

Grid-Interop

TM

Grid-interactive Electric Thermal Storage (GETS)

provides economic and environmental benefit



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 #GridInterop

Grid-Interop 2011

Steffes Corporation

Leader In Cost Effective Electric Storage

- *Load Management*
- *Fast Regulation*
- *LMP Optimization*
- *Renewable Integration*



Work with over 200 Electric Utilities, many for over 20 years

Grid-interactive Electric Thermal Storage (GETS)

Dynamically couples consumer usage to real-time grid needs

Space Heating



Water Heating



Grid-interactive Electric Thermal Storage (GETS)

- Provides Grid Reliability, Stabilization, and Optimization
- Improves System Efficiency
- Helps Integrate Large Quantities of Renewables
- Provides Economic Value:
 - Market Price
 - Regulation Services

Grid-interactive Electric Thermal Storage (GETS)

Provides “Double Green” benefits:



Economic

And



Environmental

Grid-Interactive Space & Water Heaters Are... “THERMAL BATTERIES”



With smart control, you affect the grid exactly like other electric storage technologies

Low-Cost Electric Storage

Technology	Cost	
	\$/kW-h	\$/kW
Grid-interactive Thermal Storage [†]	\$30-\$60	\$100-\$200
CAES (above ground)	\$200-\$250	\$700-\$800
ZnBr Flow Cell	\$280-\$450	\$425-\$1300
Pb-Acid Battery	\$330-\$480	\$420-\$660
NaS Battery	\$350-\$400	\$450-\$550
Flywheel	\$1340-\$1570	\$3360-\$3920

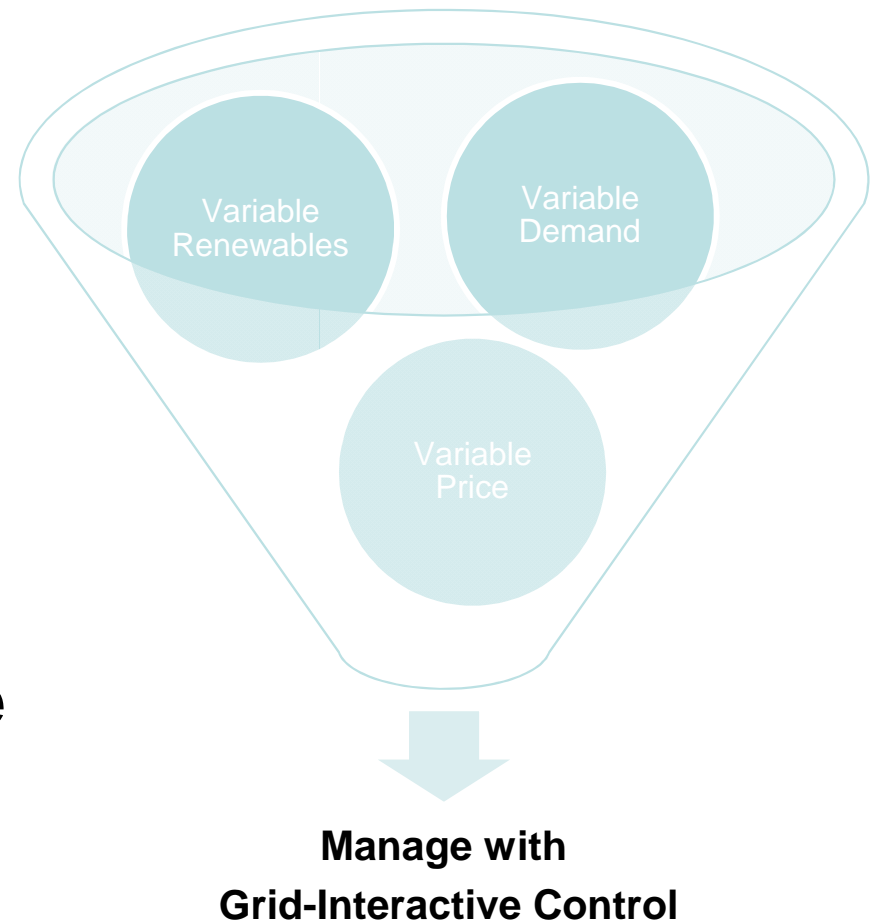
Source: EPRI 2009 energy storage technology cost estimates

[†] Source: Steffes Corporation

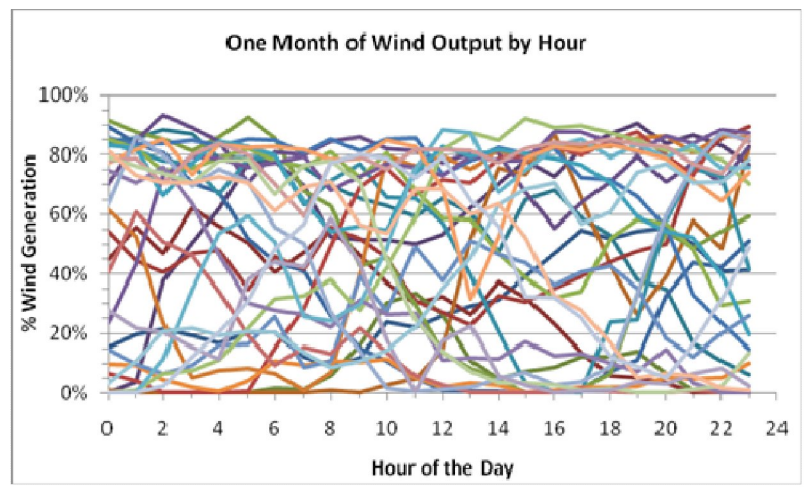
The needs of the Smart Grid today include the balancing of...

- ***Variable Generation***
- ***Variable Demand***
- ***Variable Price***

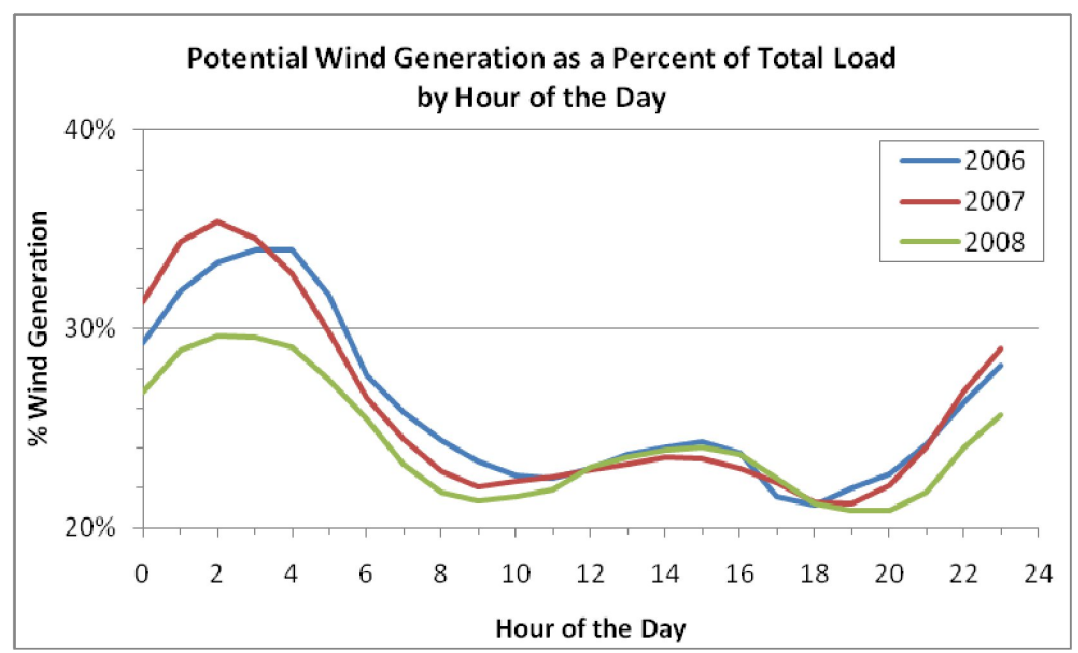
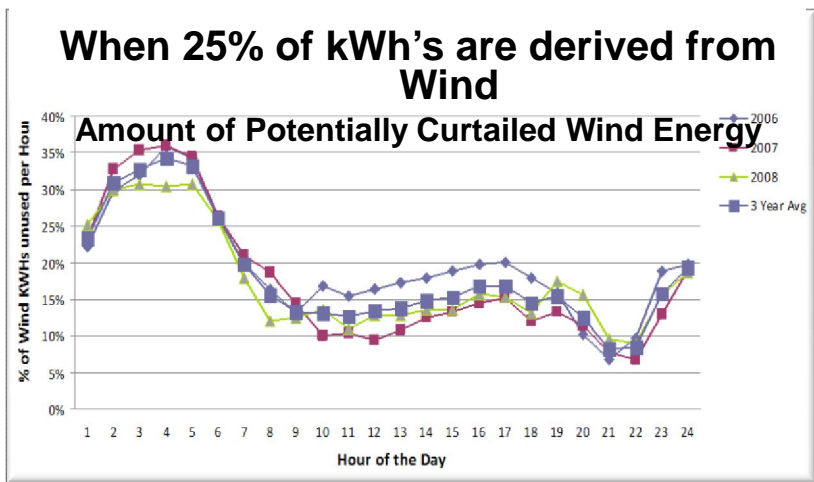
ETS Space and water heaters are grid interactive solutions



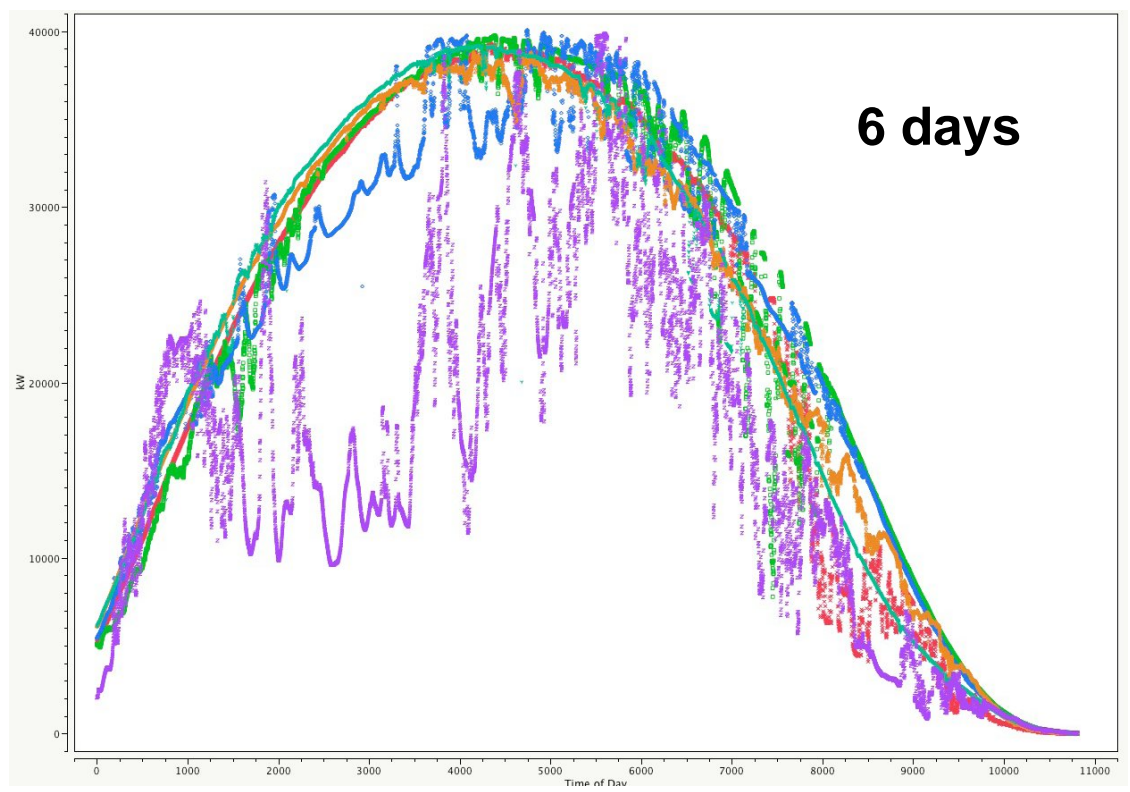
Variability of Renewables



Three Year Stable Annual Wind Output

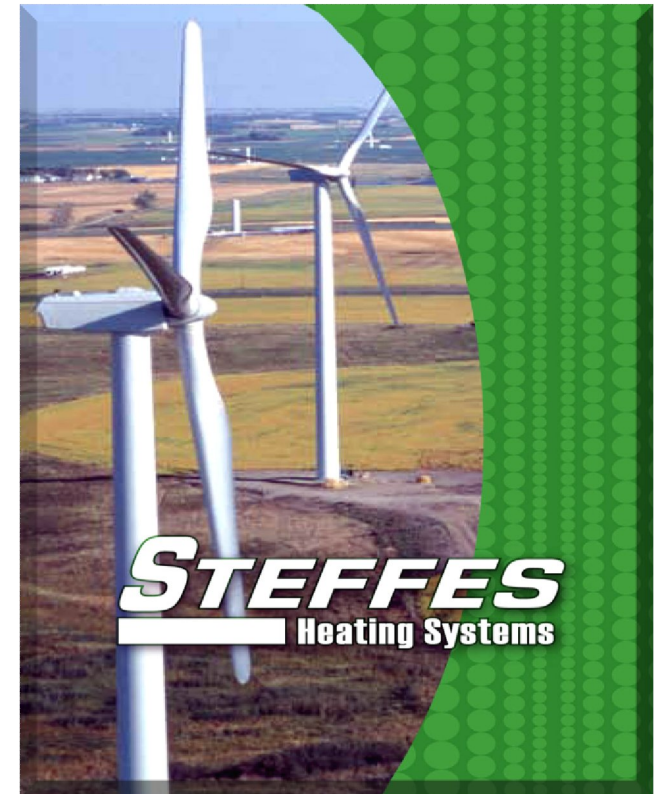


Output from a 5MW Solar PV Plant

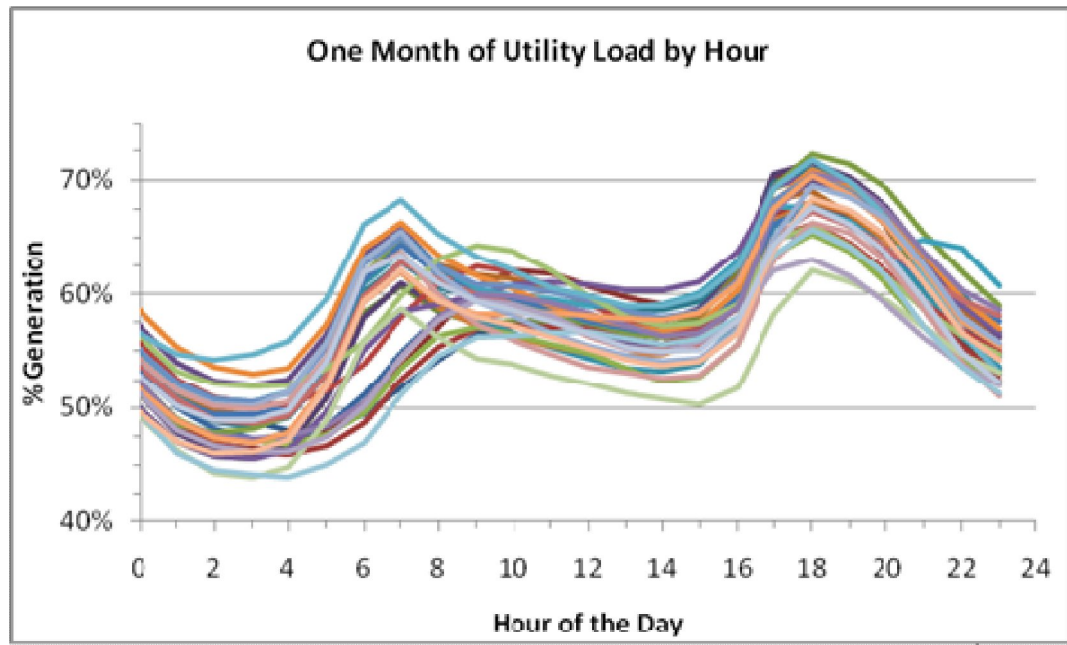


Renewable Integration

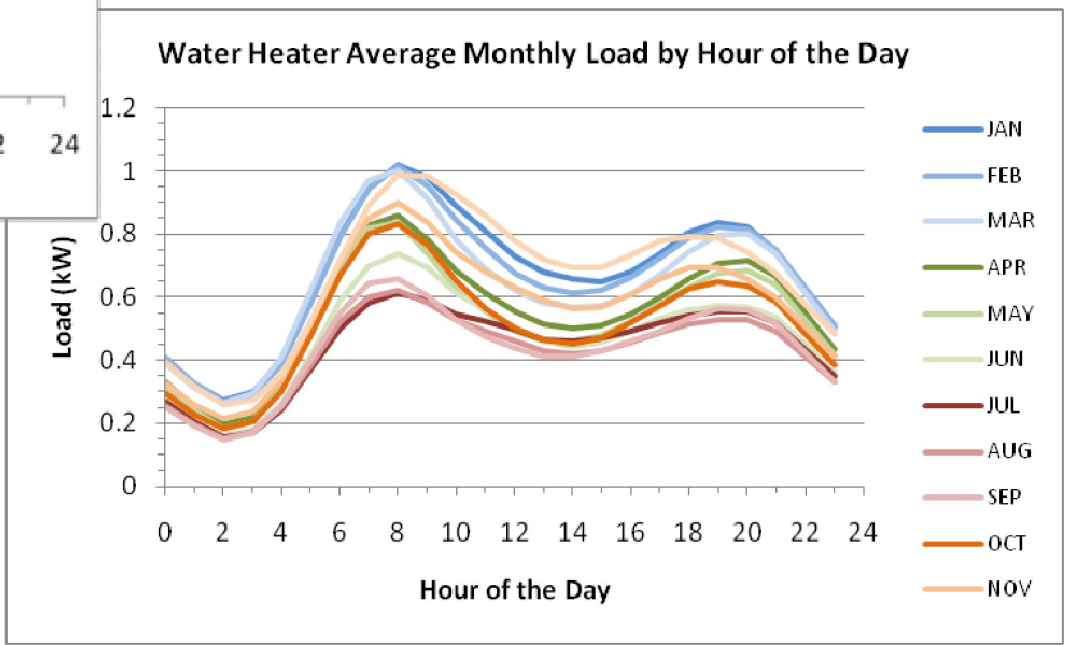
- Wind and Solar ramp up and down quickly.
 - GETS ramps just as fast
- Allows a higher % of Renewable Energy (RE)
- Enhances RE value
- Reduces Carbon Footprint
- Lowers Cost for Consumers



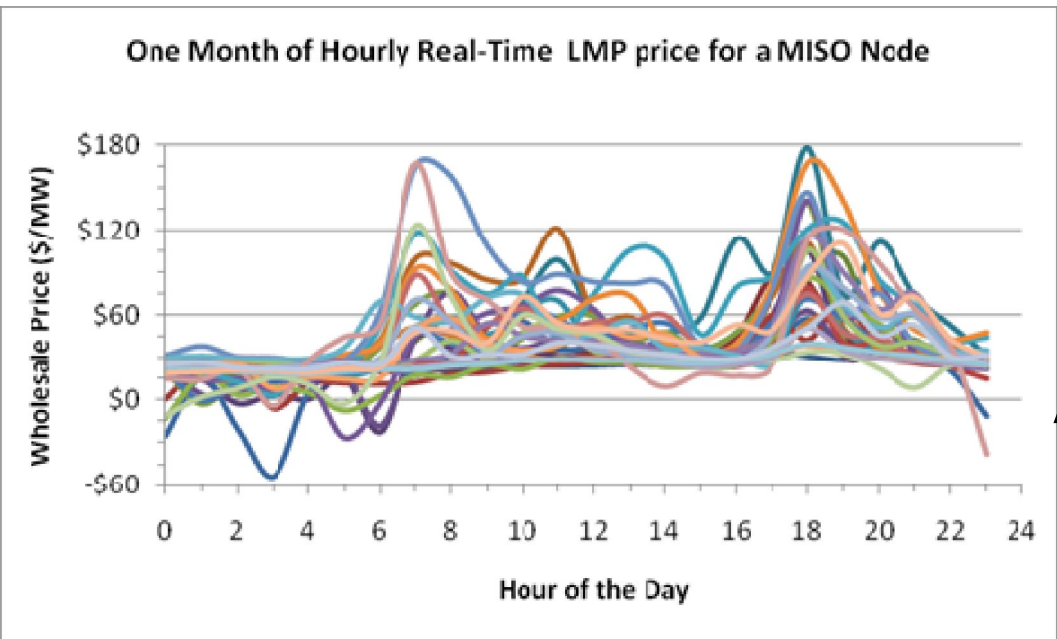
Variability of Electric Load



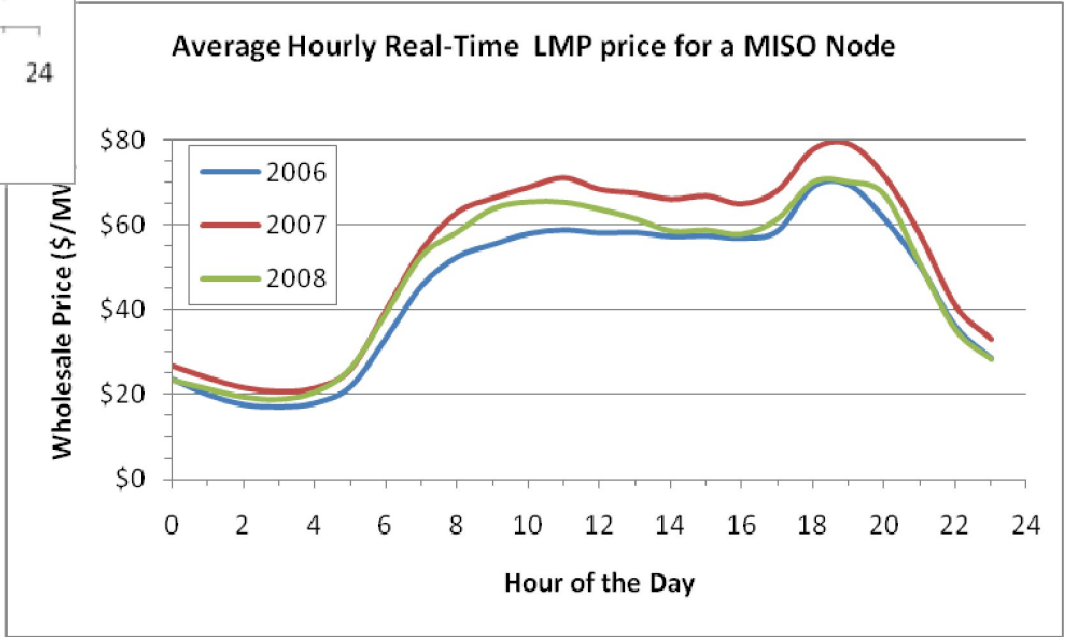
Water Heater Load



Variable Real Time Price

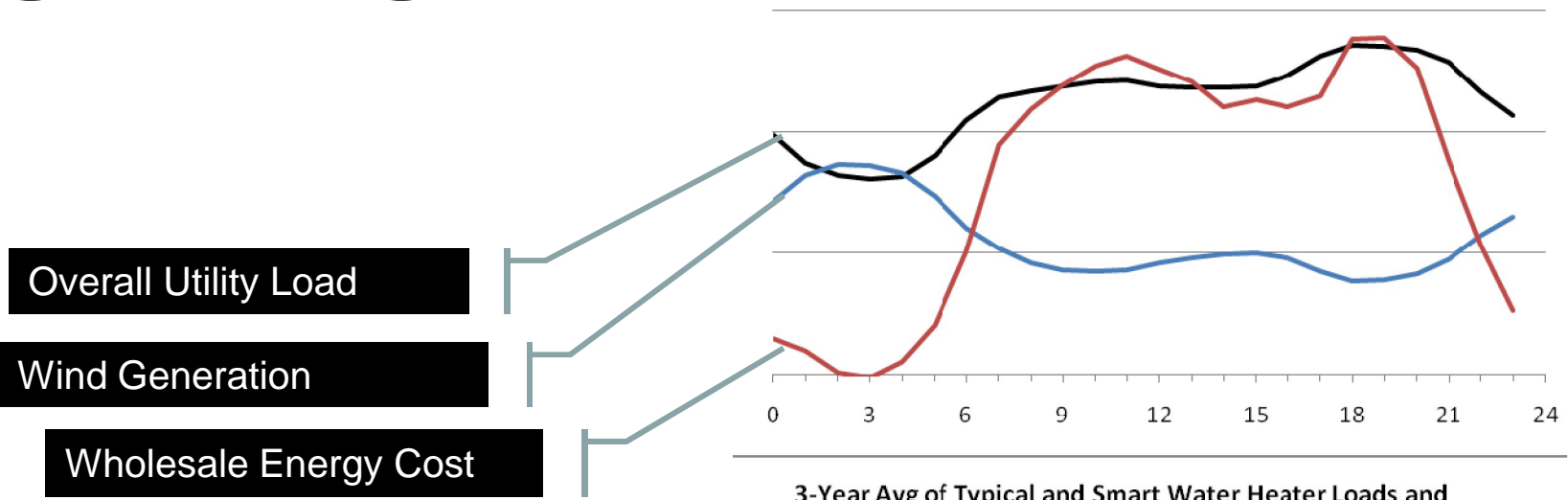


Three Year Stable Annual Average Price



Putting It Together

3-Year Avg of Utility Load, Wind Gen, and Wholesale Price

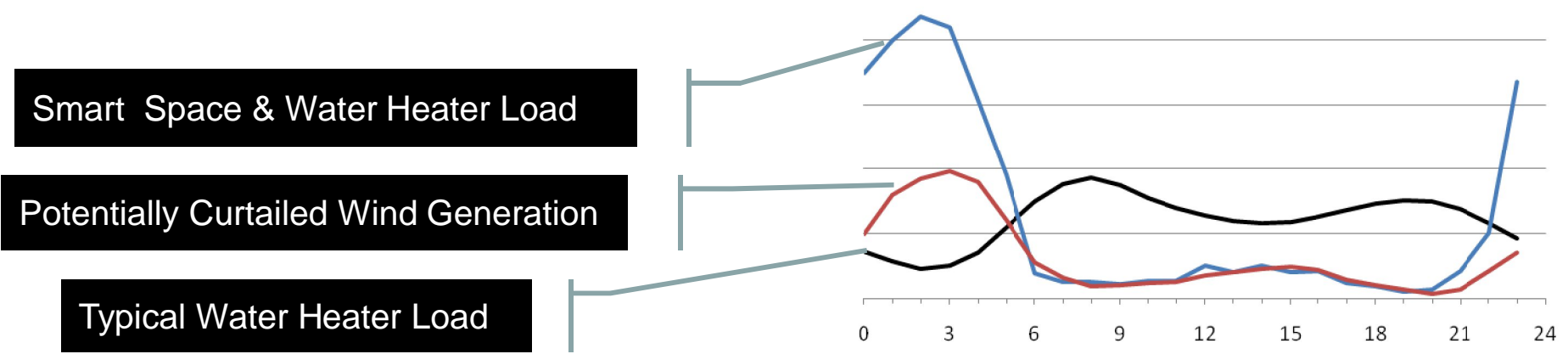


Overall Utility Load

Wind Generation

Wholesale Energy Cost

3-Year Avg of Typical and Smart Water Heater Loads and Unusable Wind



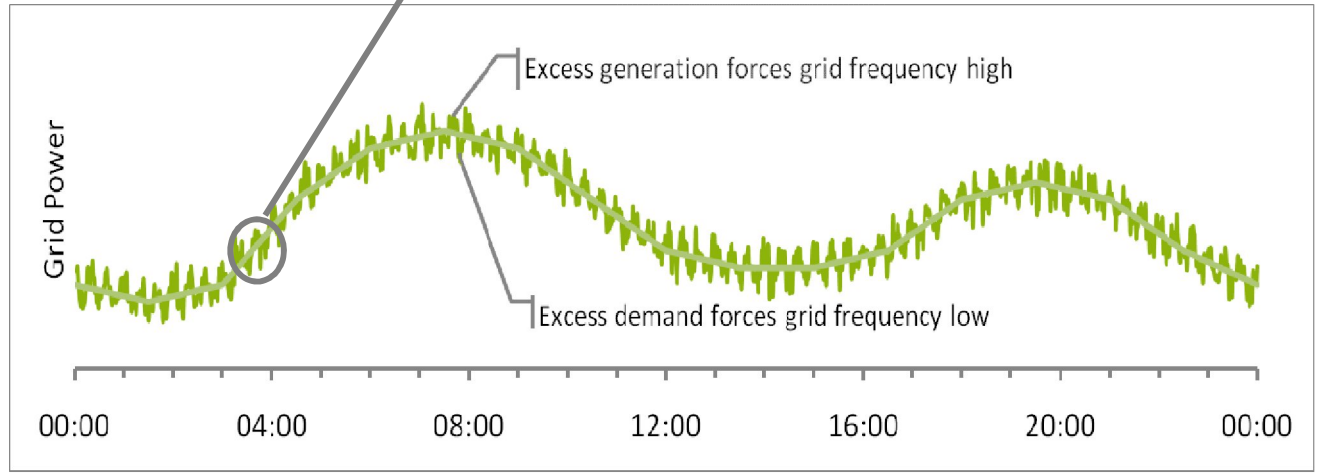
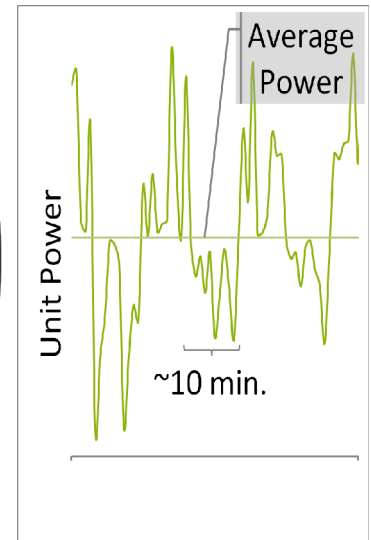
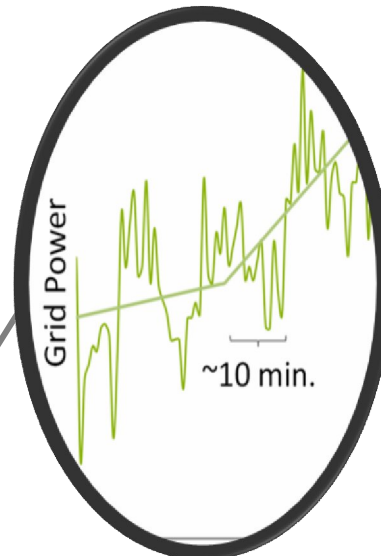
Smart Space & Water Heater Load

Potentially Curtailed Wind Generation

Typical Water Heater Load

Bonus Value Regulation/Ancillary

- Equivalent times and magnitudes above and below nominal
- Requires high-speed two-way communication



Regulation Environmental Value

CO ₂ Savings with GETS	
Coal (Base Load)	67%
Natural Gas (Peaker)	43%
Pumped Hydro	38%

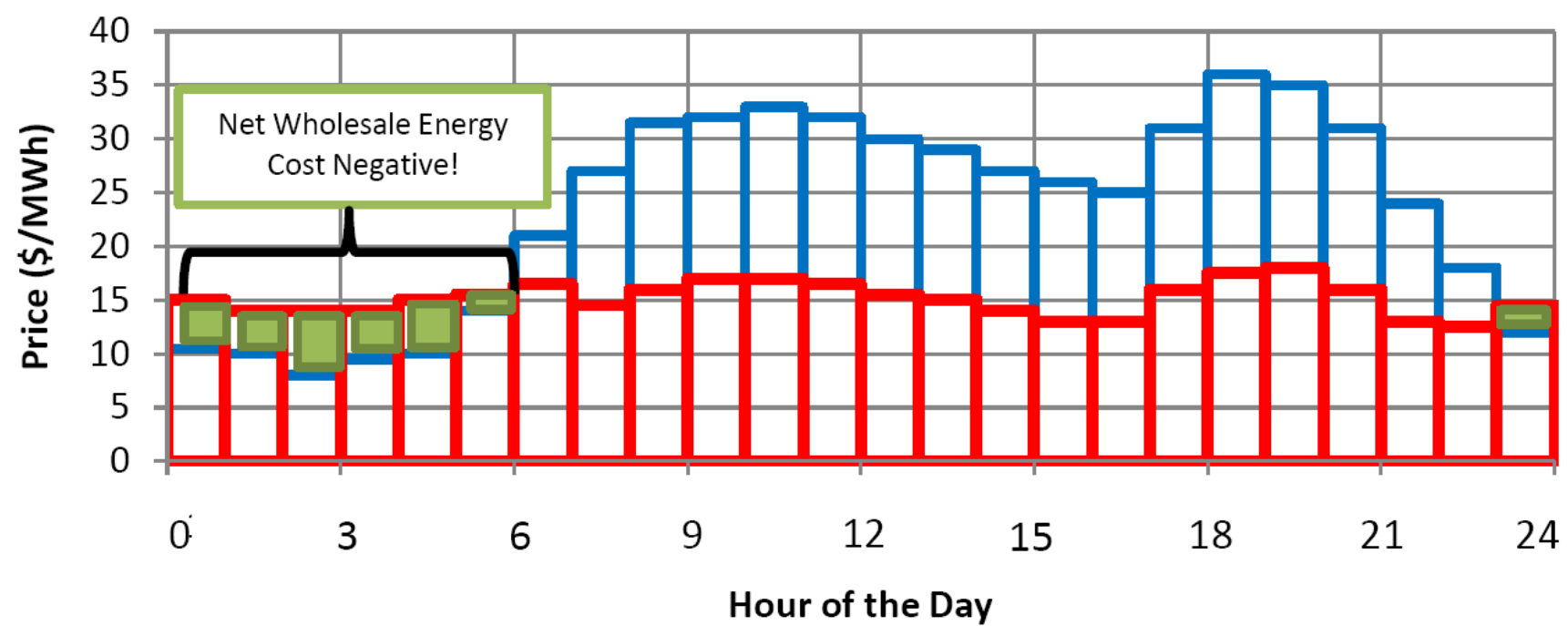
Emission Comparison for PJM

KEMA Project BPCC.0003.001

Regulation Economic Value

Typical MISO DAY

Real Time LMP VS Regulation Market Clearing Price



FERC Order 755: RMCP could be much higher

Wholesale Annual Operating Cost for Electric Water Heater

Type/Method	Energy Cost	Demand/Trans. Other Costs	Total Cost
Uncontrolled	\$256	\$50 - \$200	\$306 - \$456
Grid-Interactive LMP Optimized	\$108	0	\$108
Grid-Interactive with Regulation	-\$80	0	-\$80

- **Uncontrolled Water Heater:** No controls installed on water heater
- **Grid-Interactive Water Heater:** Consumes energy when LMP is low, but not doing regulation
- **Grid-Interactive with Regulation:** Consumes energy when LMP is low and provides regulation. (FERC Order 755: -\$230?)

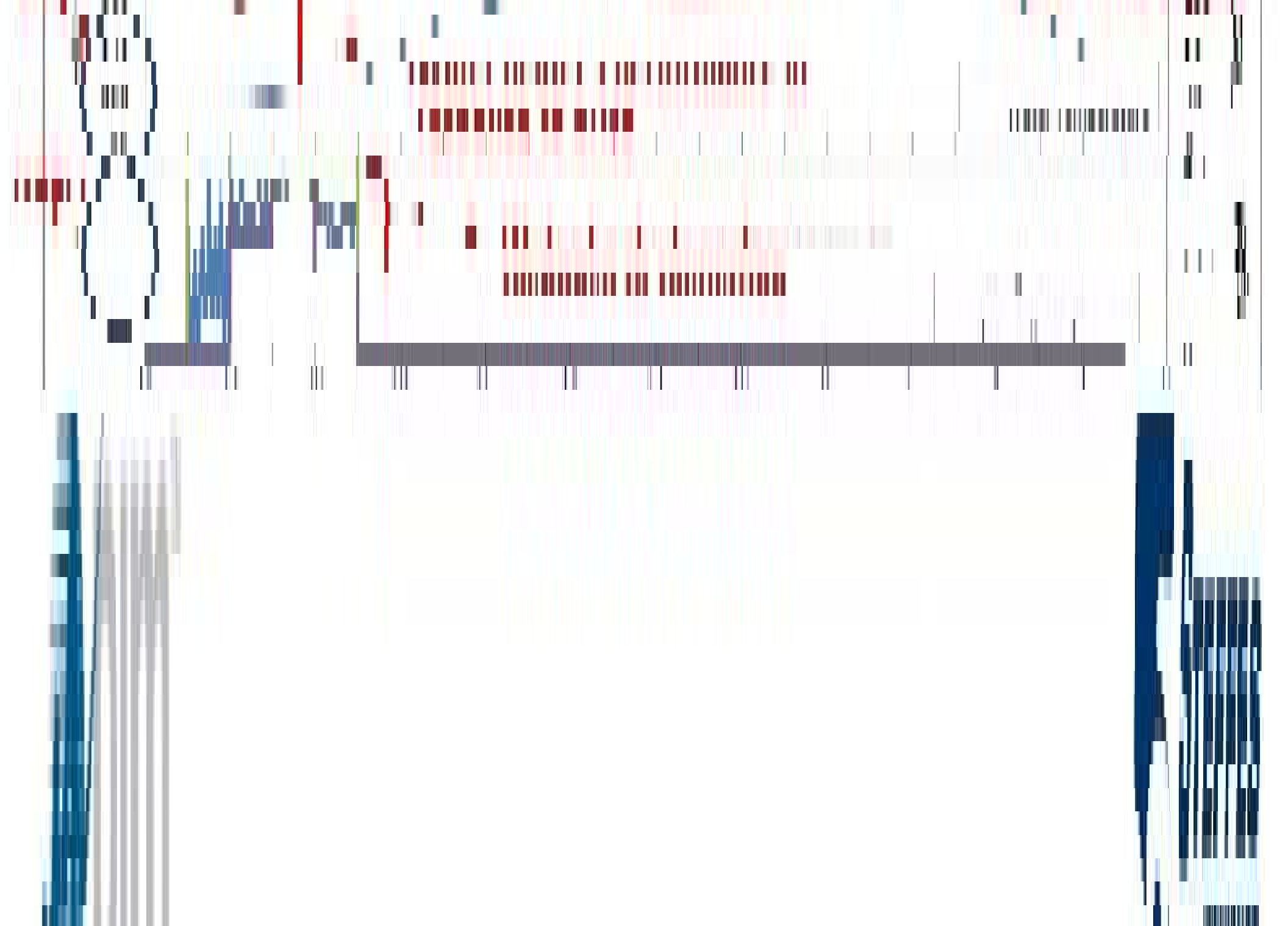
Water Heater

PJM Demonstration

- 105 Gallon Water Heater
- Control Inputs
 - Energy Price
 - Frequency Regulation Signal



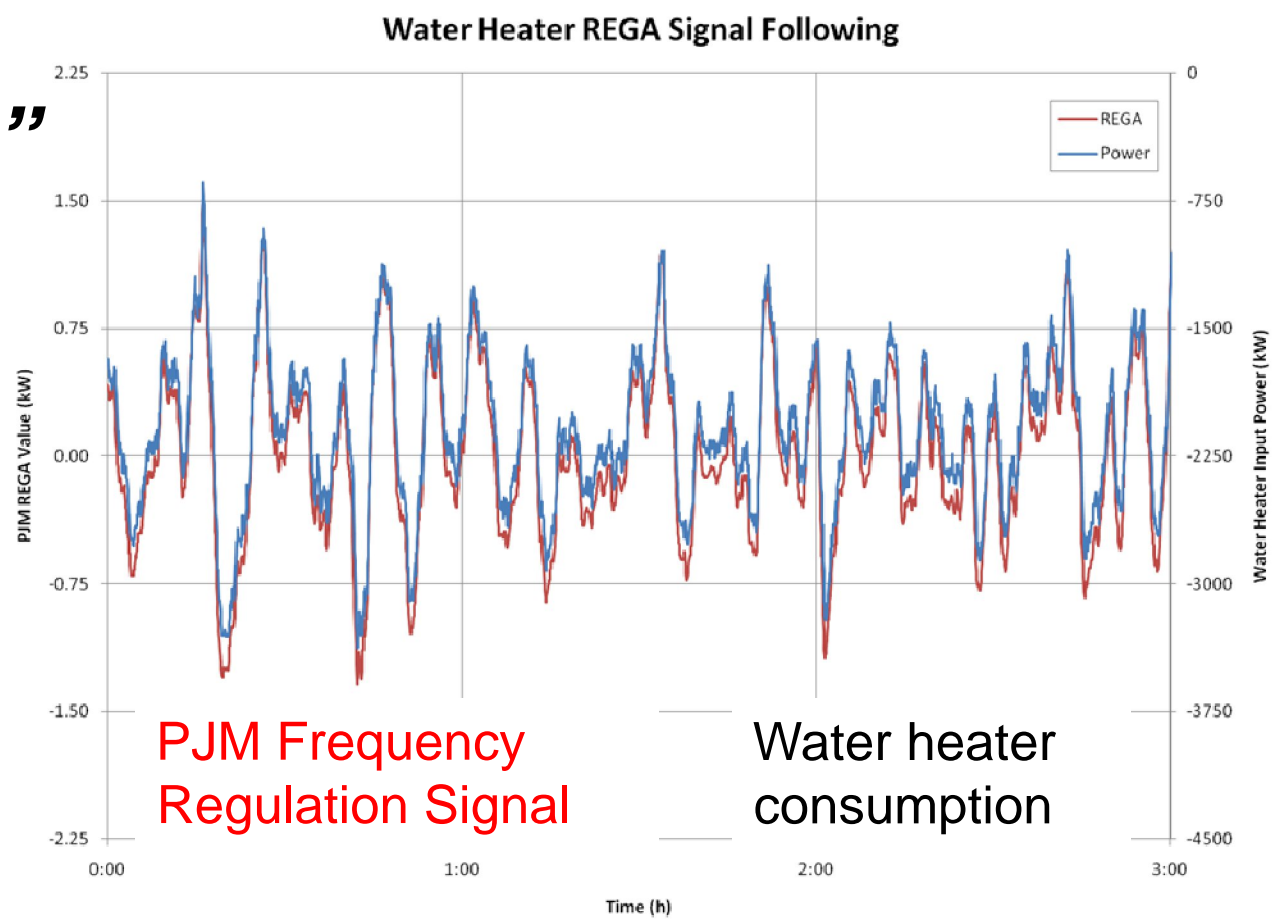
PJM Headquarters Visitor Entrance
PJM © 2011



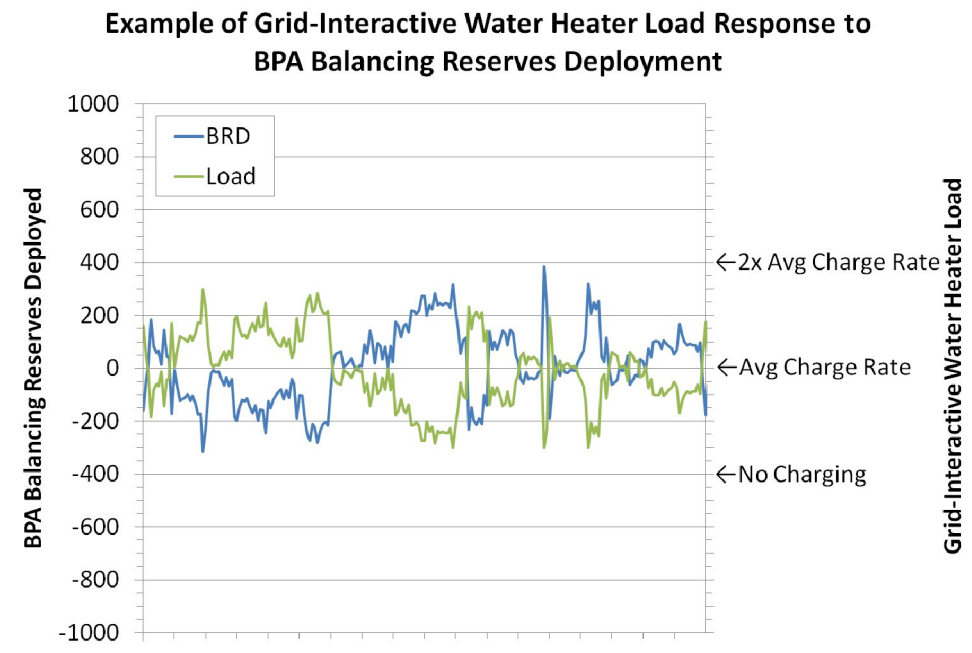
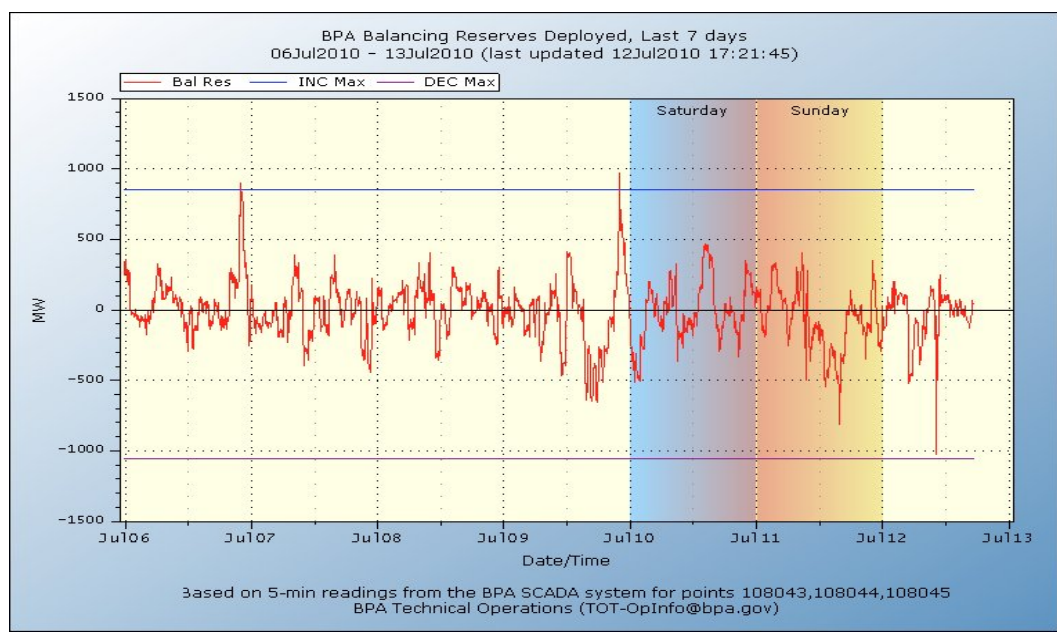
Fast Regulation

“Speed Matters...”

FERC Order 755:
Payments for fast acting
regulation resources
could be **much** higher.



BPA Balancing Reserves Deployment



GETS Equipment

Space Heating



- 13kWh to 960kWh storage
- 1.3kW to 160kW input

Water Heating

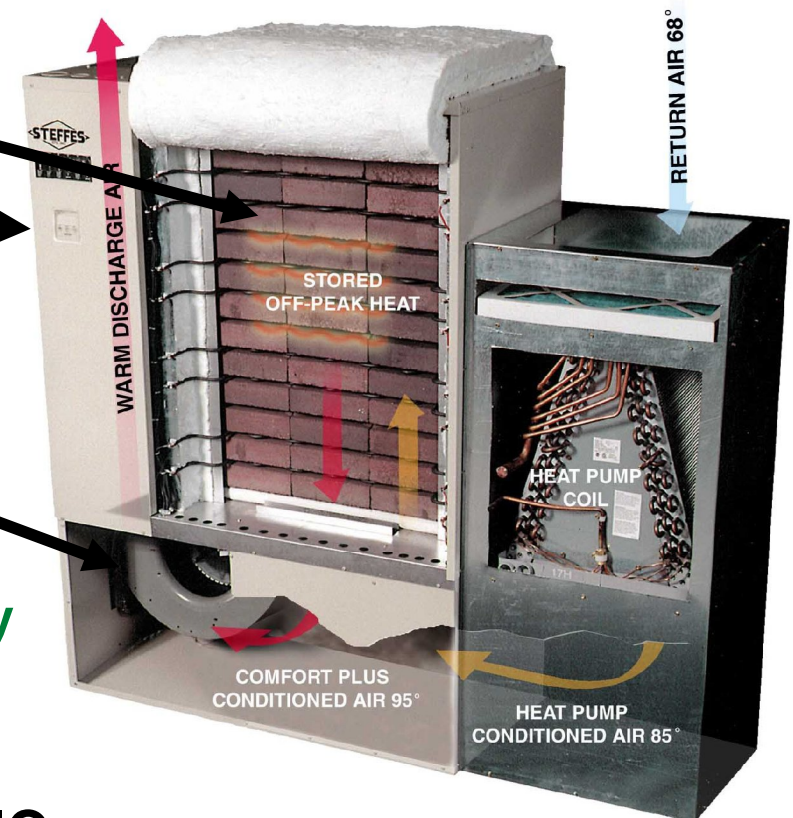


Think of a 105 gal. Water Heater as a 26kWh Battery (nominal 2-day supply of hot water)

Electric Thermal Storage

Storage of Renewable or Off-Peak Electricity in the form of Heat

- Electricity is stored as heat in a well insulated brick core.
- On-board Microprocessor based control system regulates charging and discharging.
- Internal blower system delivers the heat to the conditioned space as needed to maintain comfort 24/7.
- **Storage occurs based on availability of renewable or off-peak energy or as signaled by the utility for ancillary services.**



It's FULLY AUTOMATIC

All heating is accomplished by using off-peak or renewable energy

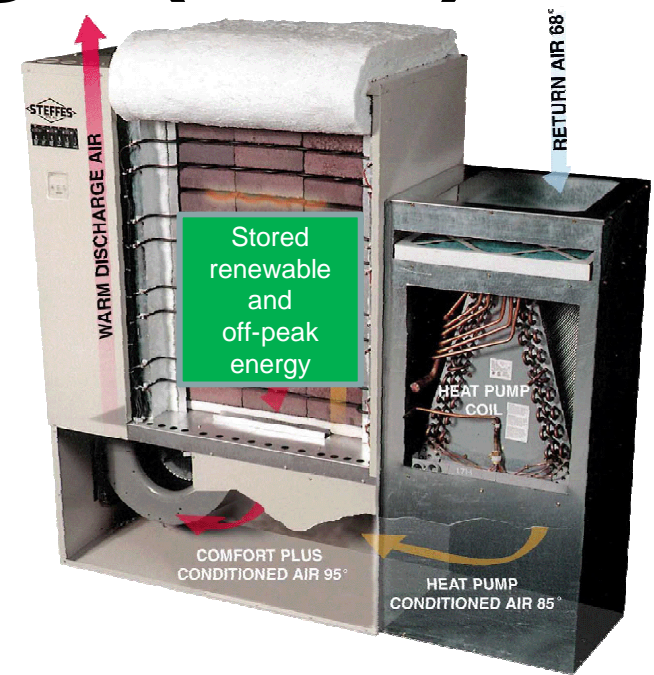
Electric Thermal Storage (ETS)



- Residential
- Commercial
- Industrial



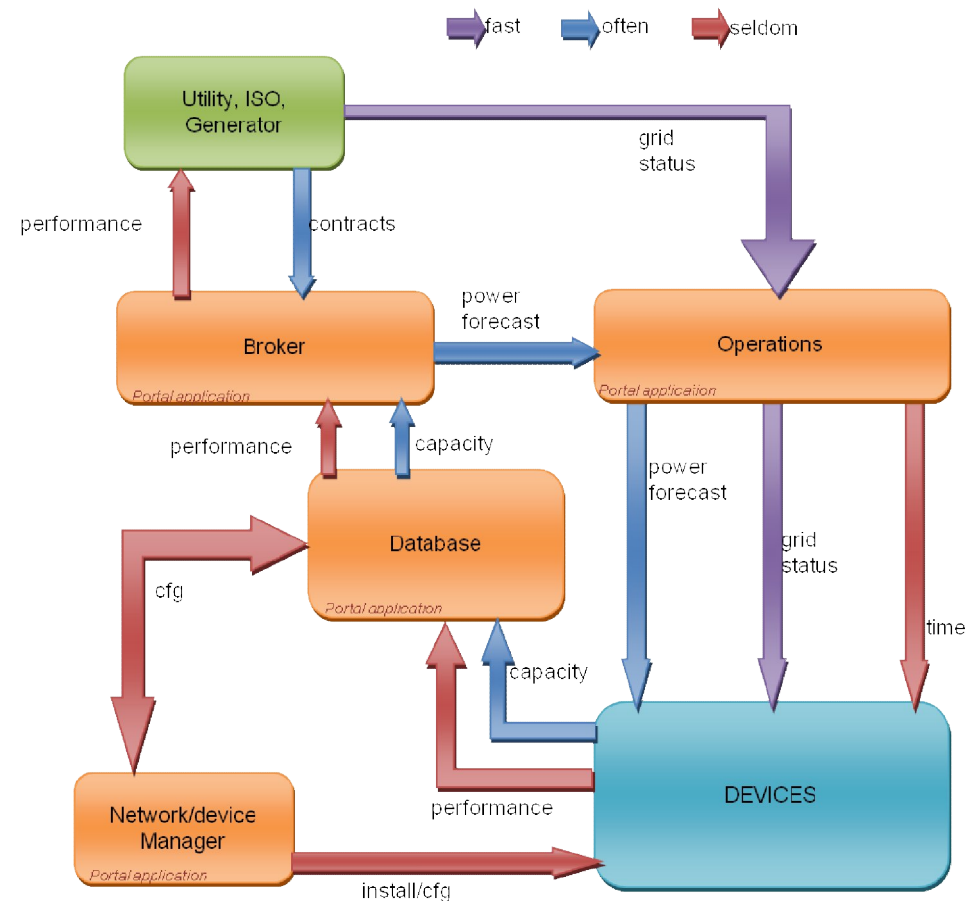
100,000 installations in North America
A distributed 10 Gwh “Thermal Battery”



- 13 to 960kWh storage
- 1.3 to 160kW input

The Universal Mission of GETS

- Ensure the space and hot water needs of the consumer are met
- Periodically report the precise amount of UP and DOWN dispatchable load that is available for a period of time into the future and can be aggregated with other similar devices
- Respond to signals to provide UP and DOWN dispatchable load as needed by the grid and provide measurement and verification



GETS VS Heat Pump

As a Renewable Integration Tool

Water Heater	Energy Cost	CO ₂ Reduction
55 Gallon Uncontrolled	\$251	Baseline
105 Gallon GETS	\$126	42%
55 Gallon Heat Pump (Florida)	\$126	50%
55 Gallon Heat Pump (Illinois)	\$187	26%
55 Gallon Heat Pump (Minnesota)	\$205	20%

Based on 3 years of wind generation scaled to 25%, and EPRI Water Heater Data

Grid-interactive Electric Thermal Storage (GETS)

- Provides Grid Reliability, Stabilization, and Optimization
- Improves System Efficiency
- Helps Integrate Large Quantities of Renewables
- Provides Economic Value:
 - Market Price
 - Regulation Services

Grid-interactive Electric Thermal Storage (GETS)

Provides

- Arbitrage Value
- LMP following
- Renewable Integration Value
- Ancillary Value
- Conservation



Benefits

- Environment
- Consumers
- Conservation
- Efficiency
- The Grid

Questions?



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Steffes Corporation
“Commitment to Innovation”