2011 EIA Energy Conference
Intelligent Electric Systems

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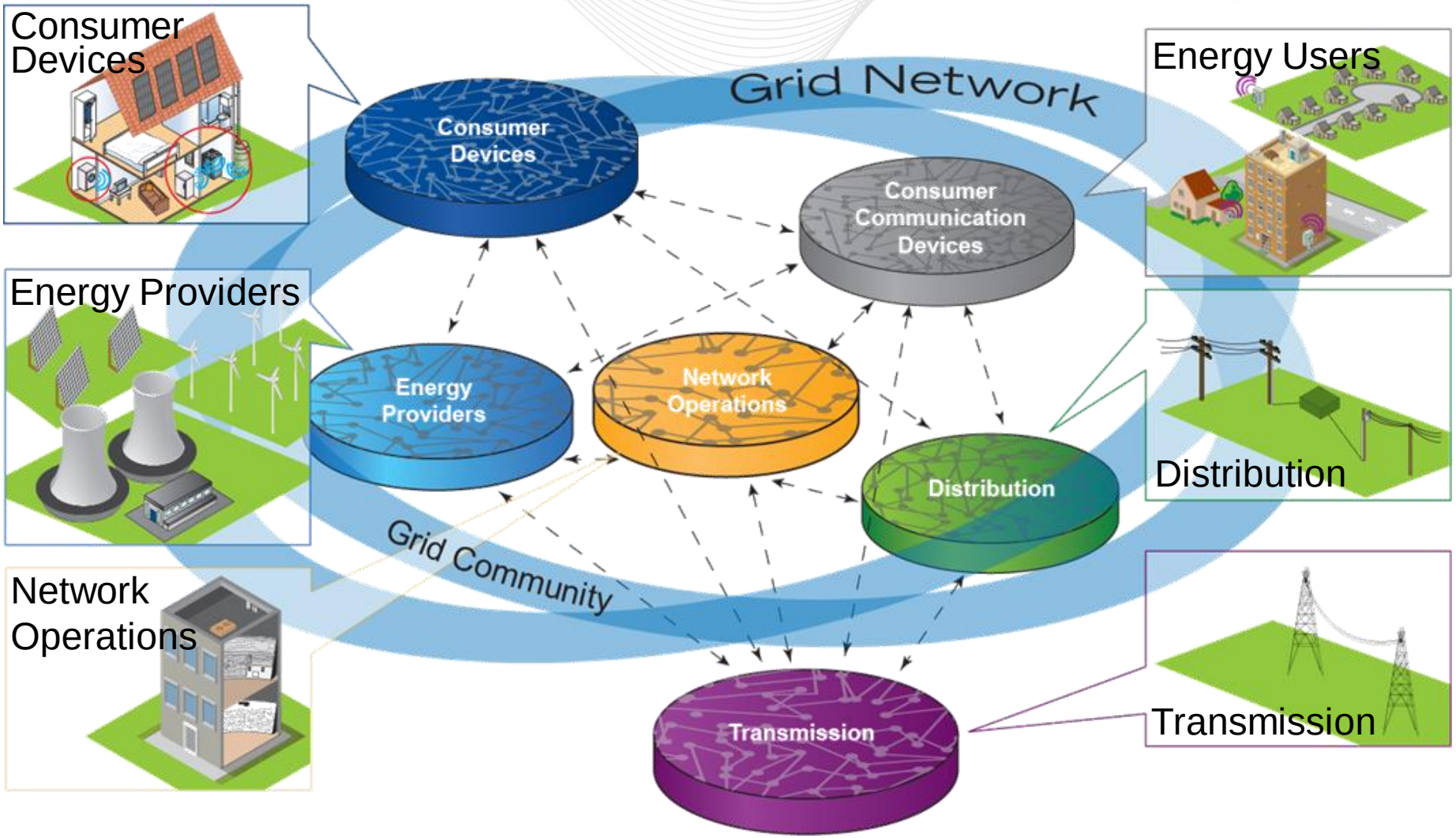
Smart Grid



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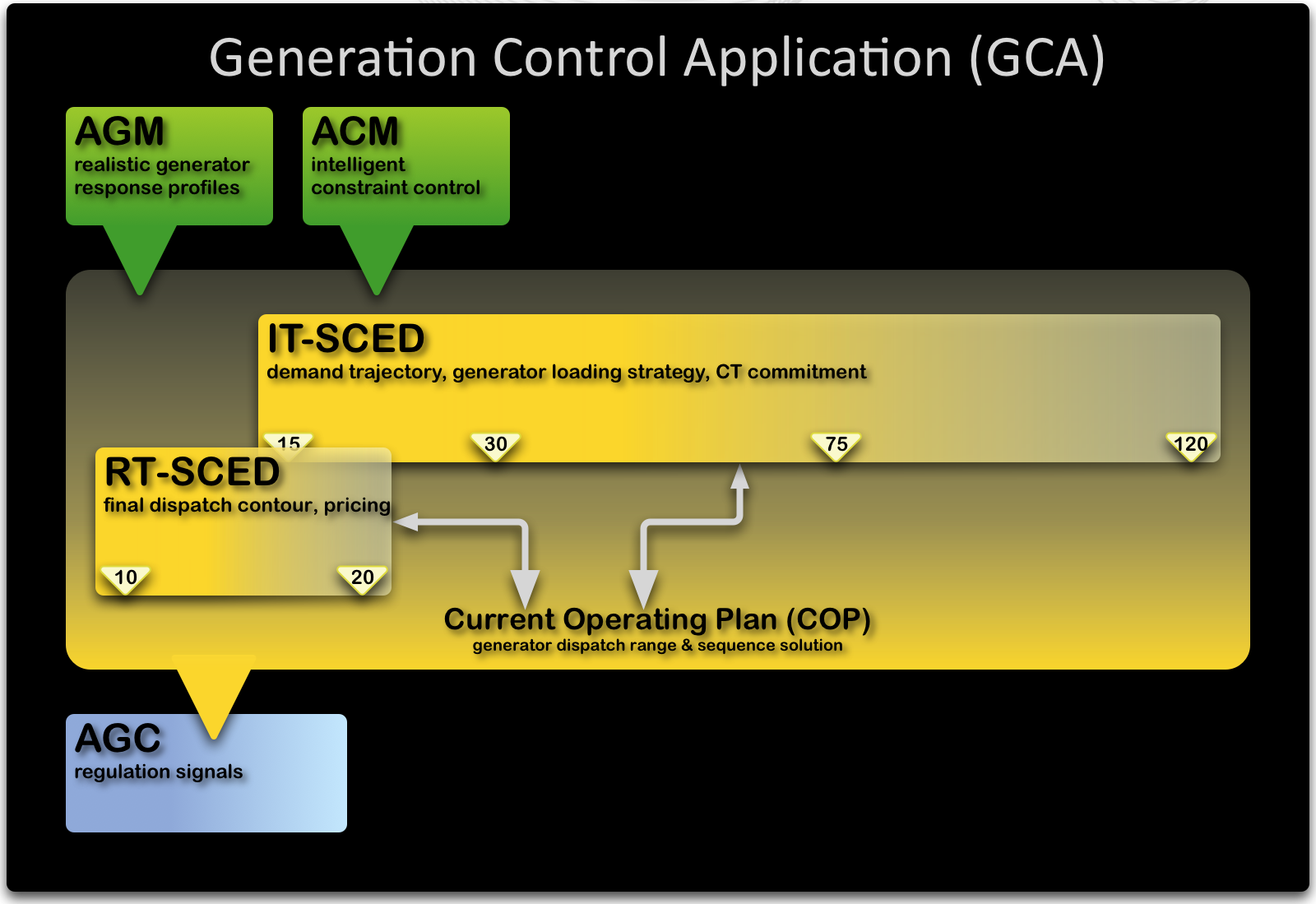
Generation Control Application (GCA)
AGM
realistic generator response profiles
ACM
intelligent constraint control
IT-SCED
demand trajectory, generator loading strategy, CT commitment
15
30
75
120
RT-SCED
final dispatch contour, pricing
10
20
Current Operating Plan (COP)
generator dispatch range & sequence solution
AGC
regulation signals

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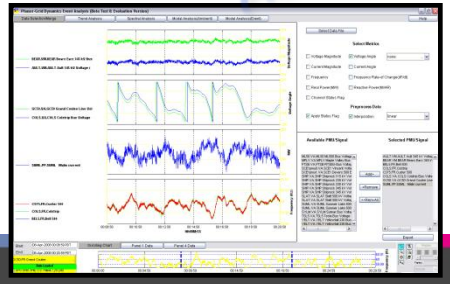
Future SynchroPhasor Applications

Data Analysis

- Use recorded data
- Verification of operations
- Analyze dynamic performance
- System model maintenance

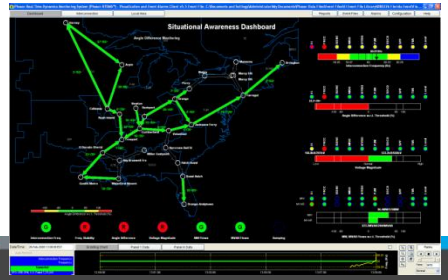
OFF-LINE



Wide Area Monitoring

- Situational awareness display & alerts
- Visual status displays
- Interface into EMS
- Limit alarms
- State measurement

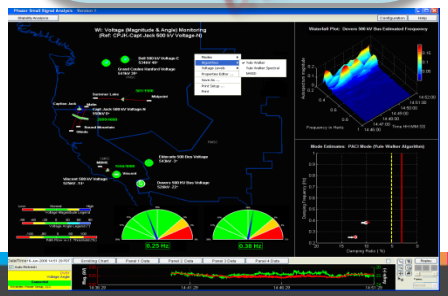
REAL TIME



System Dynamics Monitoring

- Visual displays and Alarm Processing
- Dynamic operation limits (oscillations, mode shapes…)
- Parameter estimation
- Oscillation detection
- Fault location

REAL TIME

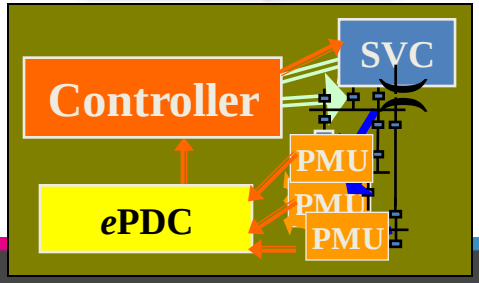


System Control, Protection & Reliability

Control Actions For:

- Wide area problems
- Out-of-step detection
- Excessive power flow, high phase angles
- Both low and high speed operation

REAL TIME



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Markets – Storage and Frequency Regulation

- Recent Trend
  - Cost efficiency savings across the RTO footprint is between $80 million and $105 million per year.
- Future Enhancements
  - Develop and implement “pay-for-performance” regulation market pricing structure to stimulate participation of advanced technologies.

Water Heater

Flywheels

Mobile Batteries

Stationary Battery

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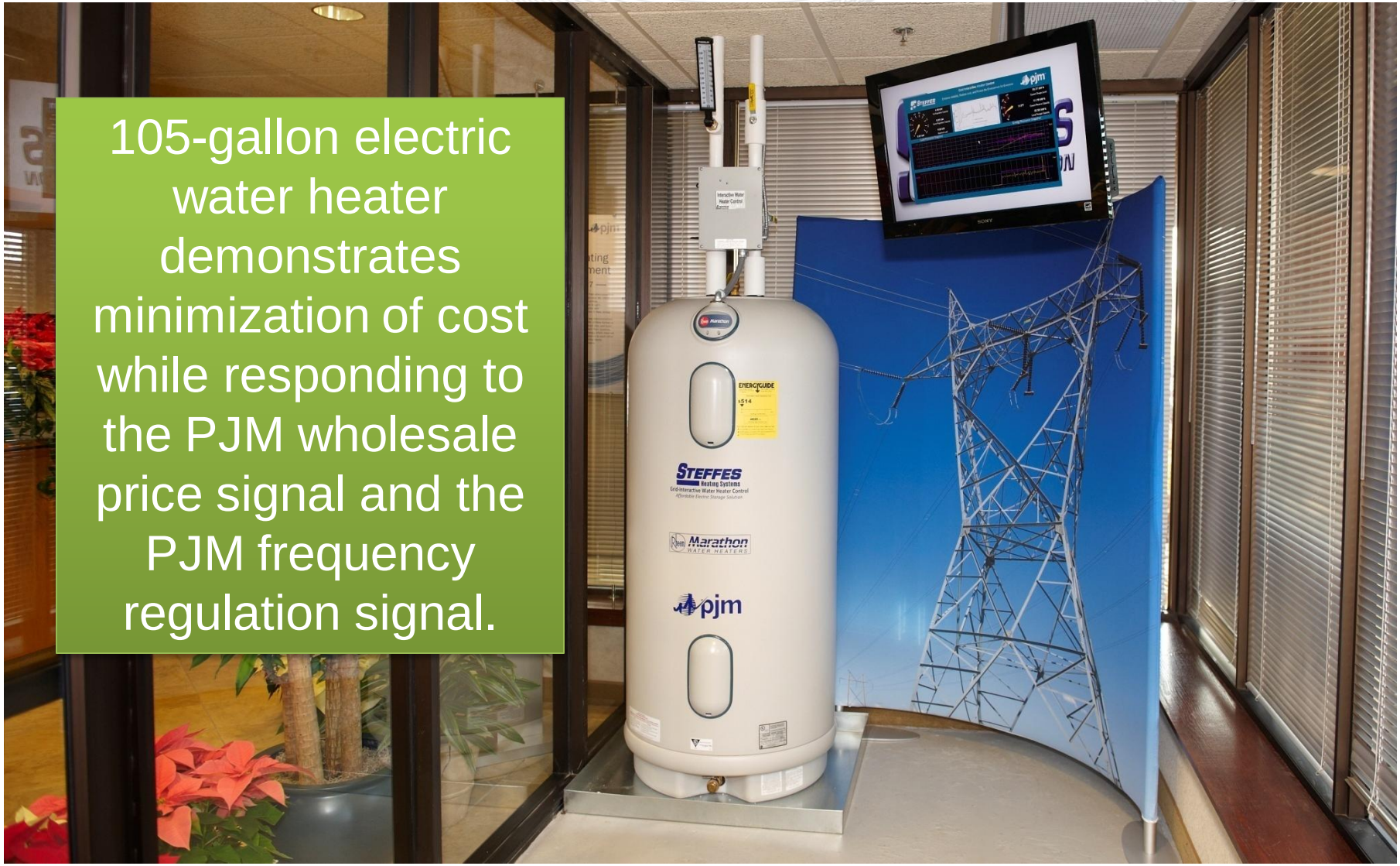
Water Heater



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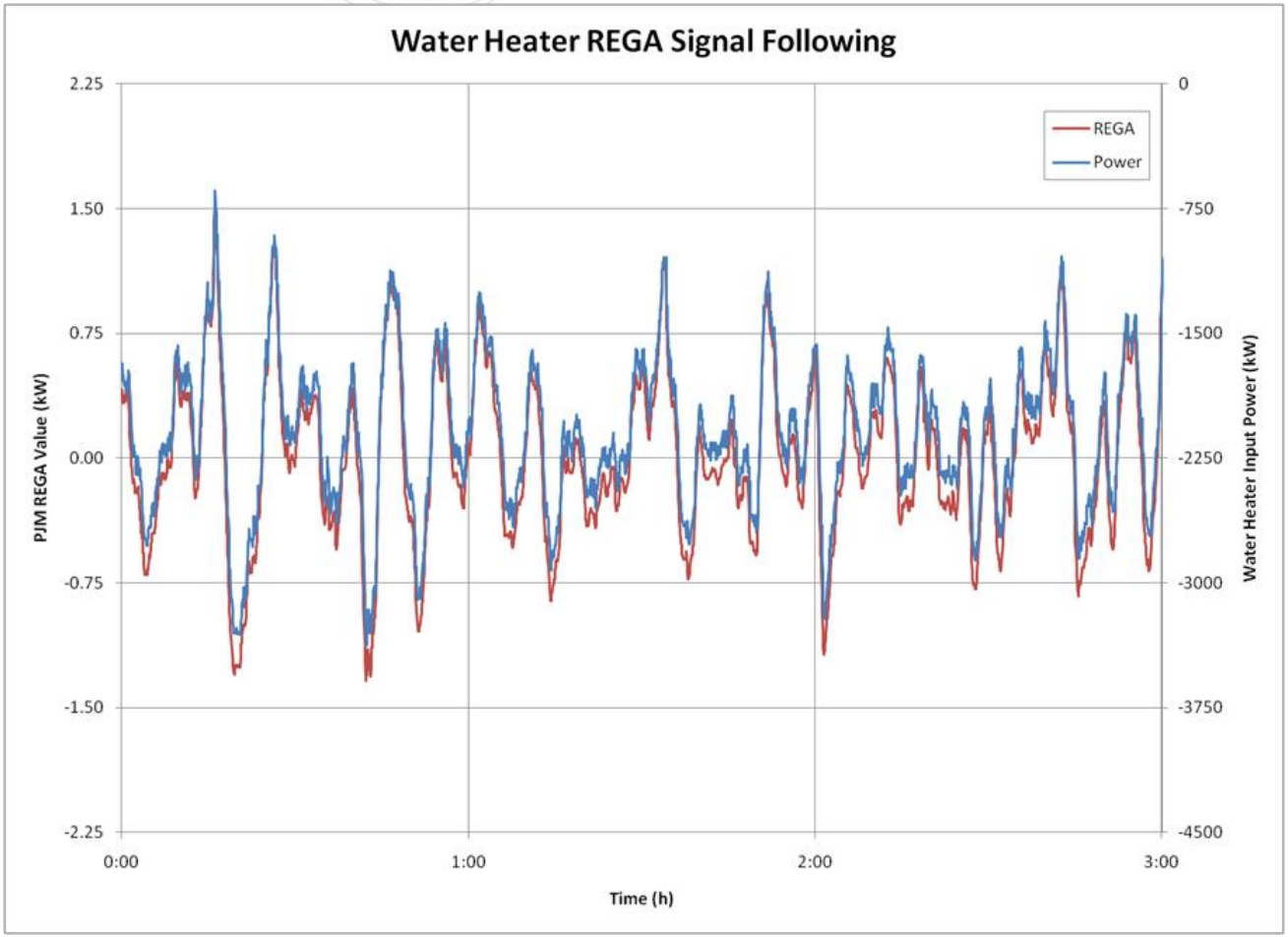
Fast Regulation: Speed Matters…

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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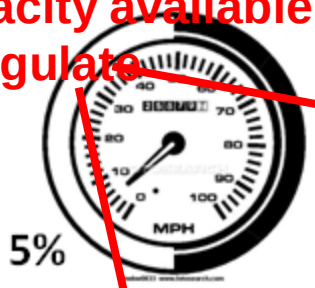
STEFFES GRID-INTERACTIVE WATER HEATER CONTROL

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

LOAD RESOURCE SNAPSHOT

THERMAL BATTERY LOAD



0.22 kW
UP-REGULATION CAPACITY

4.28 kW
DOWN-REGULATION CAPACITY

4.50 kW
MAXIMUM LOAD

Capacity available to regulate

ENERGY RESOURCE SNAPSHOT

THERMAL BATTERY CHARGE LEVEL

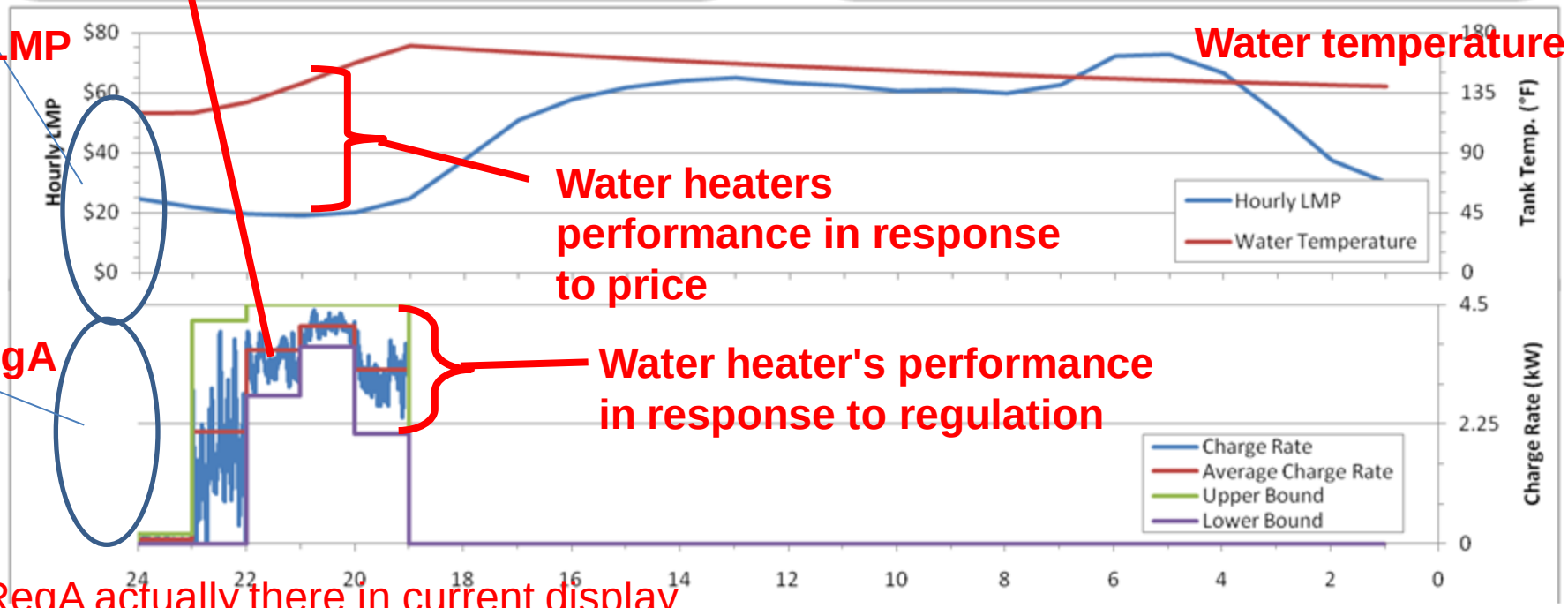
14.2 kW·h
CURRENT CHARGE LEVEL

11.8 kW·h
CURRENT RESERVE CAPACITY

26.0 kW·h
TOTAL STORAGE CAPACITY

LMP

Water temperature



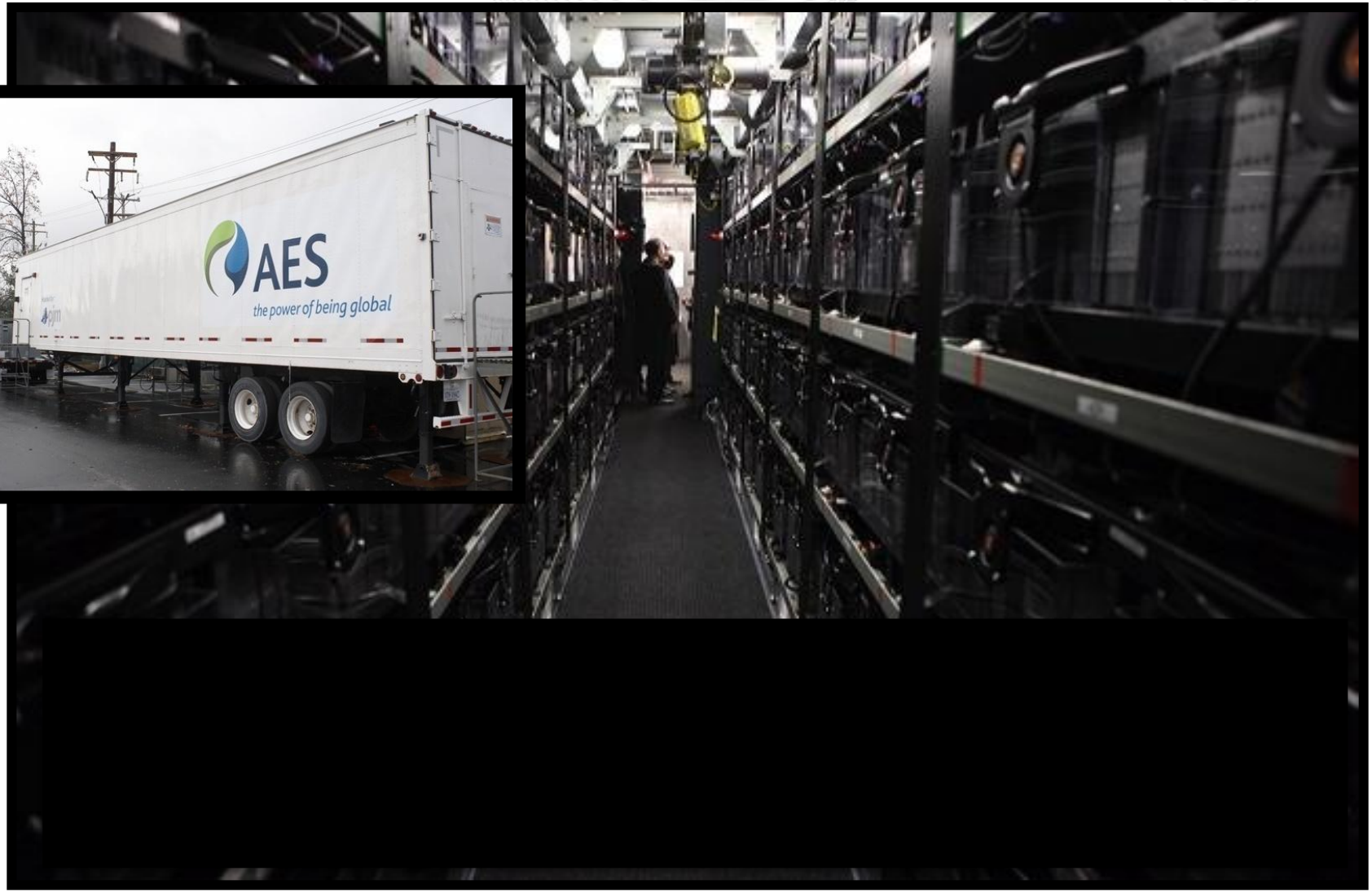
Water heaters performance in response to price

RegA

Water heater's performance in response to regulation

RegA actually there in current display

AES Grid-Scale Energy Storage System



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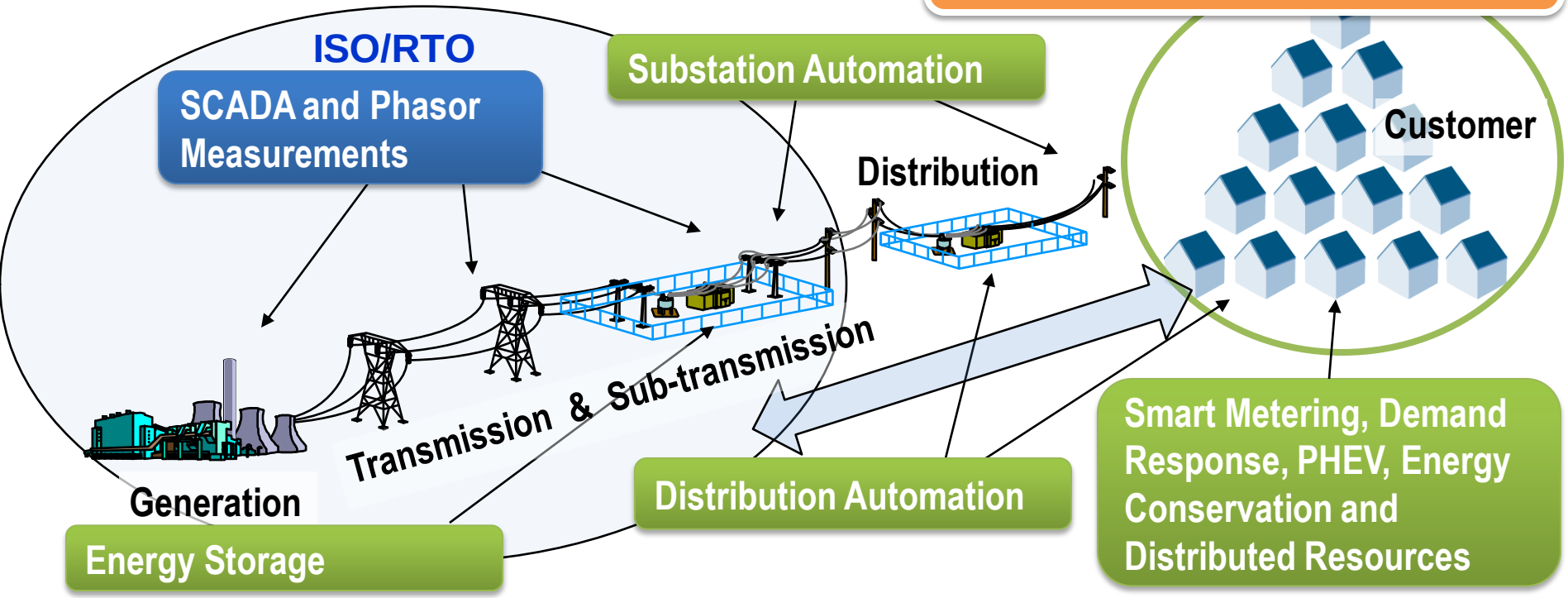
The Smart Grid is realized by merging data to achieve a total end-to-end systems view by integrating information technology and operational technology.

Two-Way Communication and Control

$800 million DOE grants



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Conceptual Price Responsive Demand Data Flow

Locational Marginal Prices (LMPs)

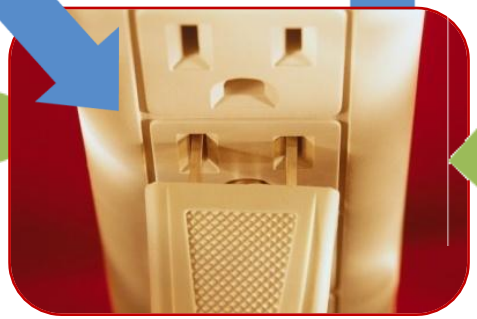
Transforms LMPs to reflect rate structures to LSE

LMPs* and/or transformed retail prices to End Consumers

Customer node to price point mapping to utility

Retail rate structures and customer-to-price point mapping

Price/quantity curves and Wholesale usage to PJM



Retail usage to utility

* In advance of time-varying retail rates, consumers that receive wholesale prices can choose to respond

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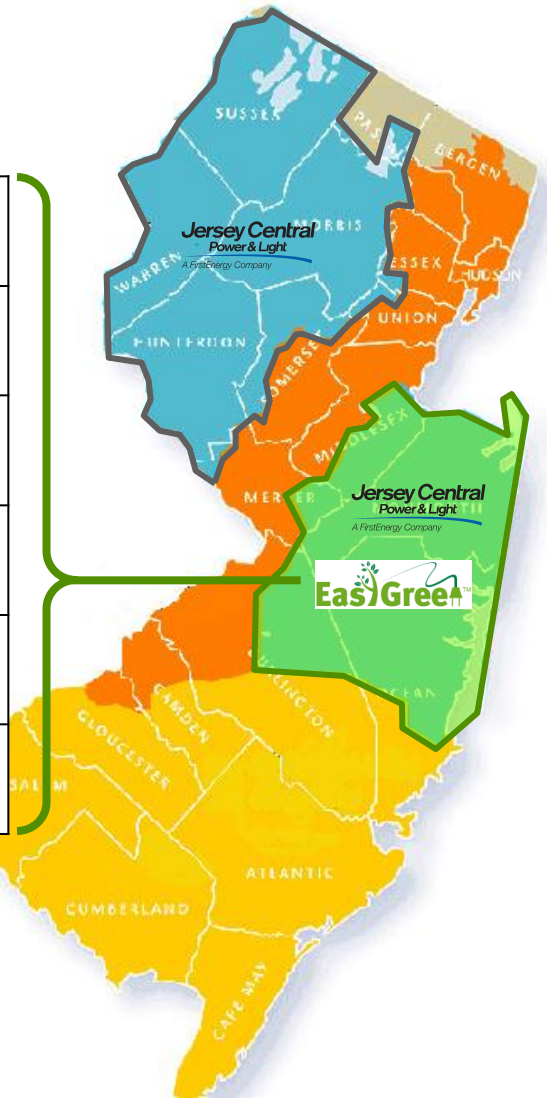
Integrated Distributed Energy Resources Project

- **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

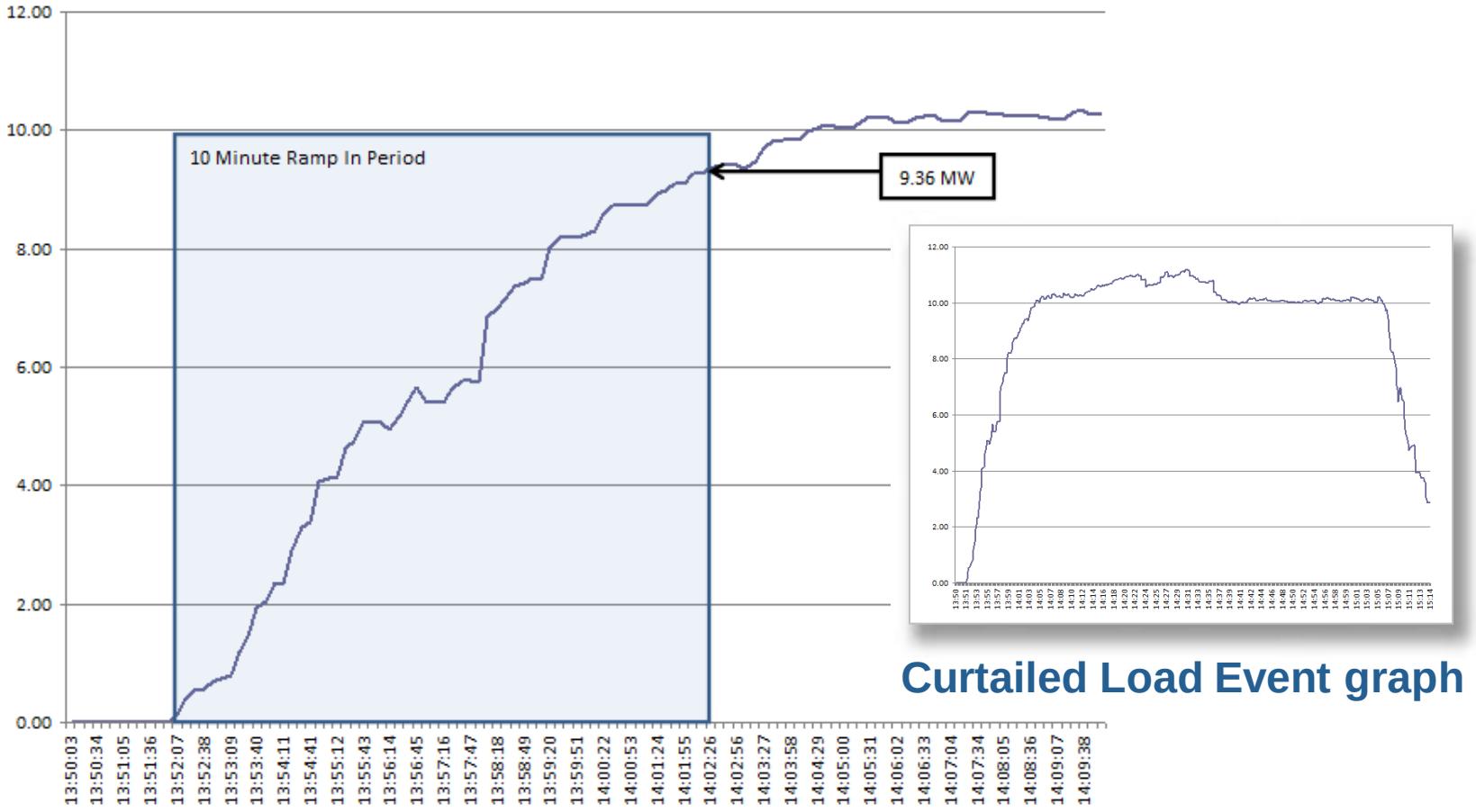
IDER Project Status

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



August 31, 2010 – One-Hour Test Event

- **Curtailed Load Event Ramp In Detail**



Curtailed Load Event graph

Note: Data shown includes T&D losses