

Grid-Interactive Energy Storage

ACEEE Water Heater Forum



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February 27, 2017



BENEFICIAL ELECTRIFICATION

Off-Peak Space & Water Heating

GRID-SCALE ENERGY STORAGE

Increase kWh Sales

CONTINUOUS DEMAND RESPONSE

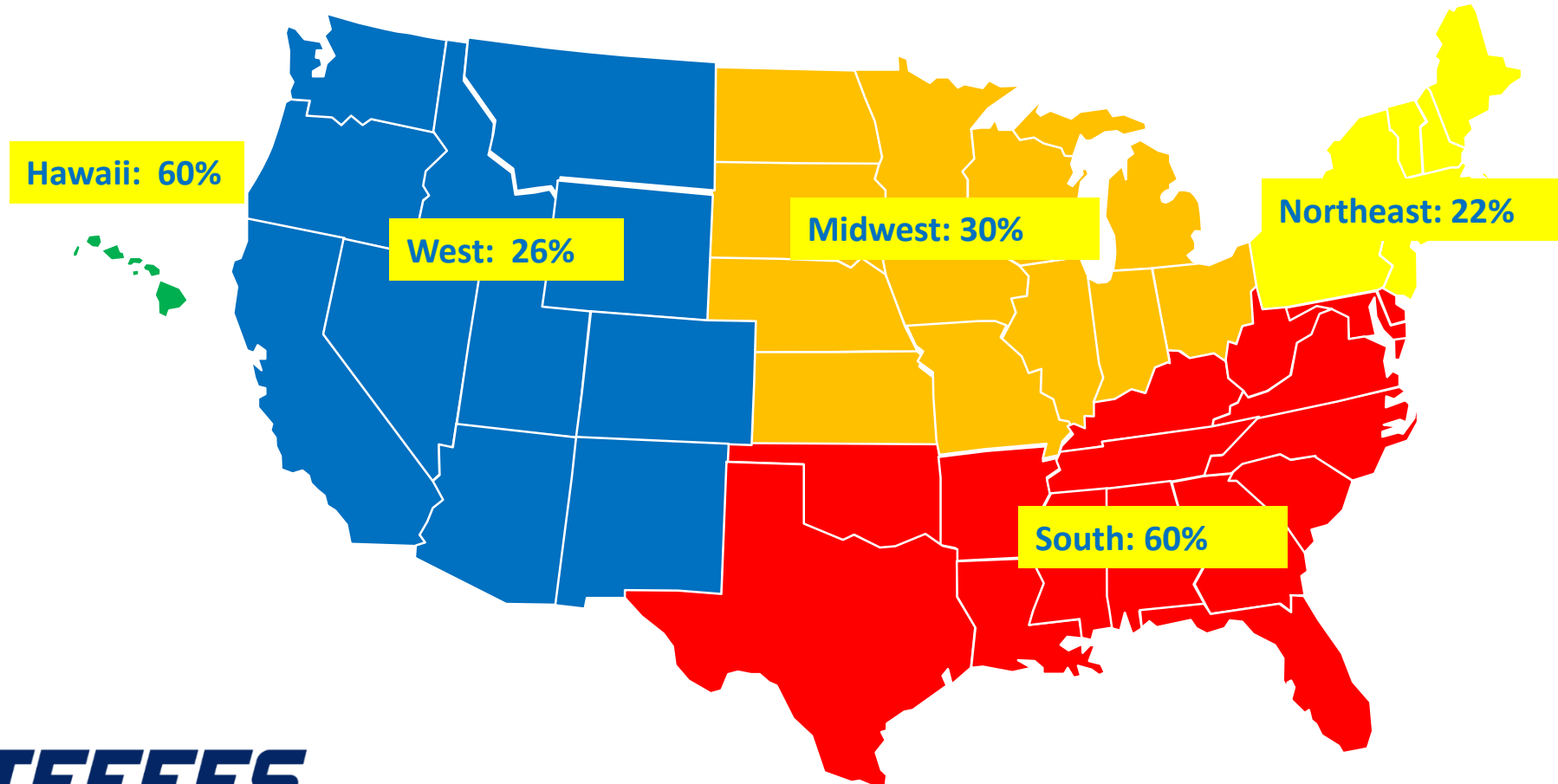
Renewable Integration



Grid-interactive Water Heating Opportunity

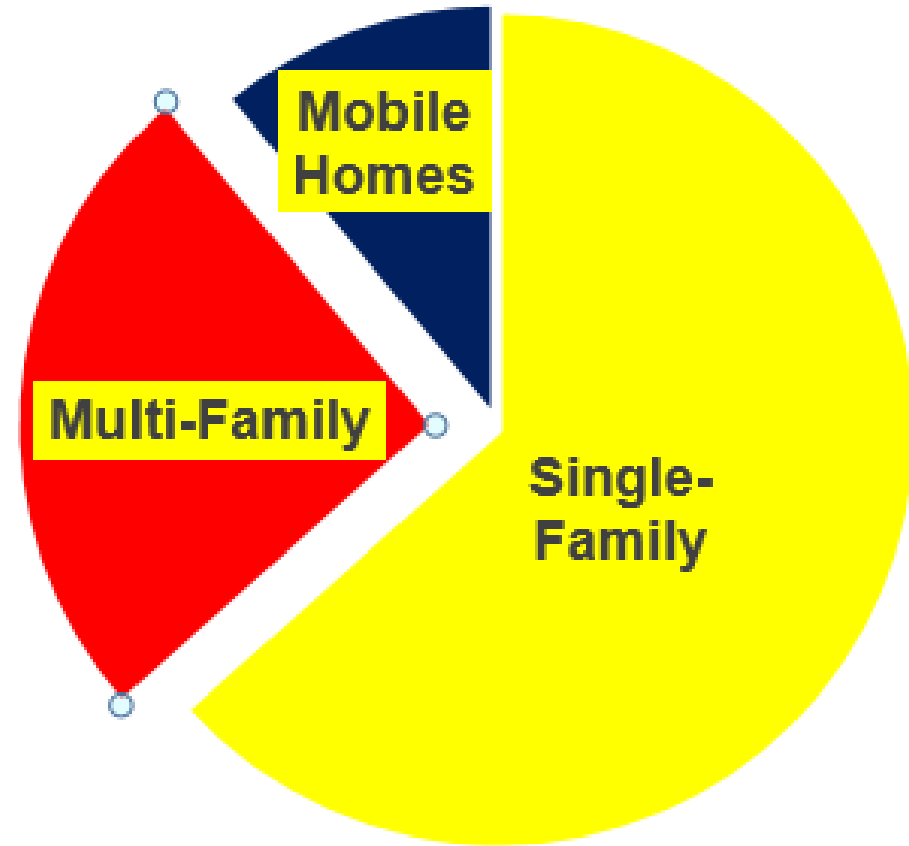


41% Electric Water Heat Saturation



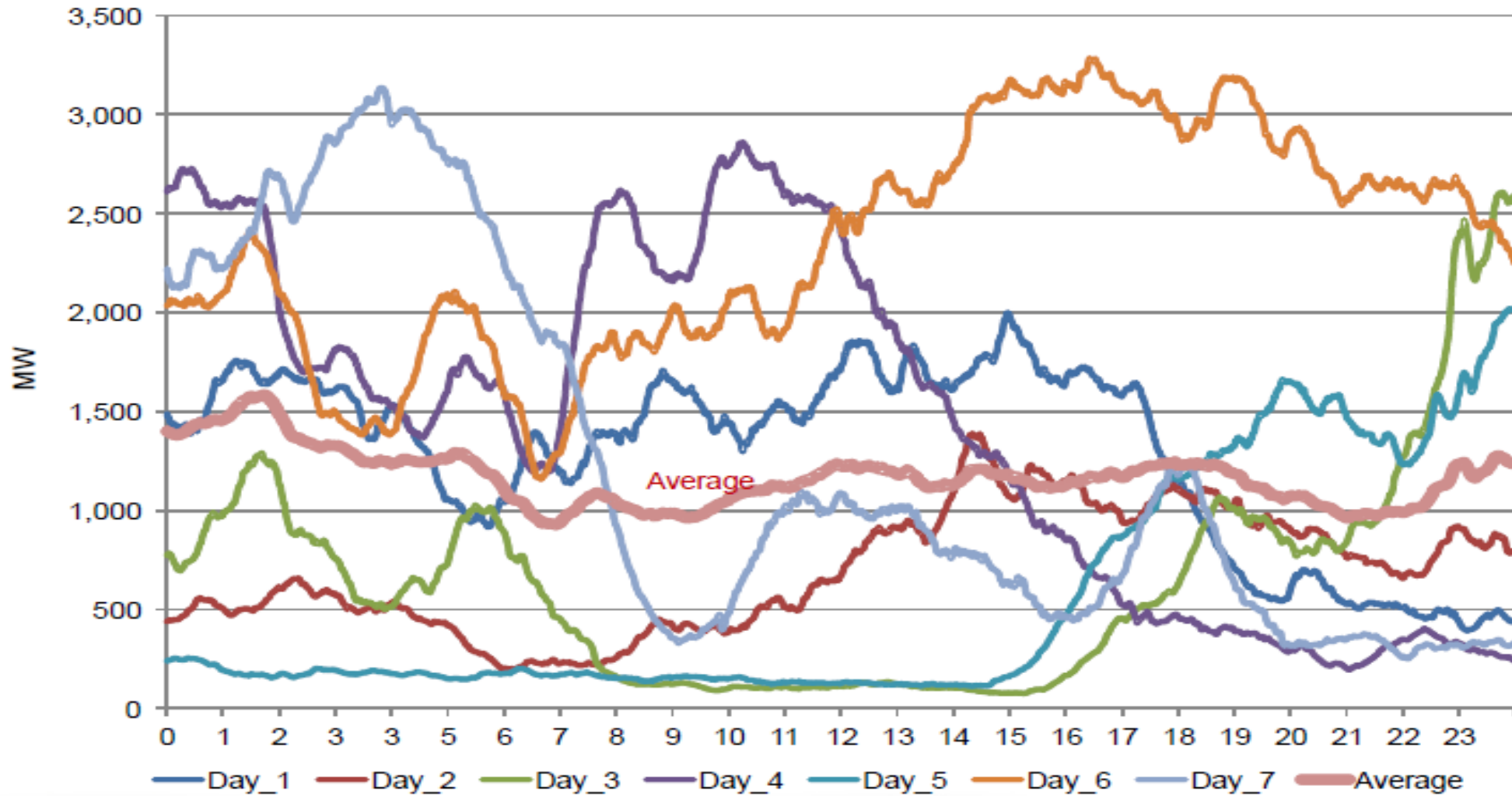
Magnitude of Potential

45 Million Water Heaters		Total
Capacity	4.5kW/ea.	202.5 gW
Energy Storage Capacity	12kWh	540 gWh
Annual Energy	3800kWh/ea.	171 tWh

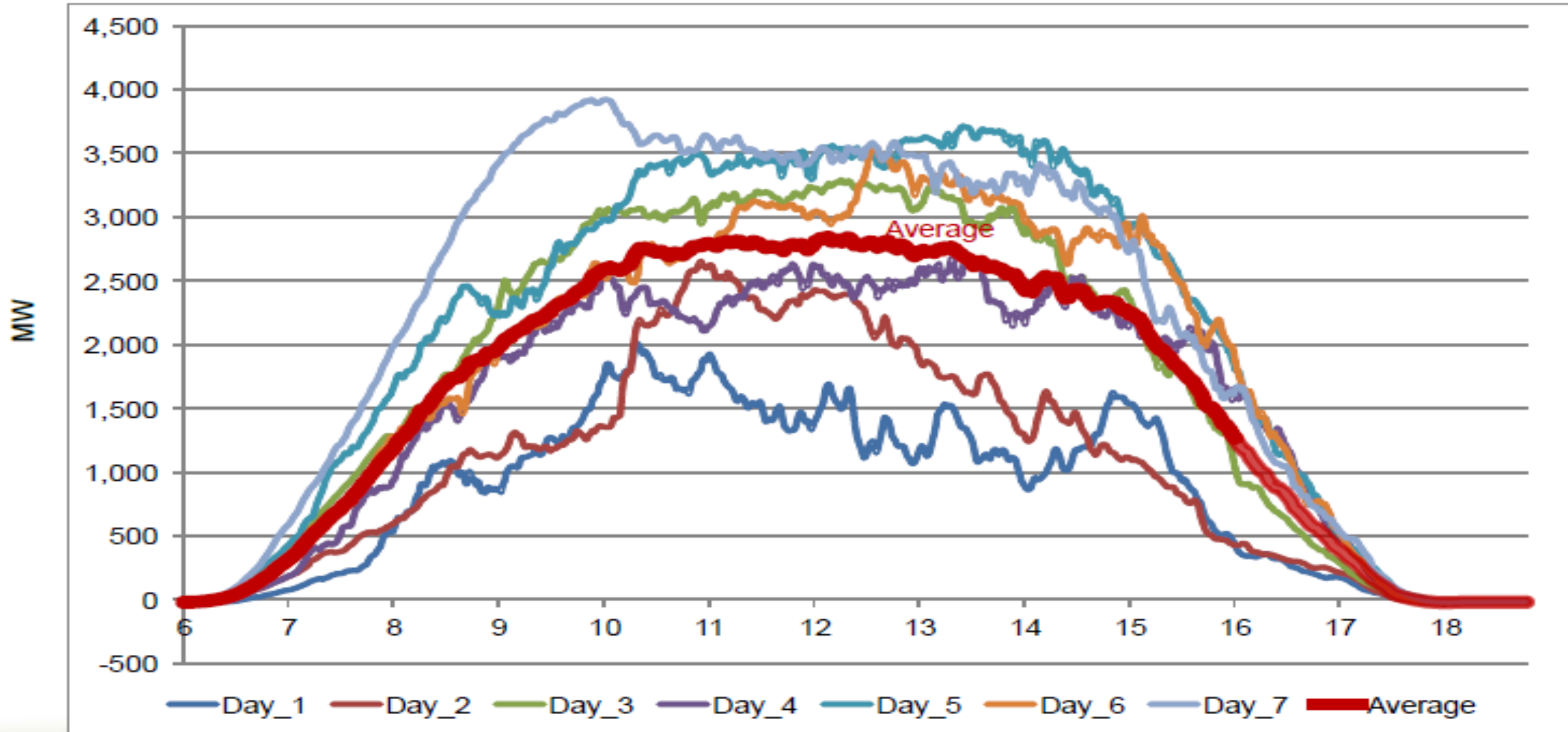


Great Variability in the Grid

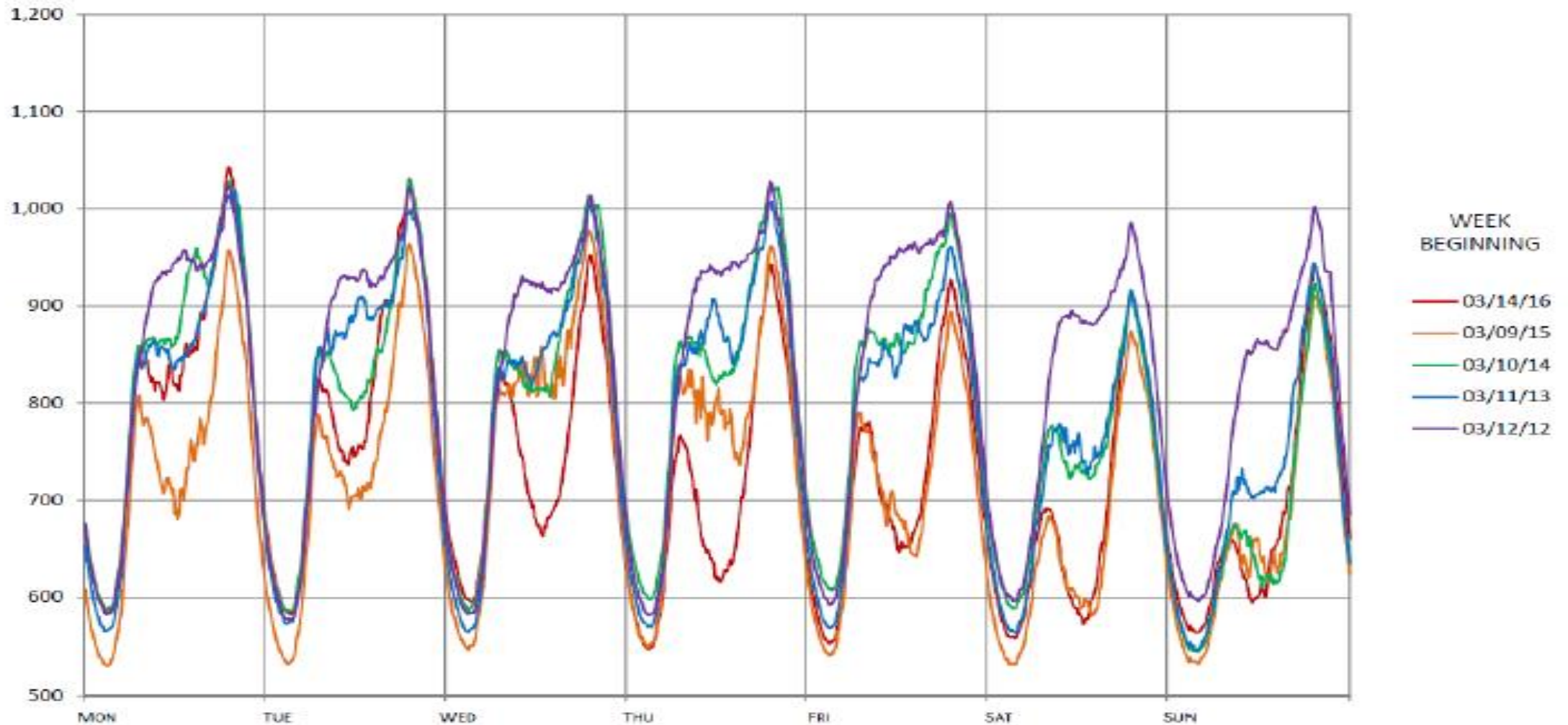
Typical Wind - Daily



Typical Solar - Daily



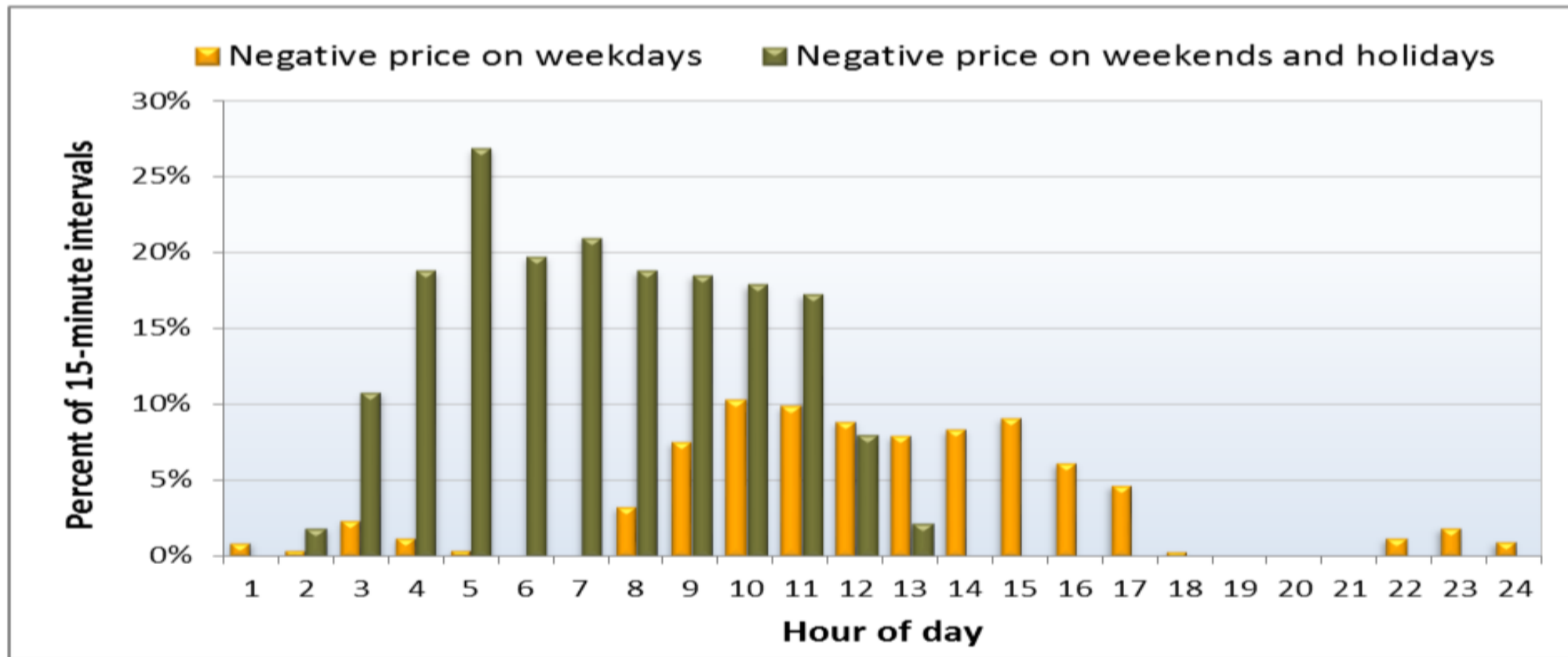
A Dramatic Evolution: O'ahu's Load Curve



Hawaiian Electric
Maui Electric
Hawai'i Electric Light

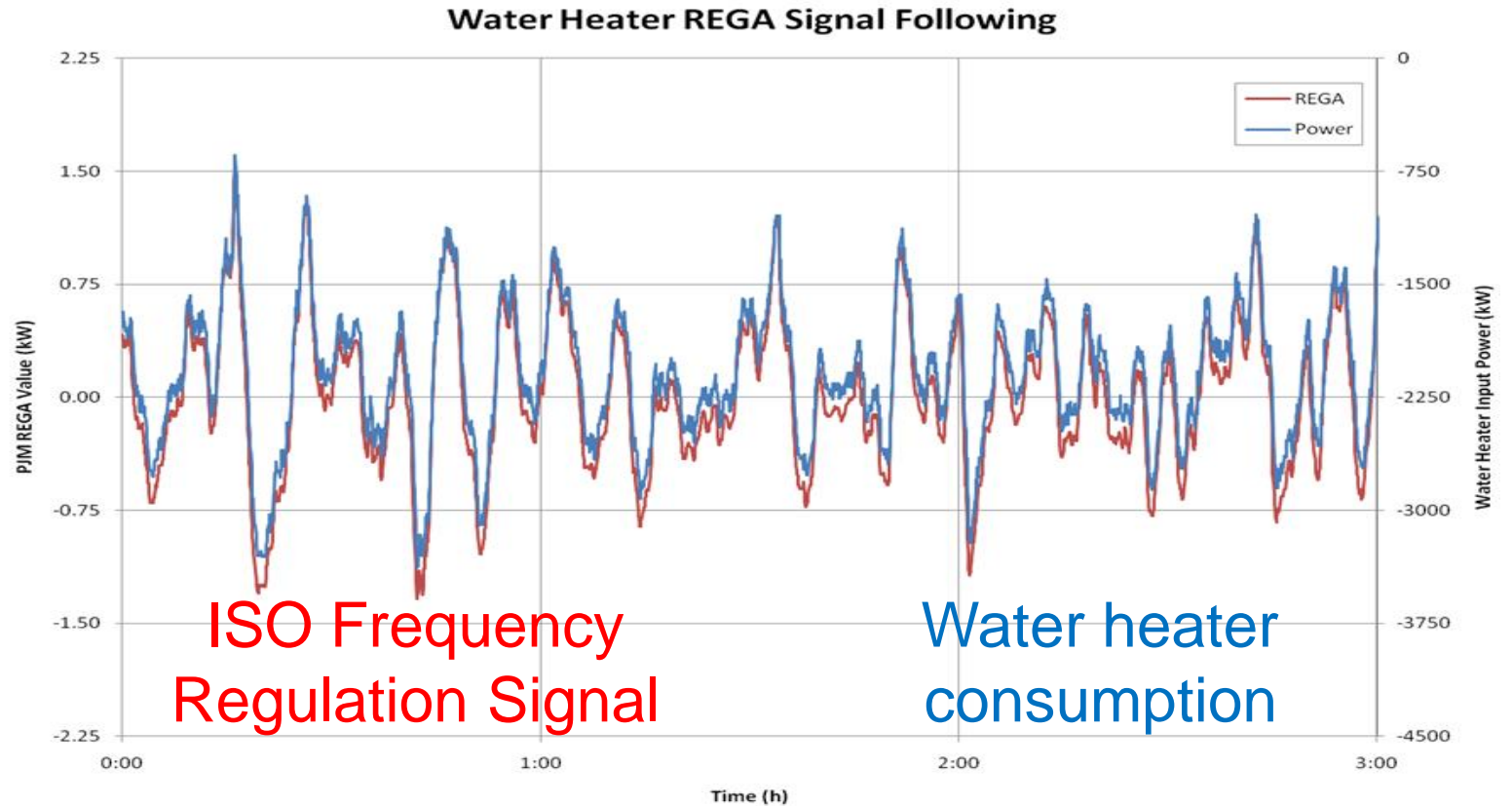
CAISO - Impact of PV to Net Load

Figure 4. Frequency of negative LAP prices in 15-minute market (April – June 2015)



Fast Regulation to balance the Grid

Under FERC Order 755, fast acting regulation resources could be compensated at **much** higher rates than today.

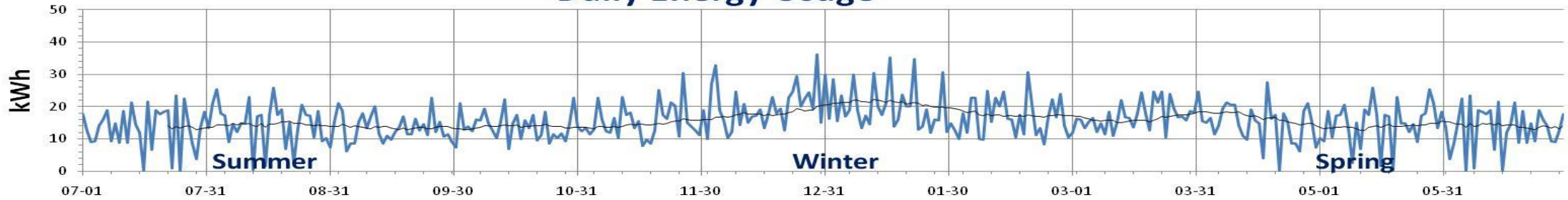


Great Variability of need for Hot Water

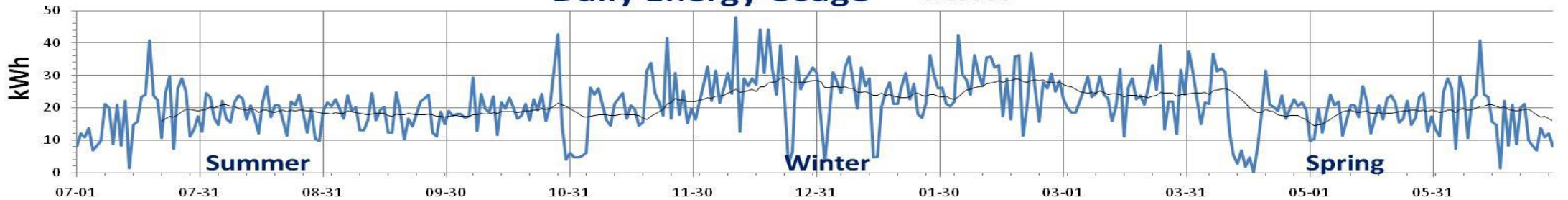
BPA – Actual kWh / day

Single WH over 365

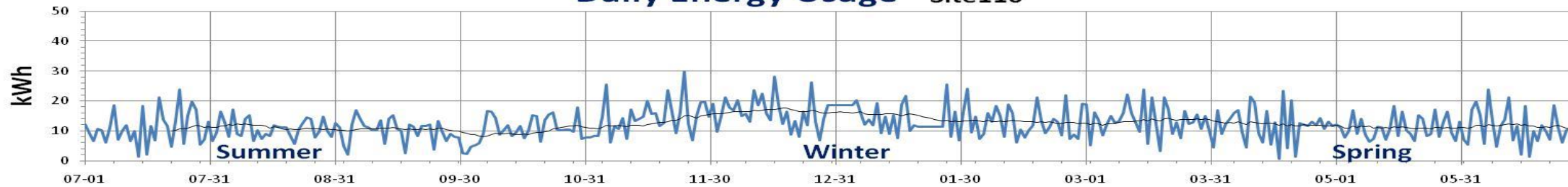
Daily Energy Usage Site091



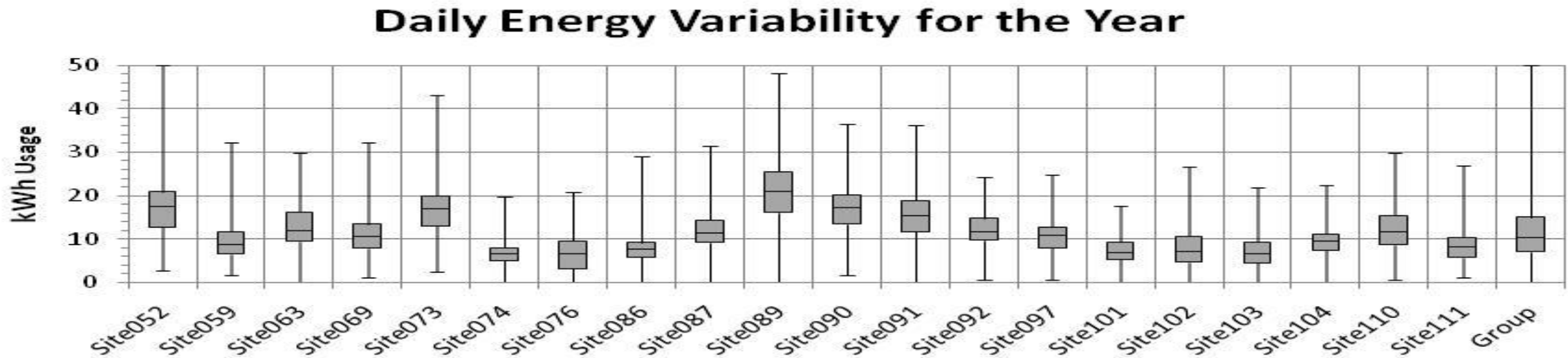
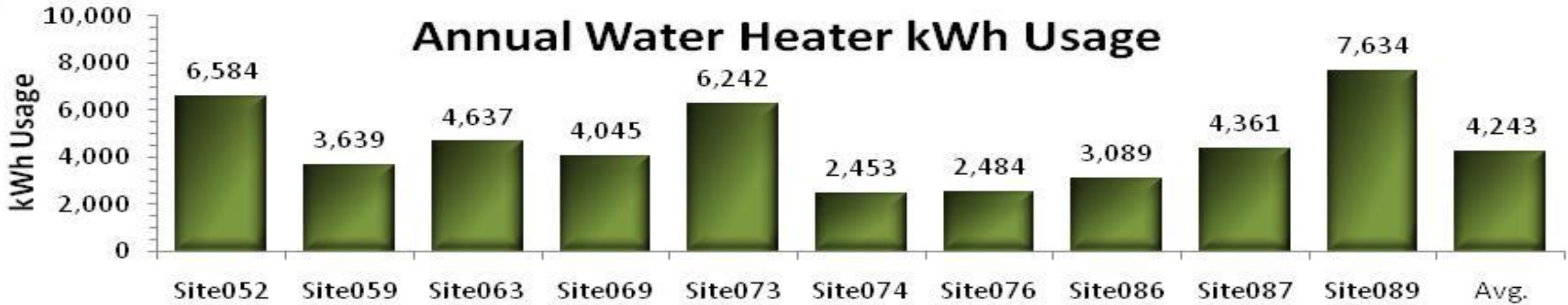
Daily Energy Usage Site089



Daily Energy Usage Site110

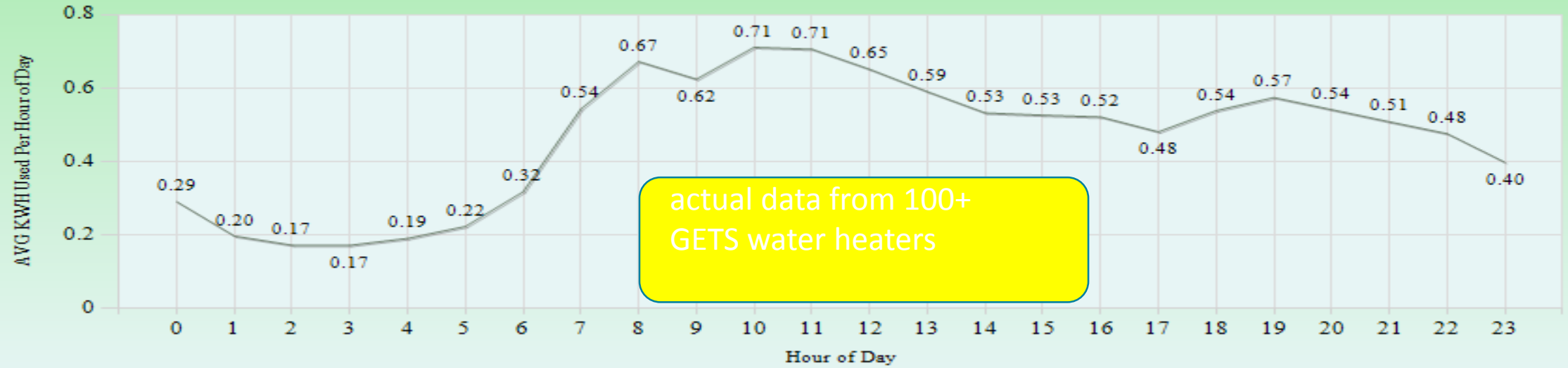


Energy Analysis

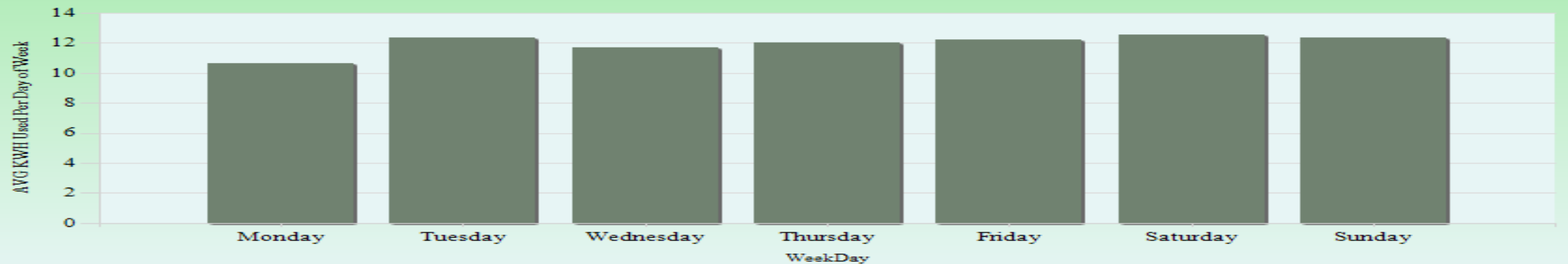


Group of 150 Water Heaters

Average for Hour of Day

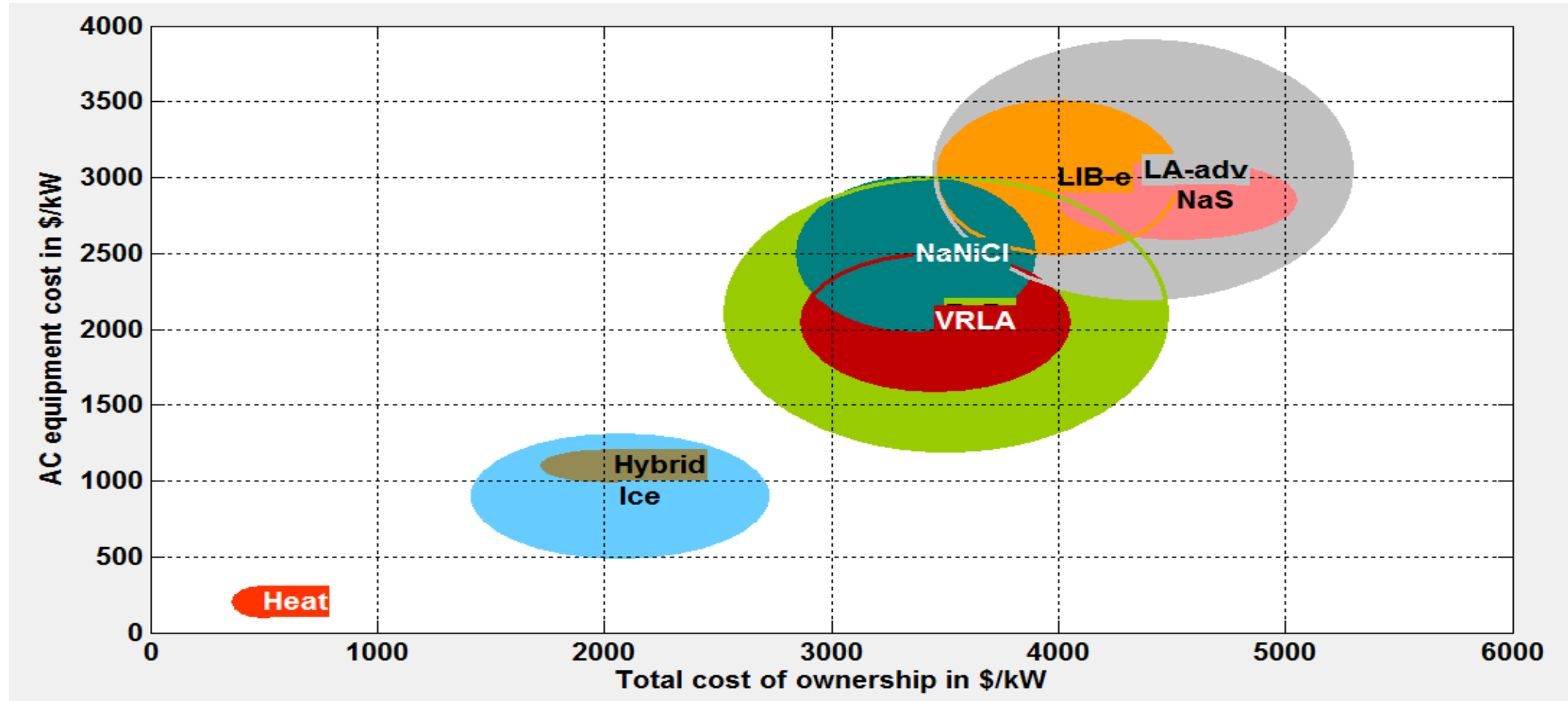


Average for Day of Week



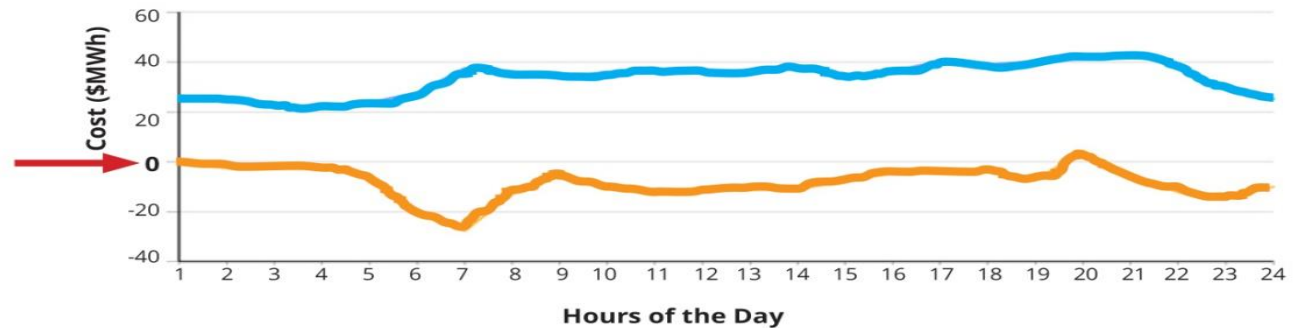
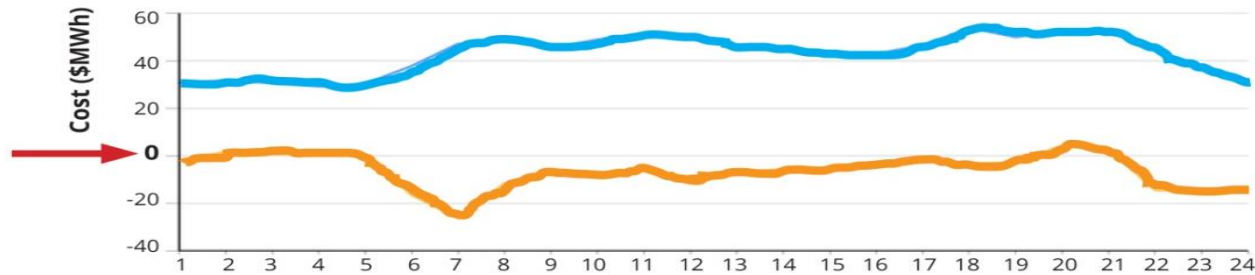
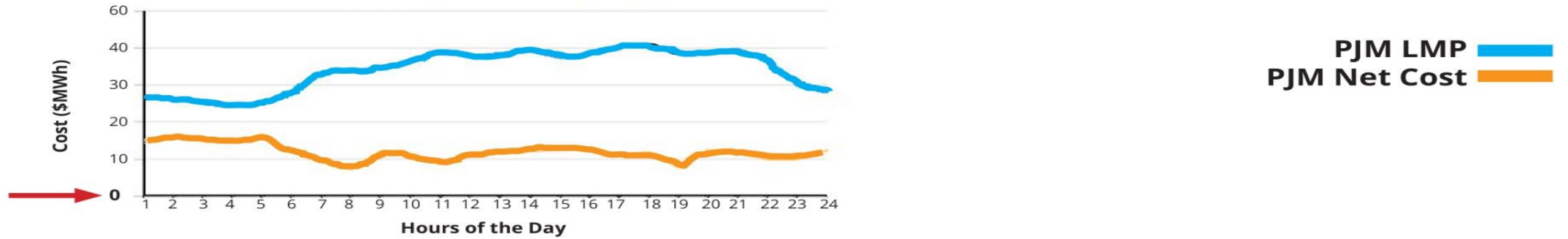
Great need for low cost Energy Storage

Sandia - Energy Storage Costs

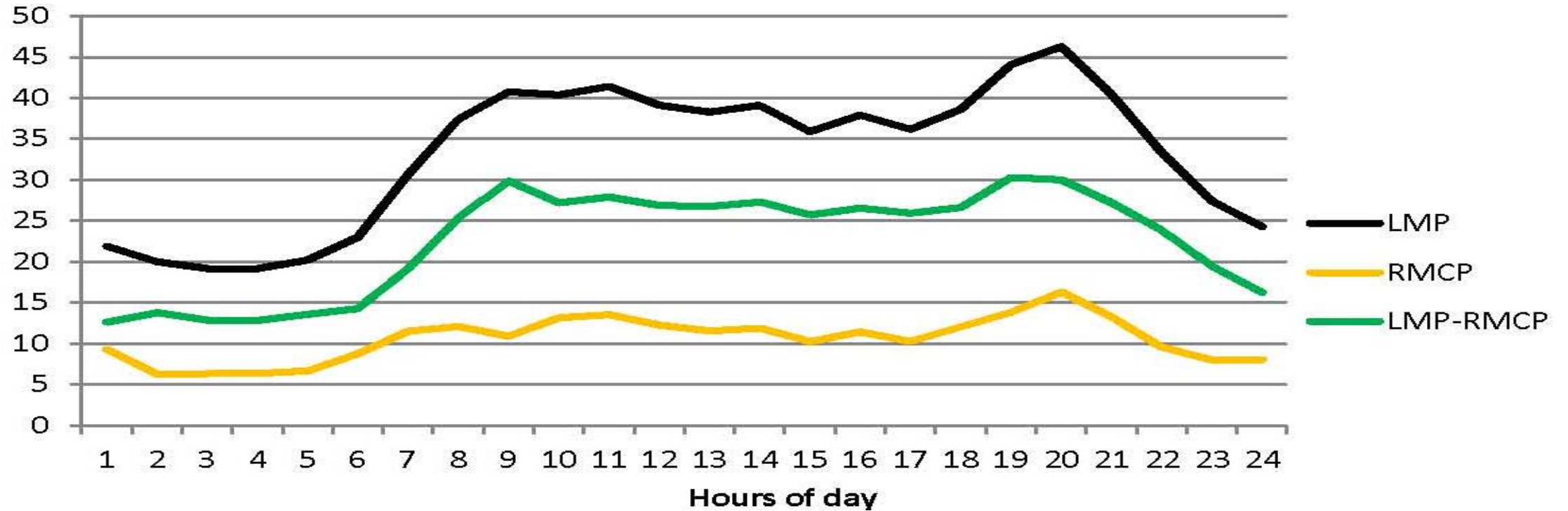


Economic Value

Value of LMP optimization and fast regulation

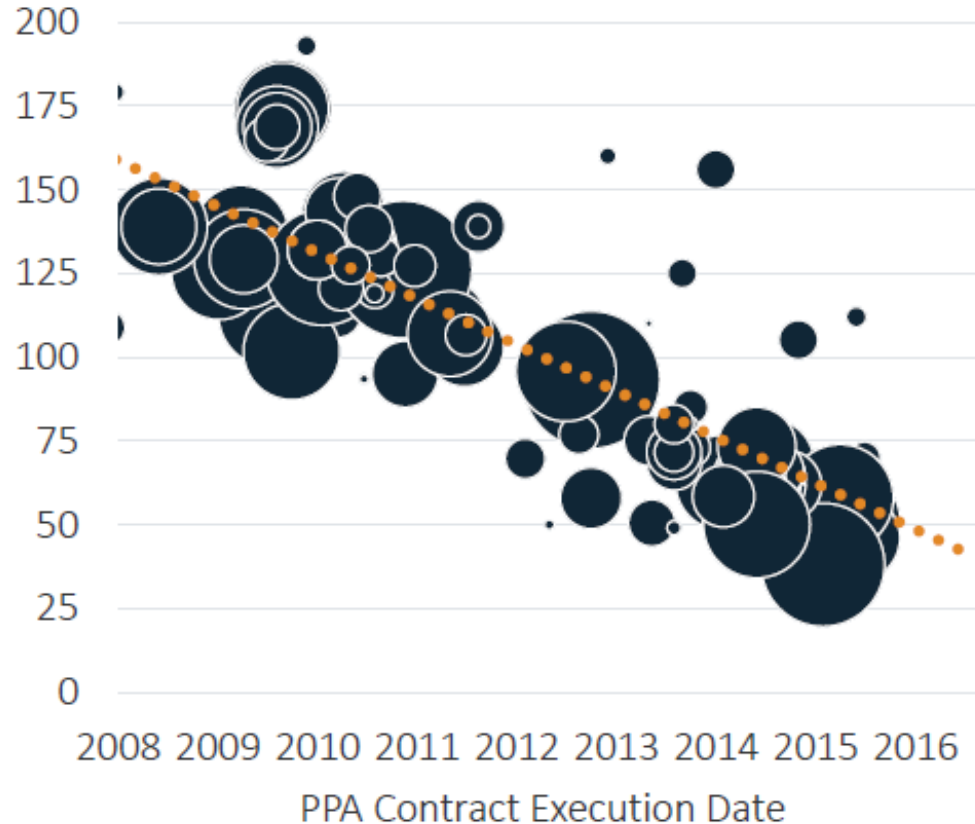


Value of using Off-Peak Electricity

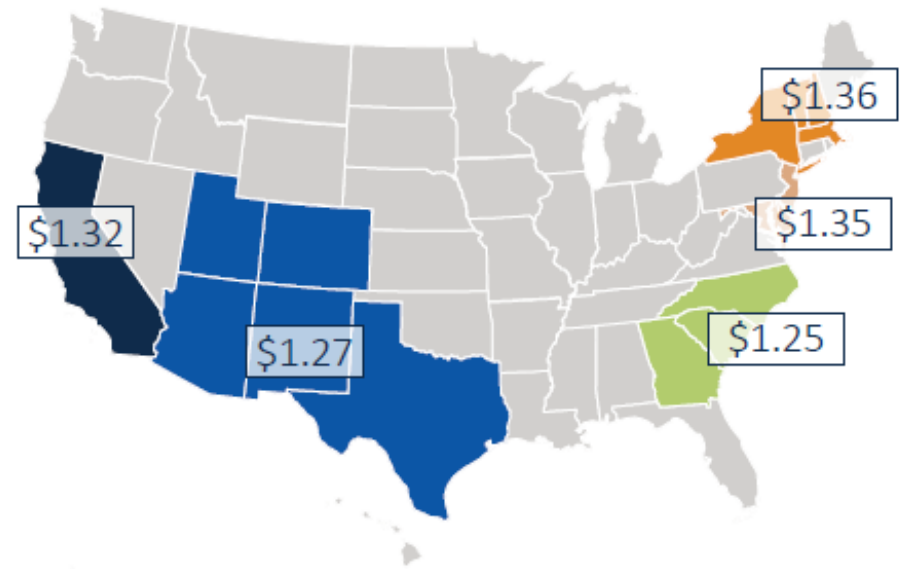


Solar – “Policy Driven” To Economic!

Average PPA Price (\$/MWh)



Average Current Turnkey Fixed-Tilt Cost (\$/W)

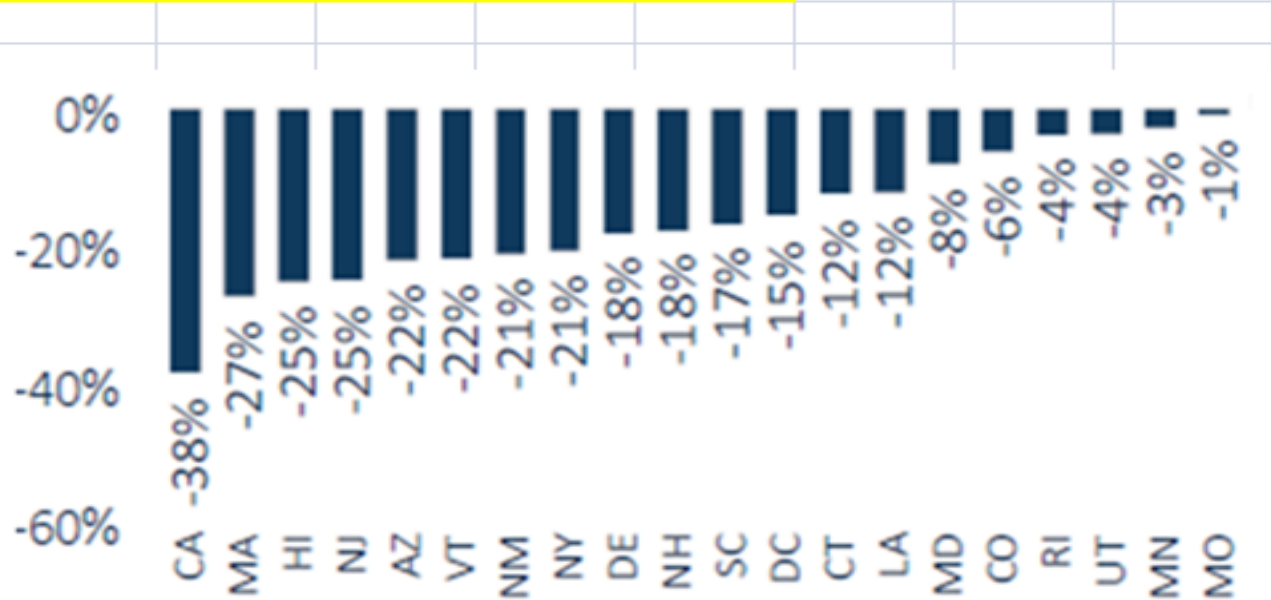


GTM Parity States versus MARC 14 States today consumer bill to bill

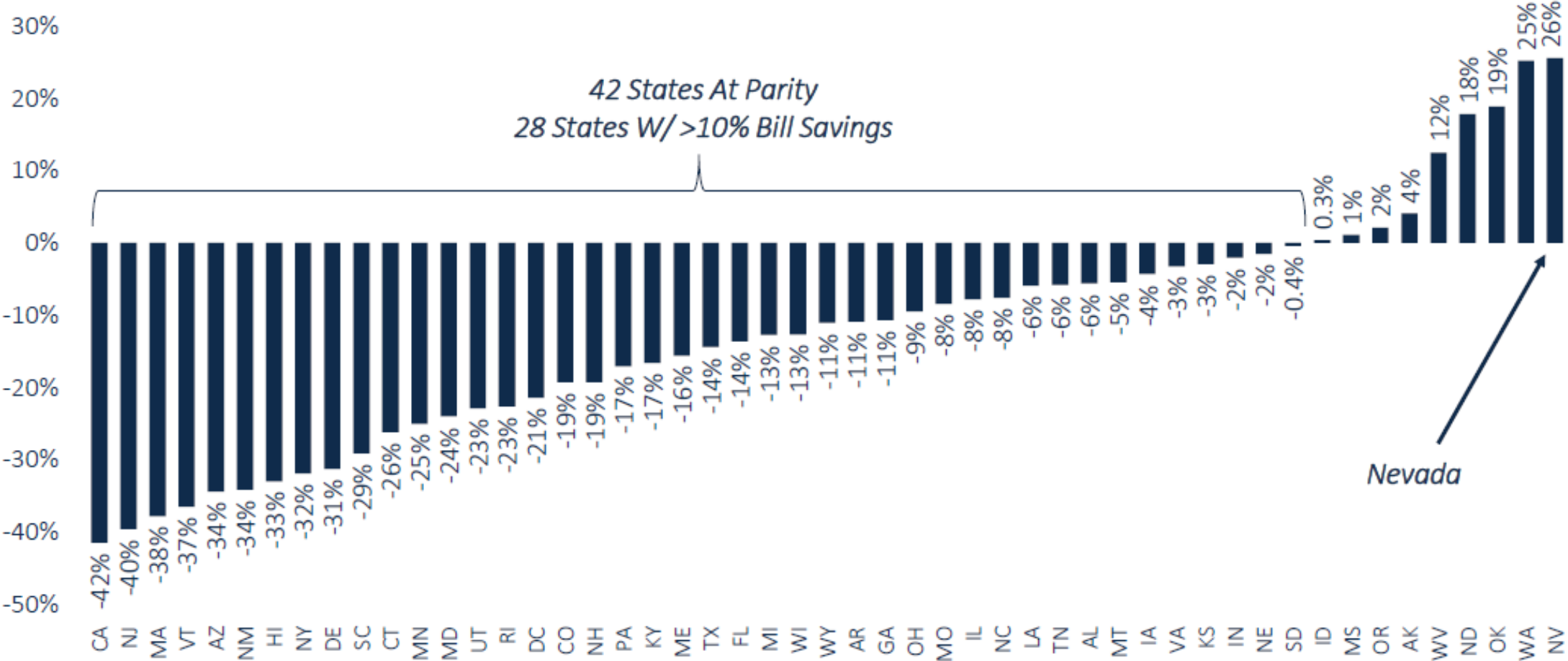
GTM Parity States (Alphabetical preceded by % bill savings) versus the 14 States on MARC

Bill Save GTM Parity State MARC 14 States

22%	Arizona	Arkansas
38%	California	Illinois
6%	Colorado	Indiana
12%	Connecticut	Iowa
15%	DC	Kansas
18%	Delaware	Michigan
25%	Hawaii	Minnesota
12%	Louisiana	Missouri
8%	Maryland	Nebraska
27%	Massachusetts	North Dakota
3%	Minnesota	Oklahoma
1%	Missouri	South Dakota
18%	New Hampshire	Texas
25%	New Jersey	Wisconsin
21%	New Mexico	
21%	New York	
4%	Rhode Island	
17%	South Carolina	
4%	Utah	
22%	Vermont	



Roof top solar is going to explode! 2020



Nevada

M

M

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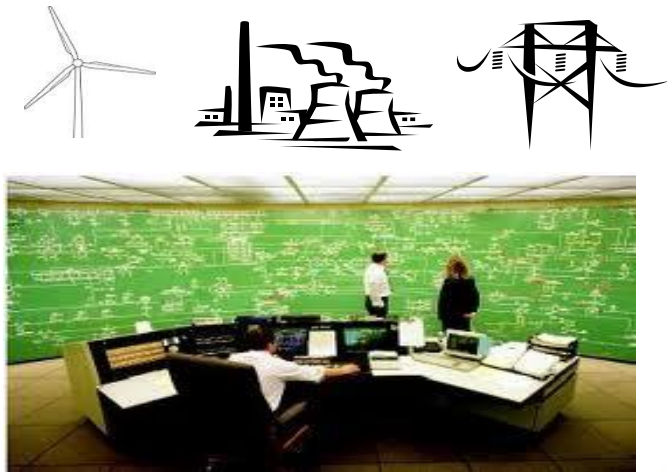
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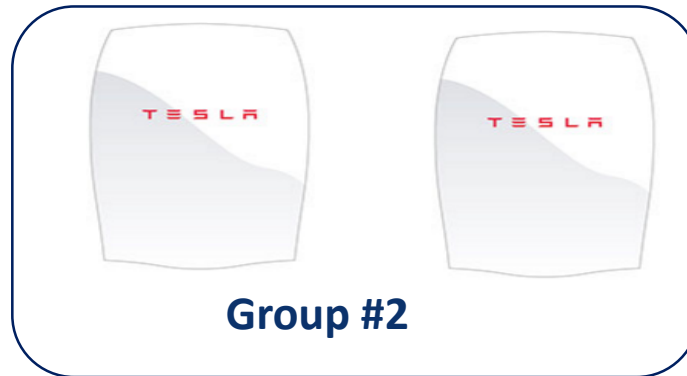
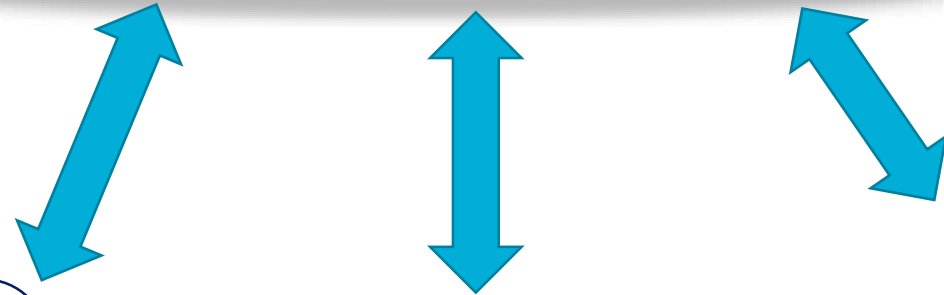
How do Grid-interactive Water Heater work?



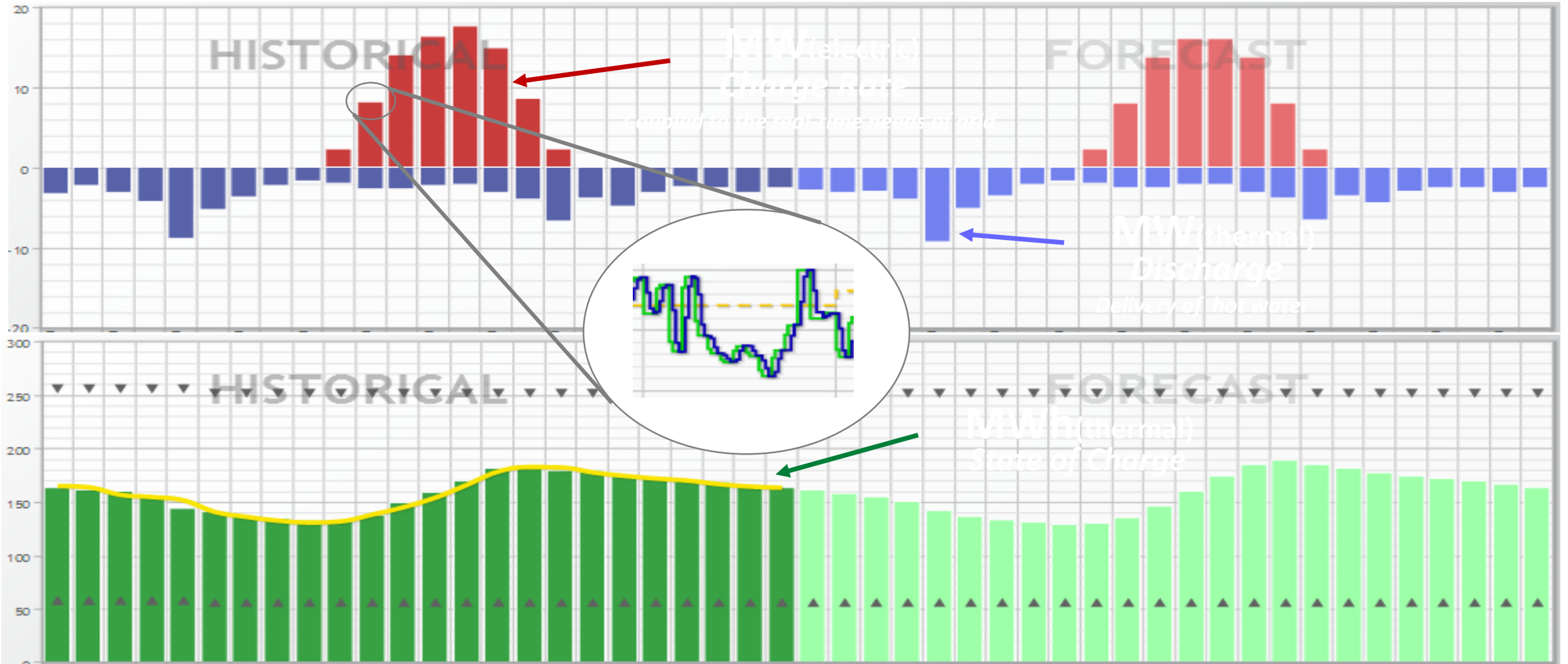


Grouping of Assets

Utility, Billing Node, Substation, Feeder or other



Dispatchable Aggregated Resources



Why Grid-interactive Space and Water Heat?



15 to 500 kWh
Energy Storage



10 to 25 kWh
Energy Storage

- *Largest users of energy in the home 60+%*
- *Have storage capability*

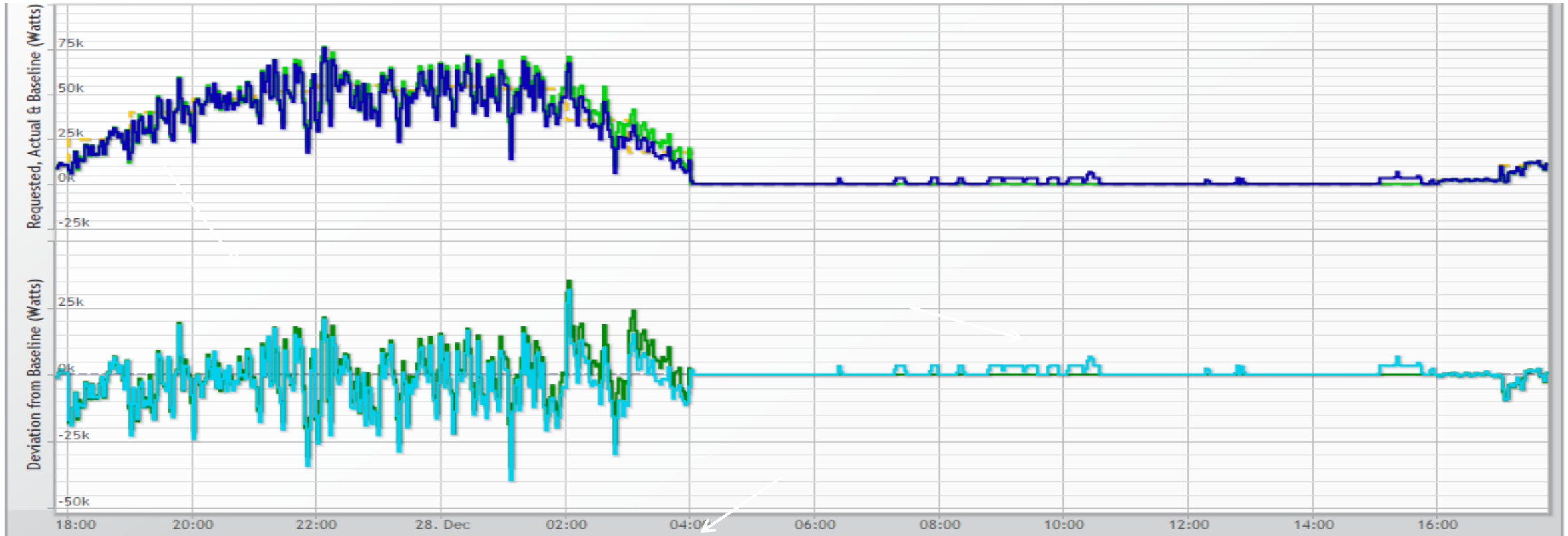
Why are things like GETS important?

- **It saves consumers money**
- It provides fast up and down regulation
- It better uses existing utility infrastructure
- It Integrates Large Quantities of Renewable
- It reduces GHG's
- It's **cost-effective** Energy Storage

WIN-WIN-WIN

Consumer, Utility, Environment

Real-Time Community Storage Aggregate Control 2.2 MW—5MW-h

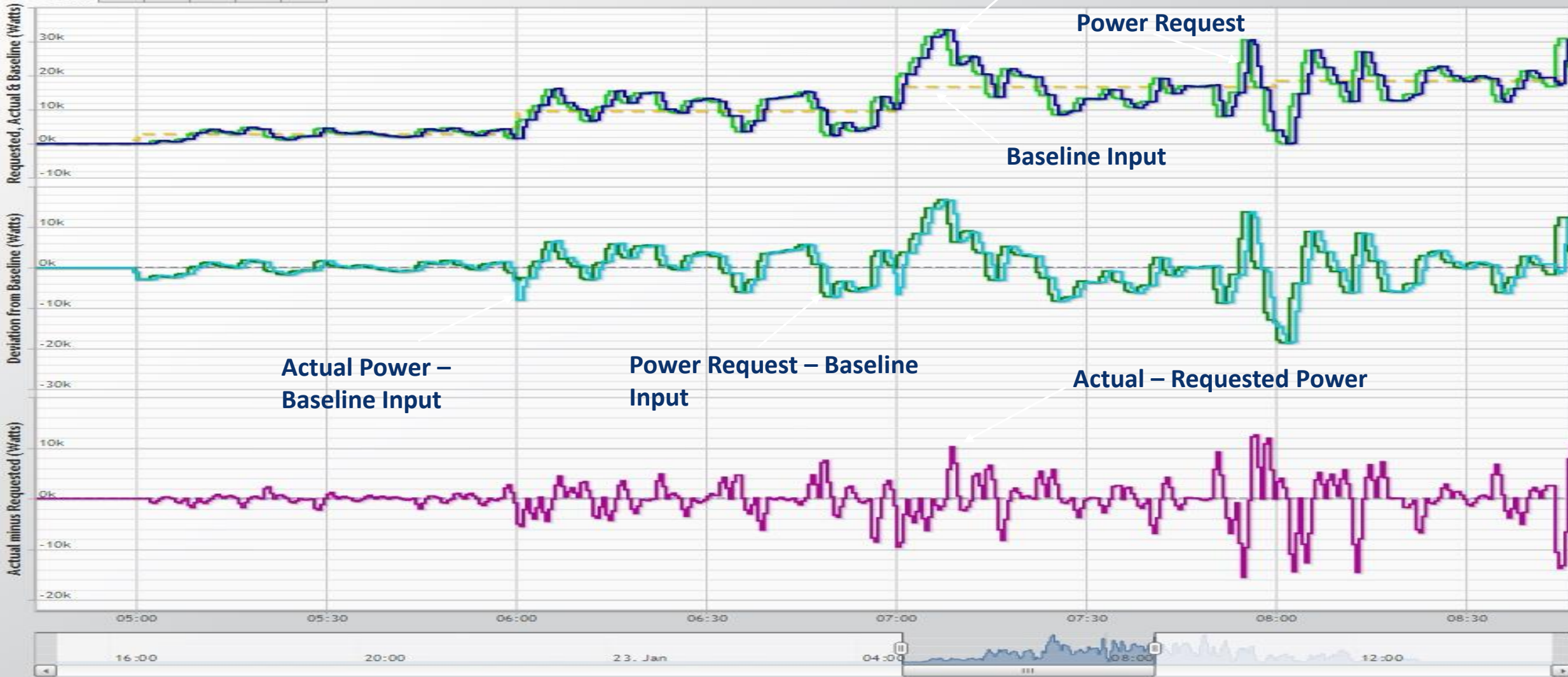


Over 100 water heaters acting in concert to provide predictable, precision control

Real-Time Community Storage Aggregate Control 5.4MW—42MW-h

REAL-TIME LOAD History
Last 24 hours

Zoom 1h 4h 8h 12h 24h



All can Win - Not just Utilities

Lose

- Low or Negative electric energy sales growth

Lose

- Increasing amounts of curtailed renewable energy

Win
—
Win
—
Win

- Grid Balance - consumers using electricity to meet the real-time needs of the Grid
- Utilities make money by delivering fast regulation services and utilizing previously curtailed renewable energy
- Participating consumers share in utility profit directly and all consumers gain from overall lower electric rates

GETS in Building Codes



Grid-interactive Electric Thermal Storage (GETS) products recognized in the 2015 International Green Construction Code.



Significance...

IGCC, ASHRAE and LEED signed a memorandum of understanding
Jointly develop products in future

Legislative Activity

- Grid-enabled Large Capacity Water Heaters
 - ❖ Final Rule 8/11/2015
- Energy Storage Tax Legislation – Coming Soon
 - ❖ Senator Heinrich (D-NM)

The Senate

The House of
Representatives



Steffes - North Dakota



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Steffes

“Commitment to Innovation”

