Energy Storage and Frequency Regulation

West Philly High PHEV

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Senior Vice President –Markets

FERC/NARUC Smart Response Collaborative
February 13, 2011

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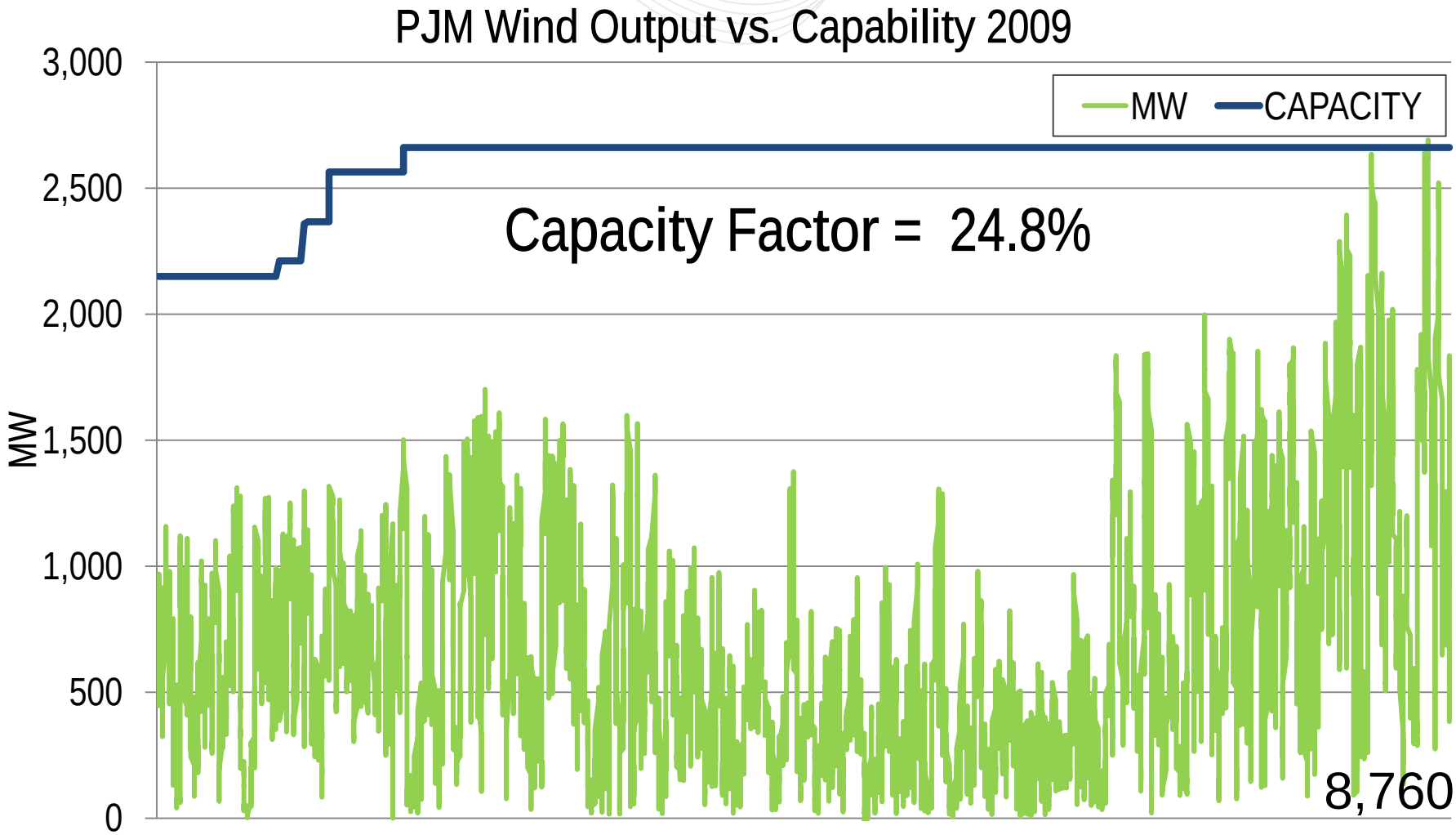
Intermittent Wind Generation



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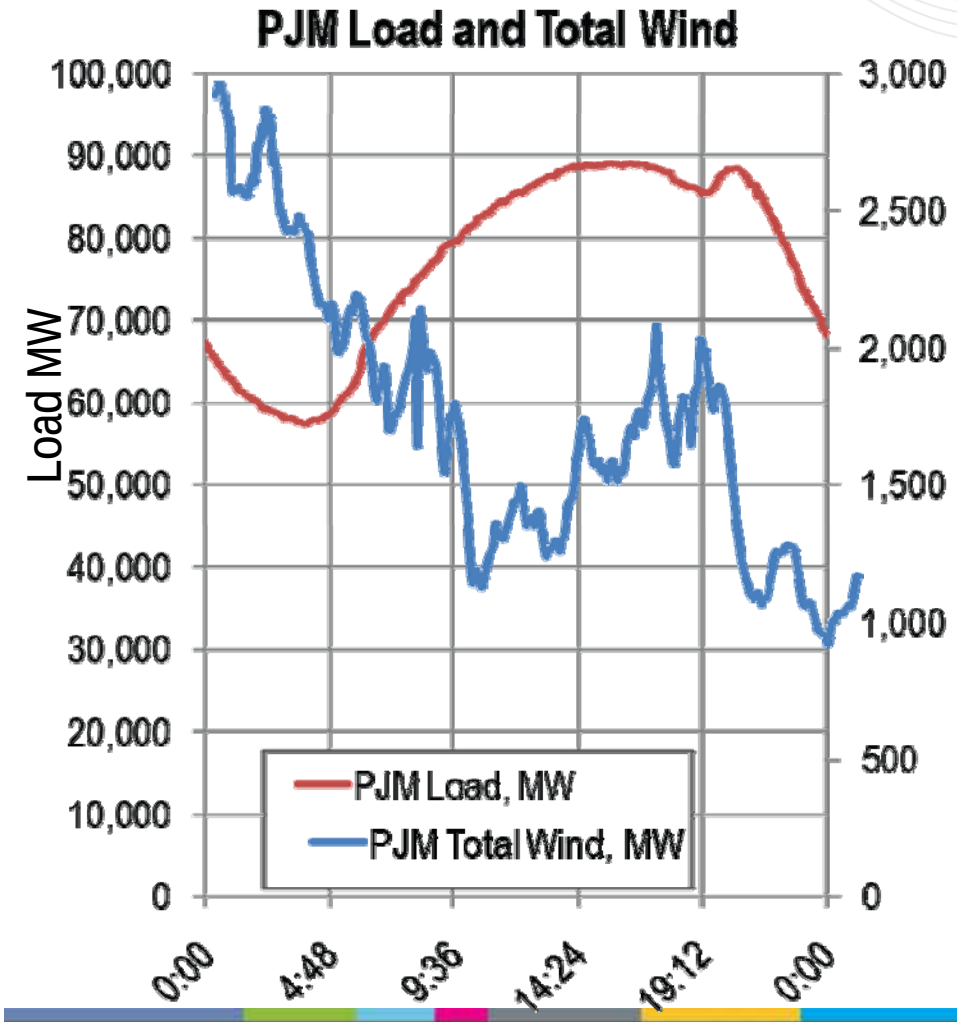
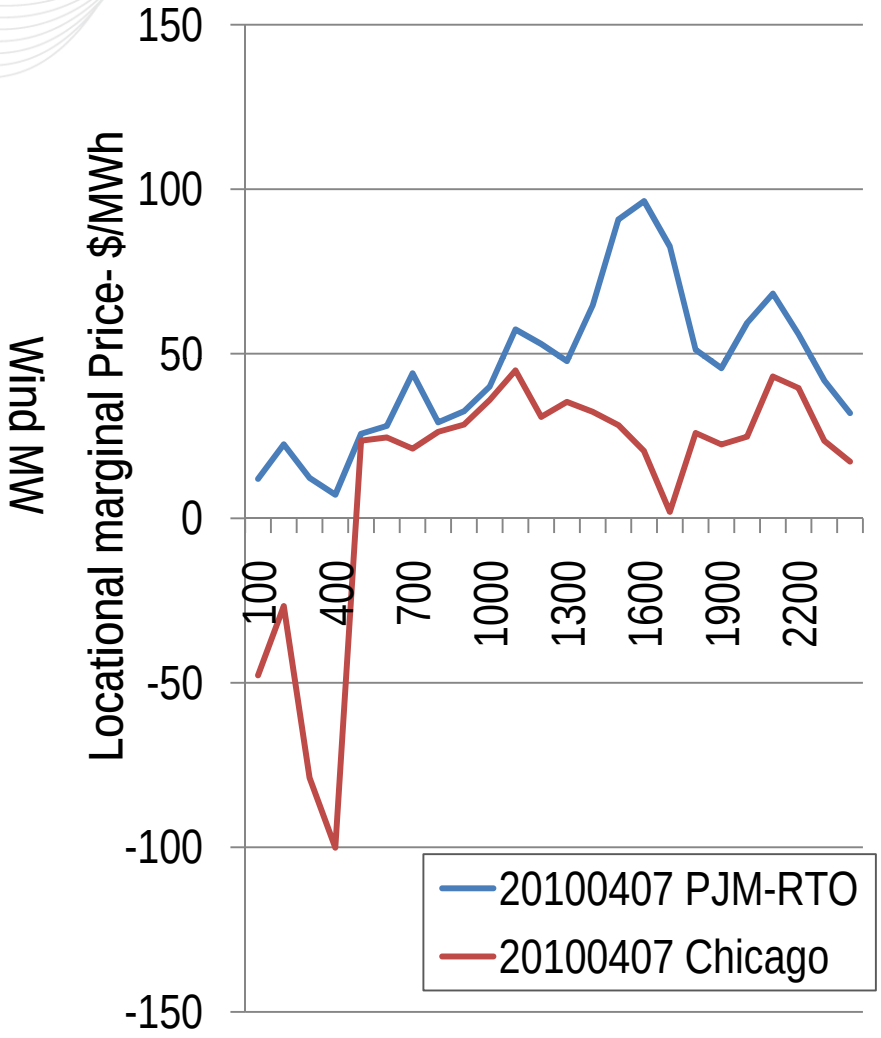
PJM Load and Wind Resources – April 7, 2009





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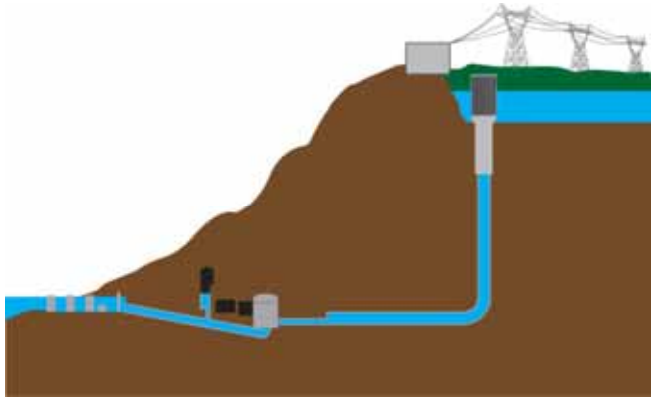
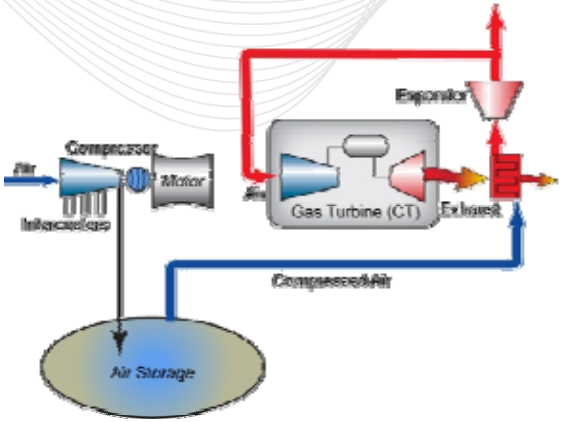
Grid Storage Types



Pumped Hydro



Compressed Air

Flywheels

Stationary Battery

Mobile Batteries

Water Heaters

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Water Heater

105-gallon electric water heater demonstrates minimization of cost while responding to the PJM wholesale price signal and the PJM frequency regulation signal.

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Water Heater – Optimization of LMP and Frequency Regulation

Charging during low LMP periods

Following PJM frequency regulation

Pilot water heater in use by PJM Technology Center

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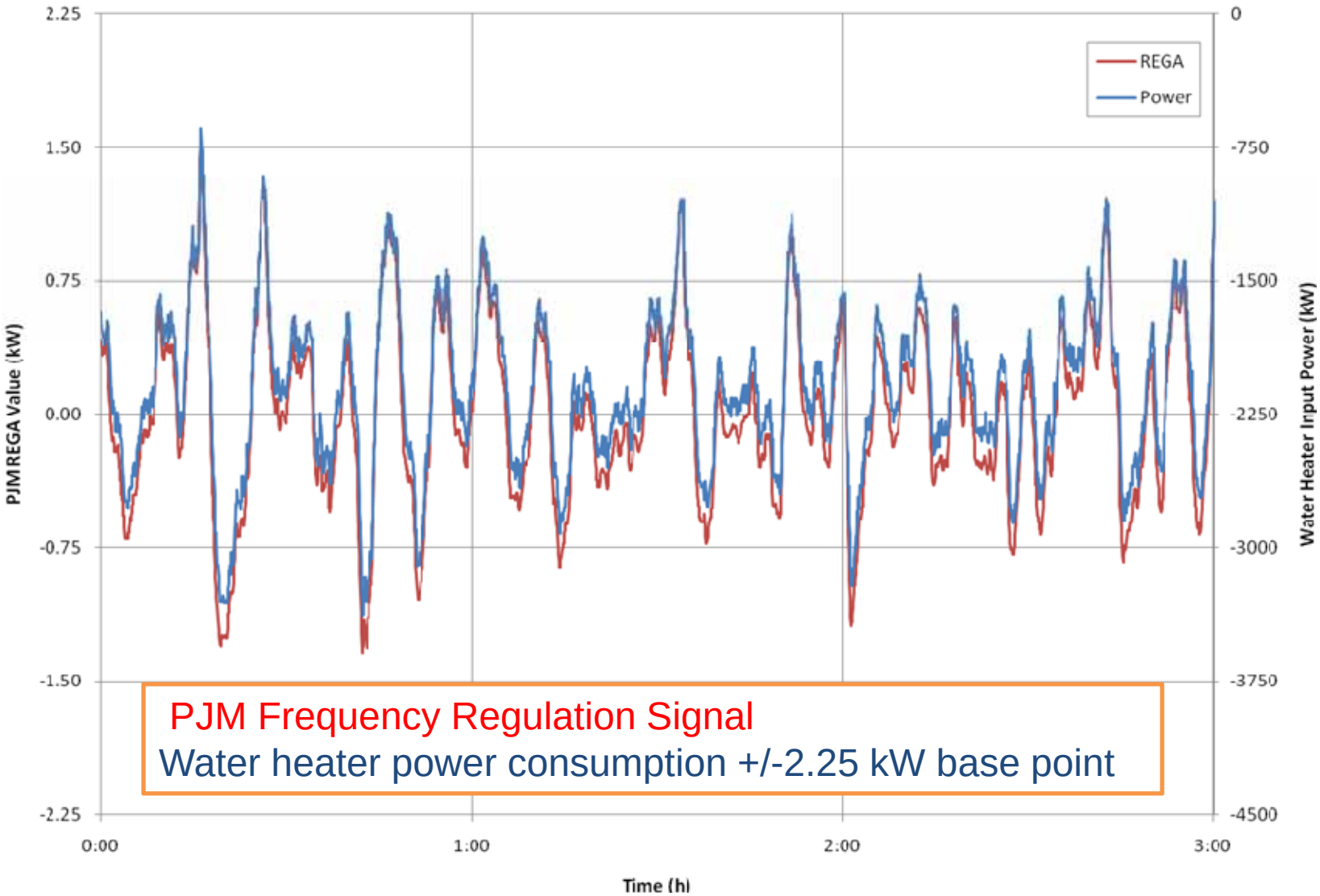
PJM Pilot Water Heater -- January 14, 2011; Midnight to 3:00 a.m.



PJM Frequency Regulation Signal

Water heater power consumption +/-2.25 kW base point

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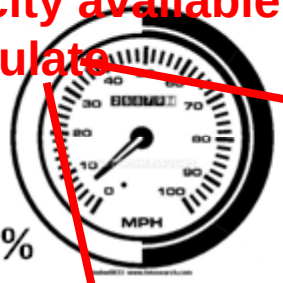
STEFFES GRID-INTERACTIVE WATER HEATER CONTROL

Enhance Reliability, Reduce Costs, and Protect the Environment for Everyone

LOAD RESOURCE SNAPSHOT

THERMAL BATTERY LOAD

Capacity available to regulate



5%

0.22 kW
UP-REGULATION CAPACITY

4.28 kW
DOWN-REGULATION CAPACITY

4.50 kW
MAXIMUM LOAD

ENERGY RESOURCE SNAPSHOT

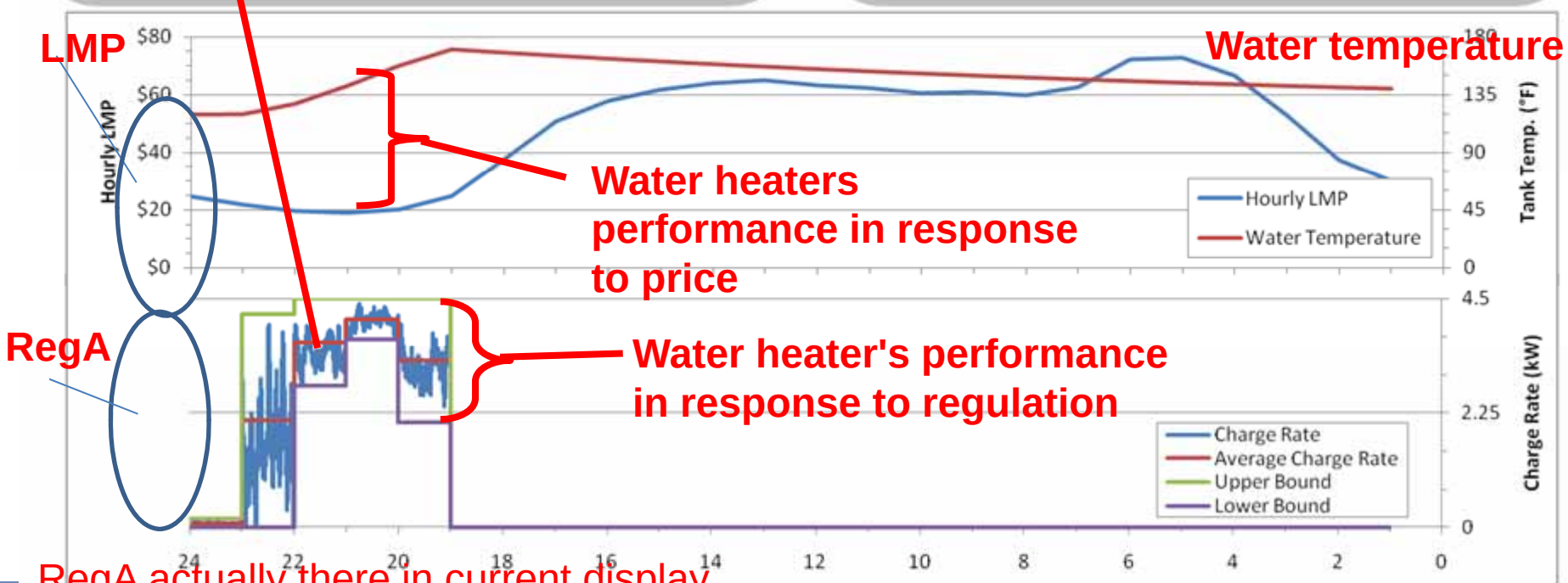
THERMAL BATTERY CHARGE LEVEL

55%

14.2 kW·h
CURRENT CHARGE LEVEL

11.8 kW·h
CURRENT RESERVE CAPACITY

26.0 kW·h
TOTAL STORAGE CAPACITY



RegA actually there in current display

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STEFFES CORPORATION

AES Grid-Scale Energy Storage System

Operational Details

- Altairnano, Inc – Lithium Ion nano titanate battery
- Power: 1 MW for 15 minutes
- Energy: 300 kWh
- Usable Charge Range: 5% - 99%
- Efficiency: 90% round trip

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MAGICC – PJM's PHEV Demonstration Project

- Smart Meter allows car to roam
- Mid-Atlantic Grid Interactive Car Consortium (MAGICC)

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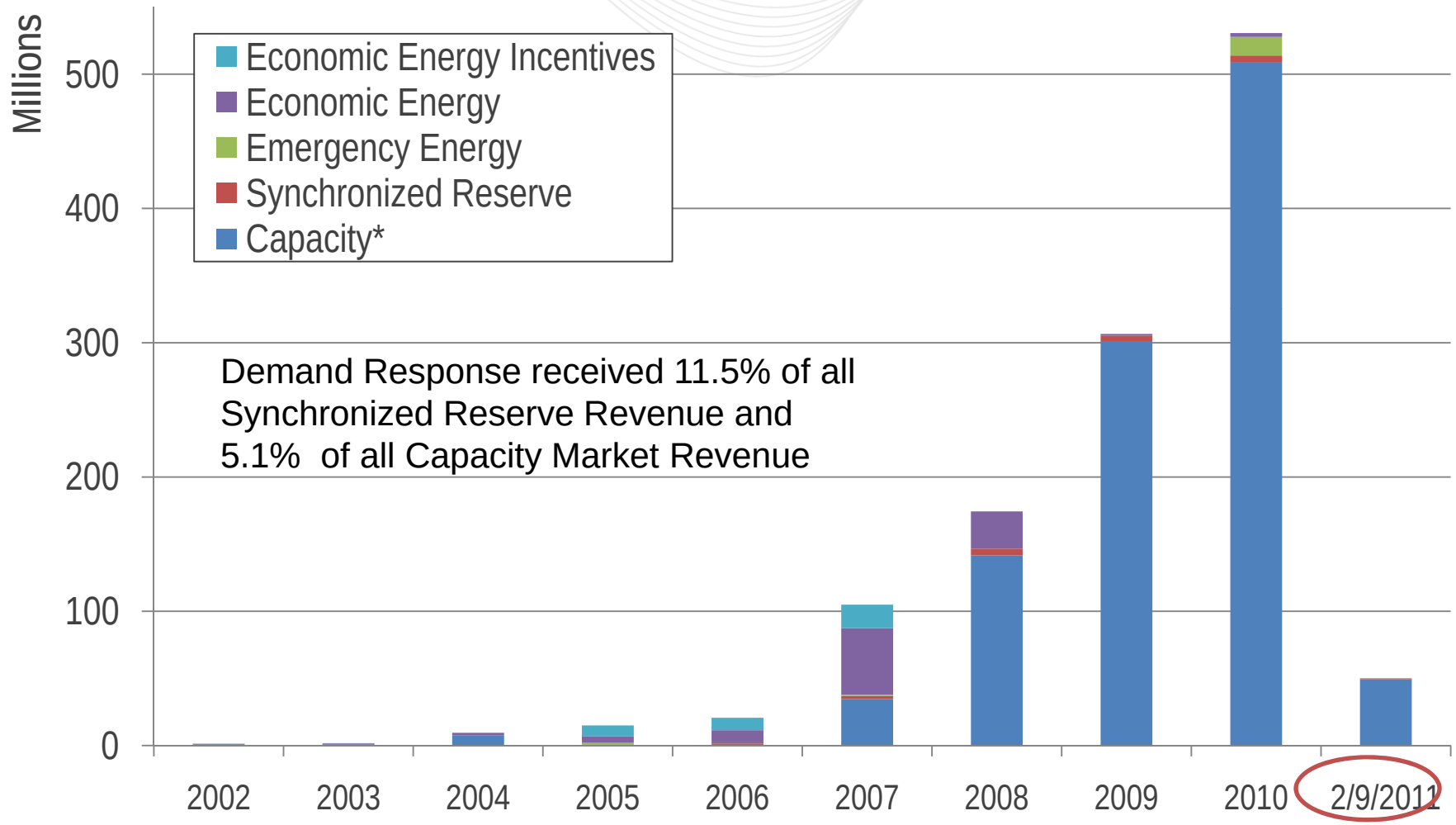
PJM Demand Side Response Revenue



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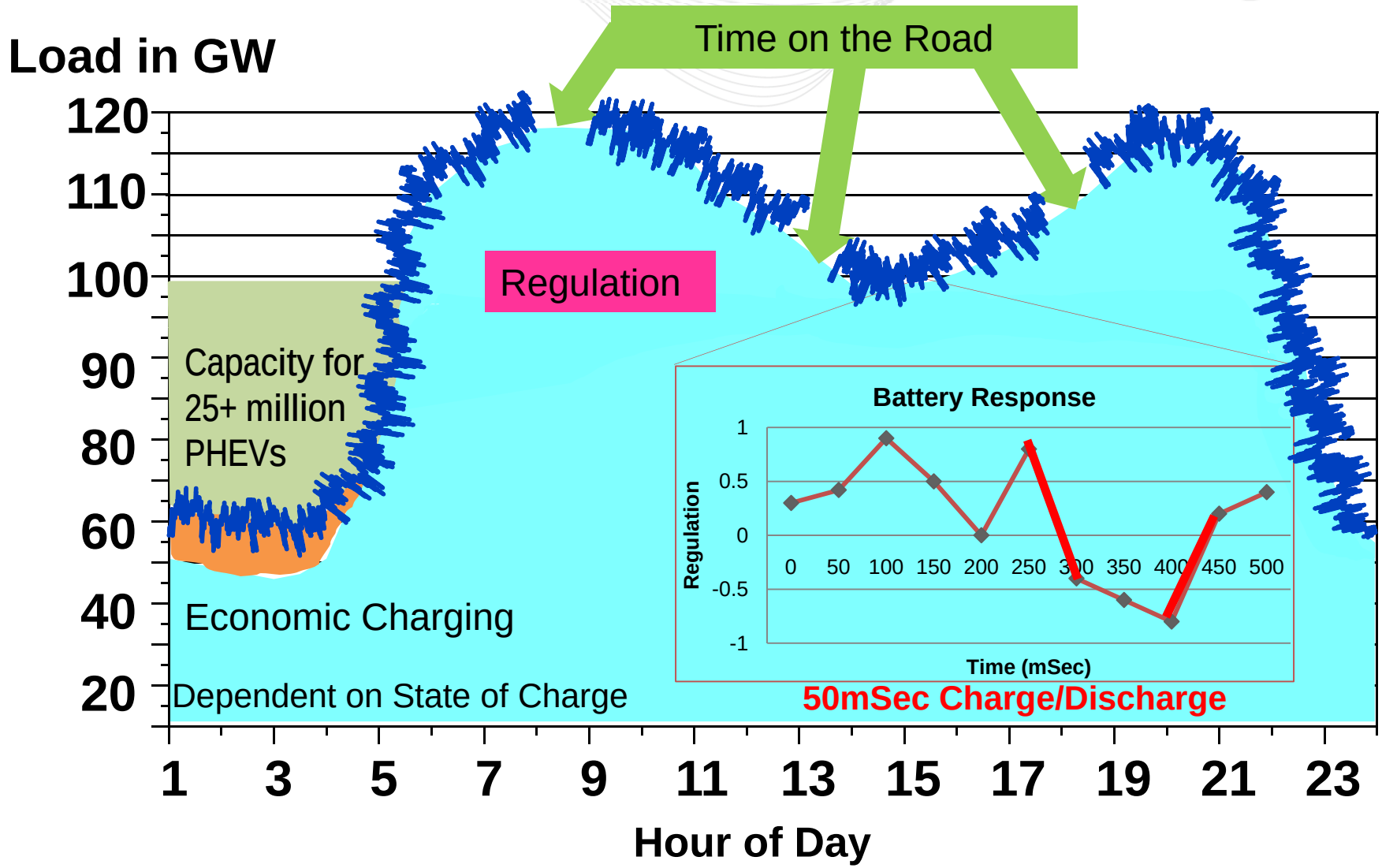
Grid Benefits – Regulation vs. Economic Dispatch



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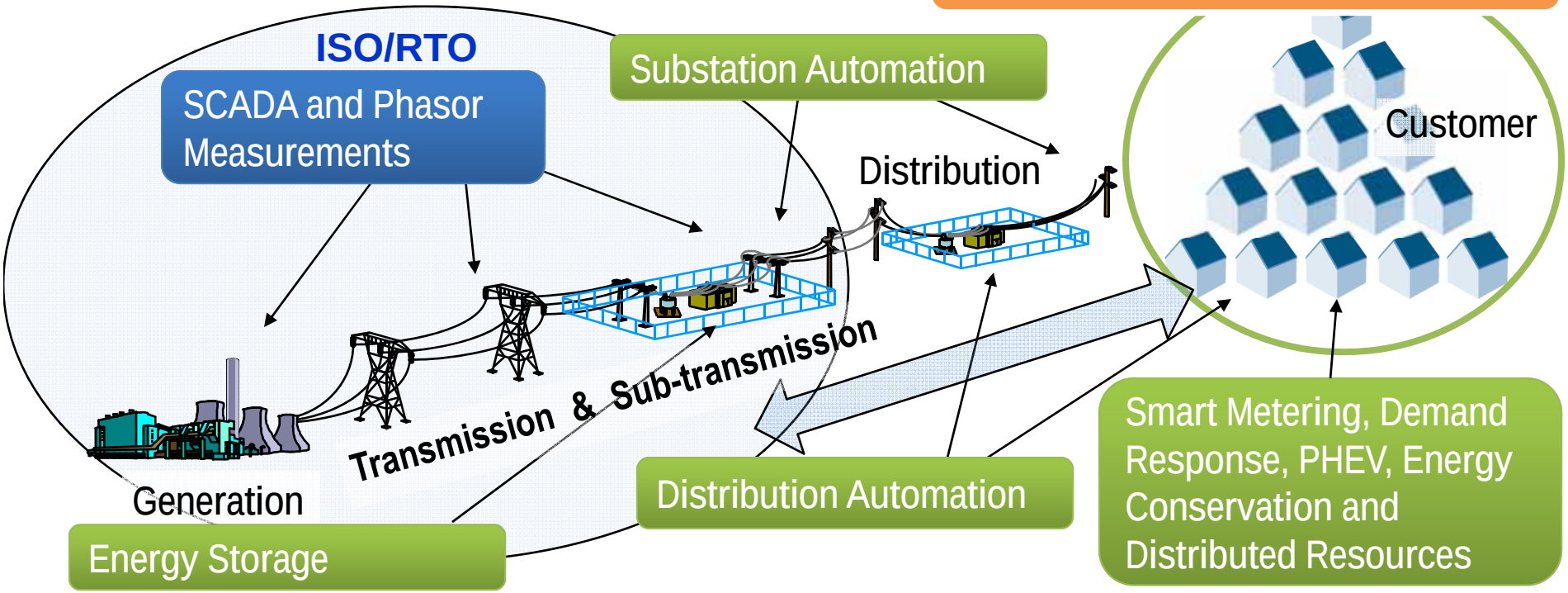
PJM's Role in the Smarter (Robust) Grid

The Smart Grid is realized by merging data to achieve a total end-to-end systems view by integrating information technology and operational technology.

Two-Way Communication and Control

$800 million DOE grants



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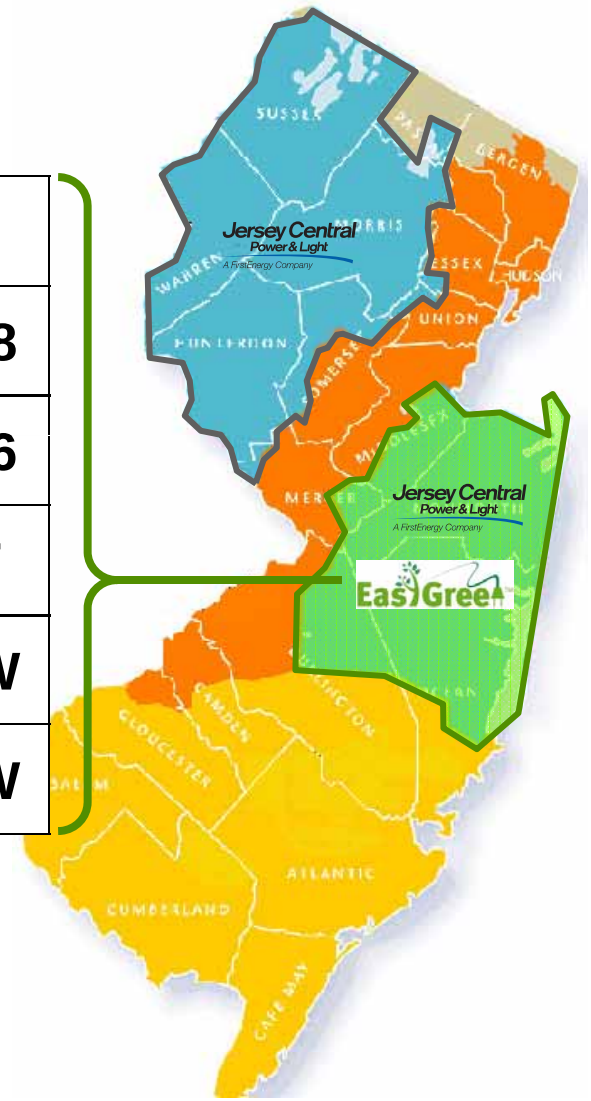
Integrated Distributed Energy Resources Project

- **Marketed to customers as EasyGreen®**
- **Residential Customer Value Proposition**
  - Saves money on electric bill
  - $50 gift card
  - Helps the environment
  - Voluntary participation

- **Key Features**
  - EasyGreen® uses two sensors to manage central air conditioning systems and monitor temperature in homes to assure comfort
  - Customer choice:
    - Comfort Program +6° F
    - Max Savings Program +9° F

IDER Project Status

Substations in Program	29
Customers Enrolled	13,078
Controllers Installed	12,566
Controllers Communicating	9,977
2010 Curtailable Load – up to	17 MW
Target Load	38 MW



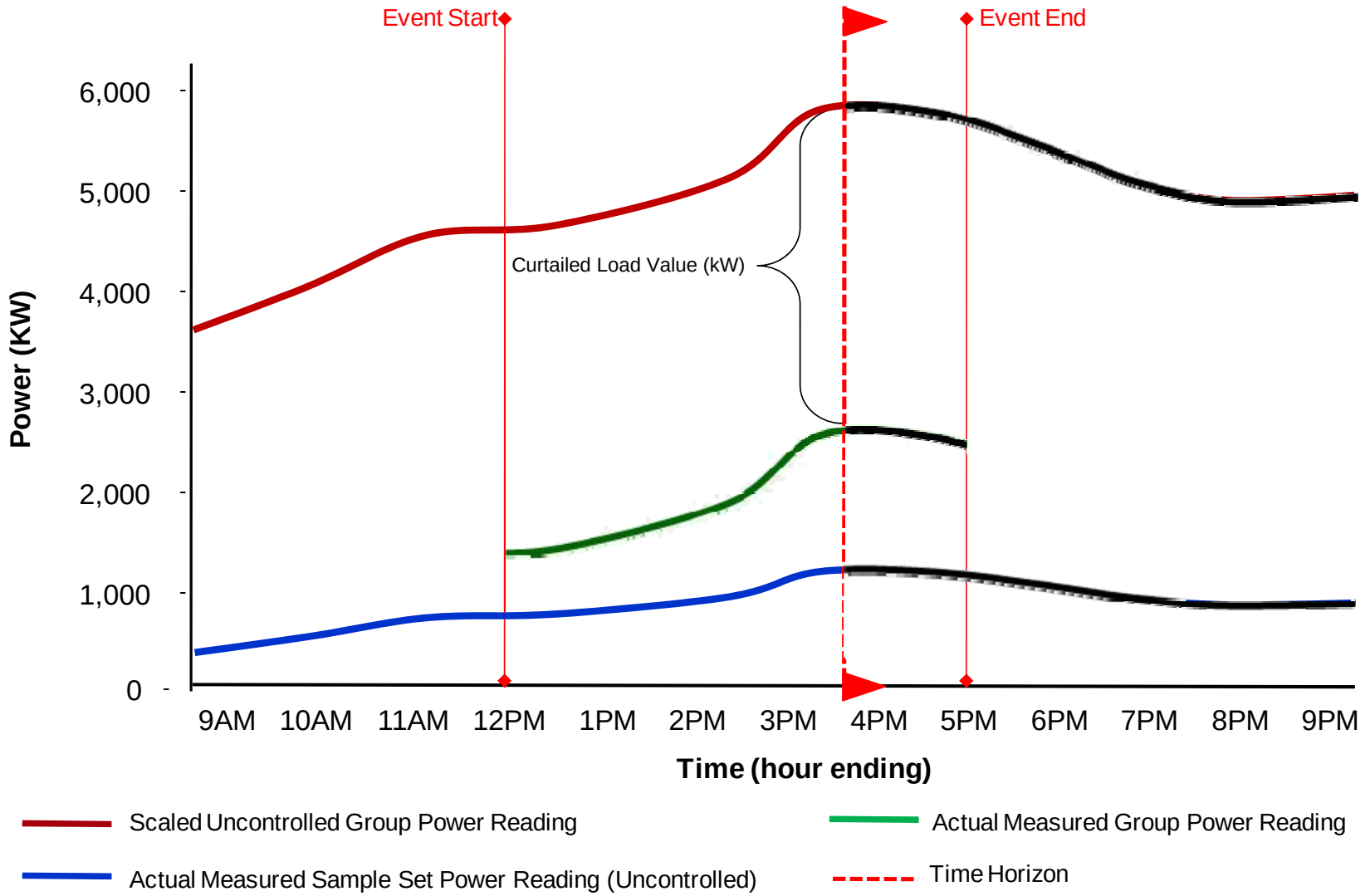
Methodology

- **Customers agree to 6ºF or 9ºF temperature rise during an event**
  - Lower set point is temperature when event begins
- **Control of air conditioner is released back to thermostat after temperature rise has occurred**
  - Once premise temperature lowers by 2º, controller becomes eligible again
- **Each air conditioner is monitored continuously for power status**
- **Aggregated information is recalculated in the Integrated Control Platform at 15 second intervals; hour ending load is the average of 240 readings**

Initiating an Event

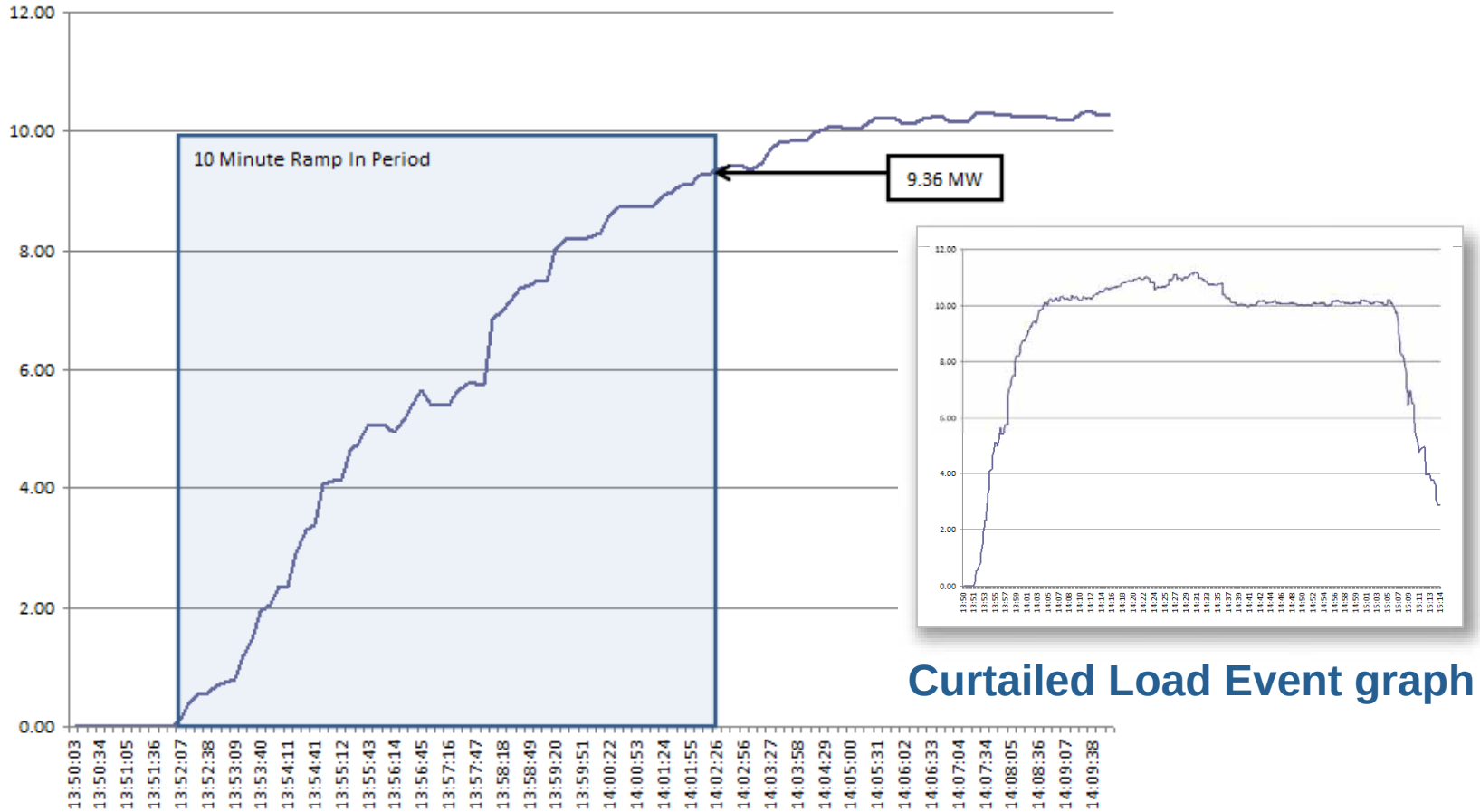
- **At start of event, the Integrated Control Platform dispatches controllers to meet pledged amount of load reduction**
- **Active controllers include eligible controllers only**
- **Controllers receive commands from the Integrated Control Platform through 2-way communication network**
  - Status is updated in database when data packets are returned back from controllers
- **Integrated Control Platform extracts the instantaneous power reading when the data packet information is received**

Load Curtailment Event Curve



August 31, 2010 – One-Hour Test Event

- **Curtailed Load Event Ramp In Detail**



Curtailed Load Event graph

Note: Data shown includes T&D losses