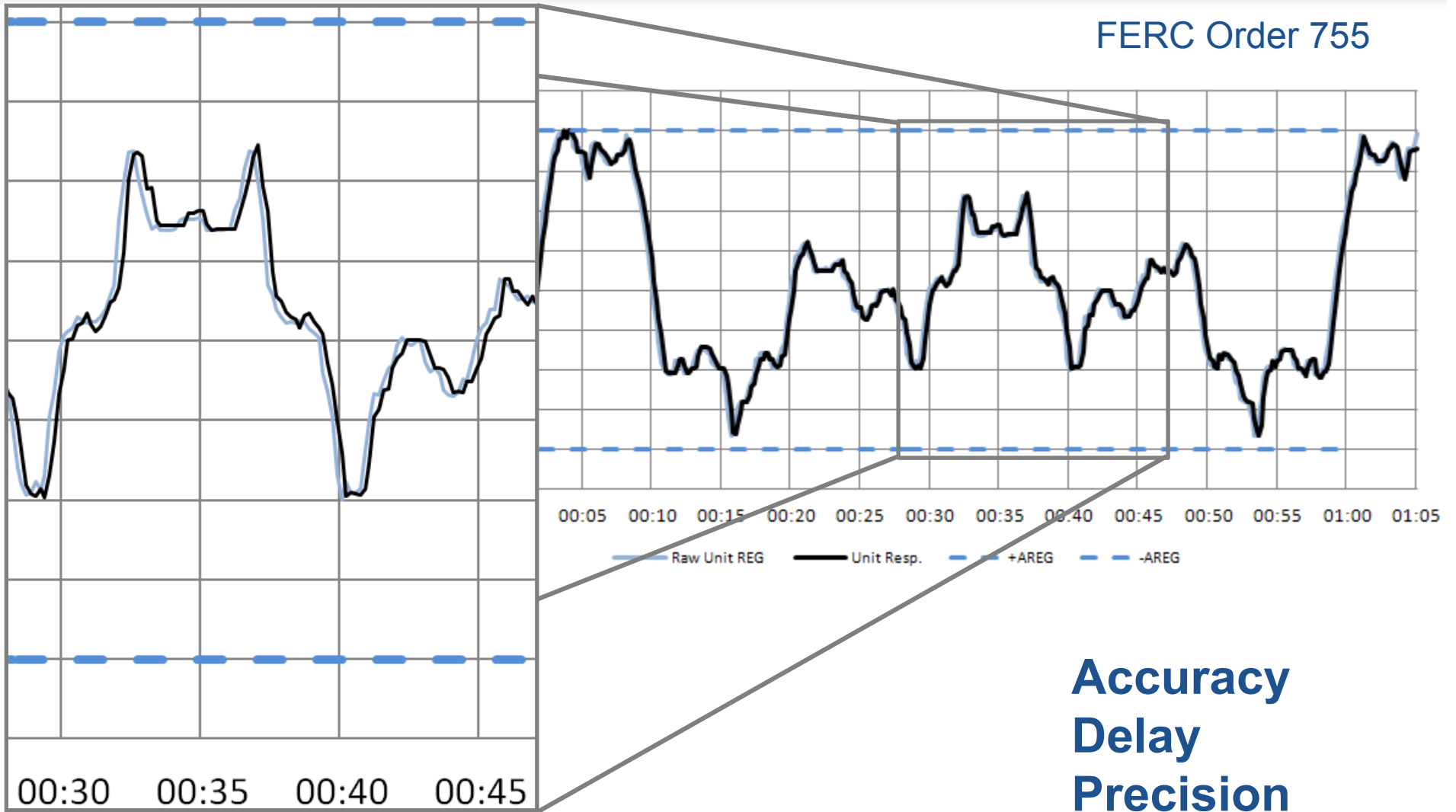
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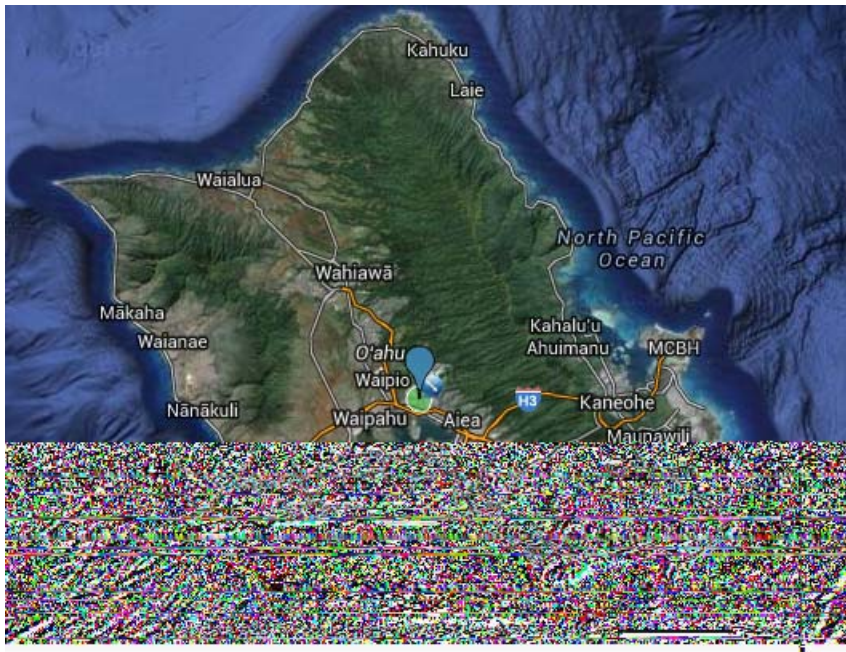
Pay for Performance





What is the potential?

O'ahu has nearly 300 MW of installed solar capacity today.



- Nearly 300 000 water heaters
- 1.3 GW of distributed load capacity
- 2 GW·h of energy storage capacity



Summary

- Renewable energy development is on the rise
- Energy storage is needed to support high penetrations of renewable energy
- Thermal energy storage is a grid-scale, low-cost, high-performance option
- Regulatory and legislative work is needed to support all forms of distributed and fast-ramp storage resources



Questions?



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Steffes Corporation

“Commitment to Innovation”



Setup

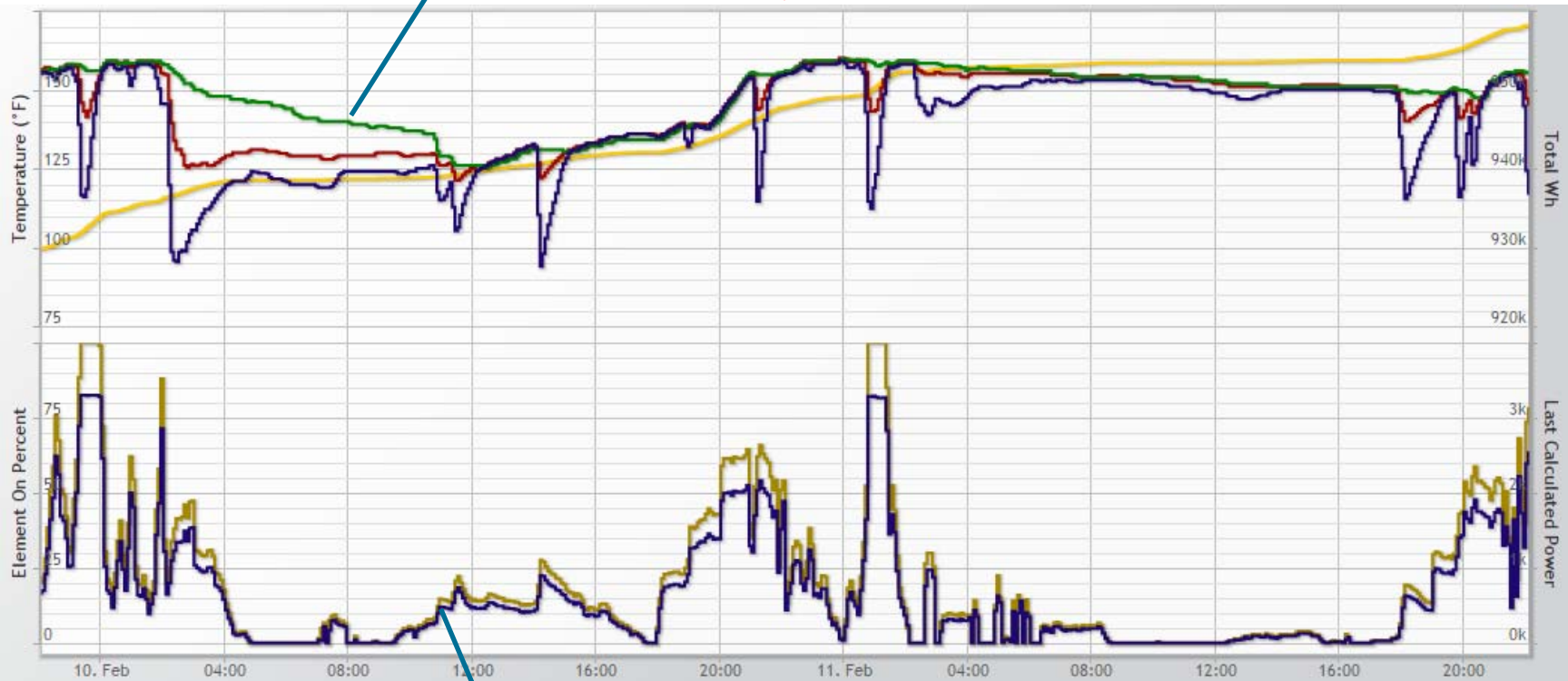
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 - Certified UL test lab





Intra-day Variability

Temperatures



Load Profile