

Smart Electric Storage

*Resources for
Grid Optimization, Fast Regulation and Renewable Integration*



"Commitment to Innovation"

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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 ETS (GETS)

Provides “Double Green” benefits:



Economic

And



Environmental



Electric Thermal Storage

- Provides Grid Reliability, Stabilization, and Optimization
- Improves System Efficiency
- Helps Integrate Large Quantities of Renewables
- Provides Economic Value:
 - Market Price
 - Regulation Services (FERC Order 755)



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



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



What is the value?

Category of Benefits	Distributions Benefits \$/kW	G&T Benefits \$/kW
Peak Shaving	2,748-5,946	700-1200
T&D Asset Deferral	300-3,111	300-3,111
Arbitrage	260-1,088	260-1,088
Frequency Regulation (FERC Order 755)	1,318-2,636	1,318-2,636
Total of all value streams	4,626-12,331	2,578-8,035



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

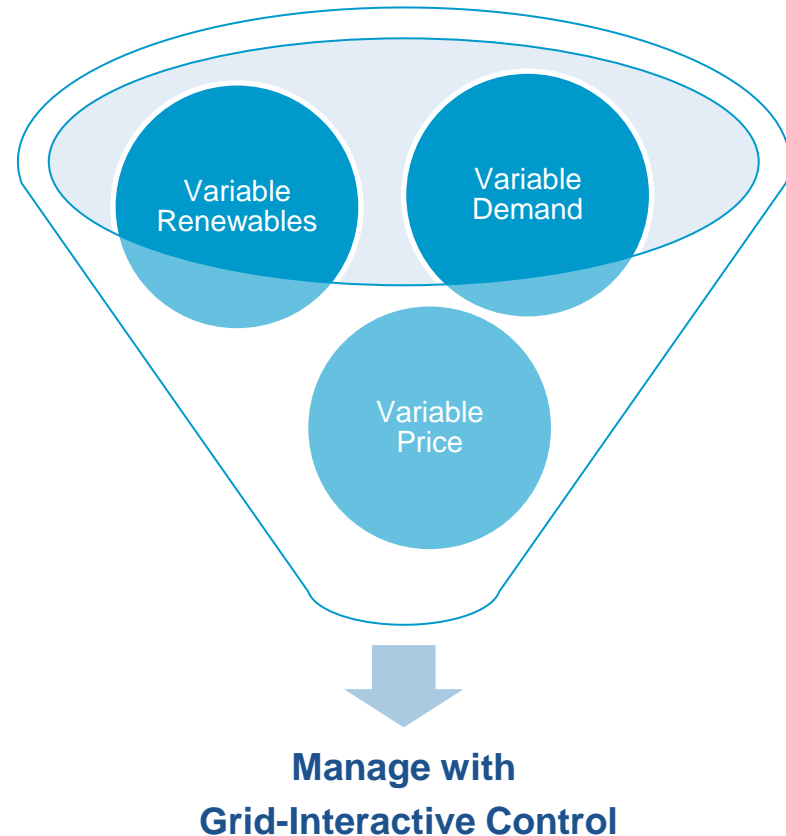
Source: EPRI 2009 energy storage technology cost estimates

[†] Source: Steffes Corporation



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

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

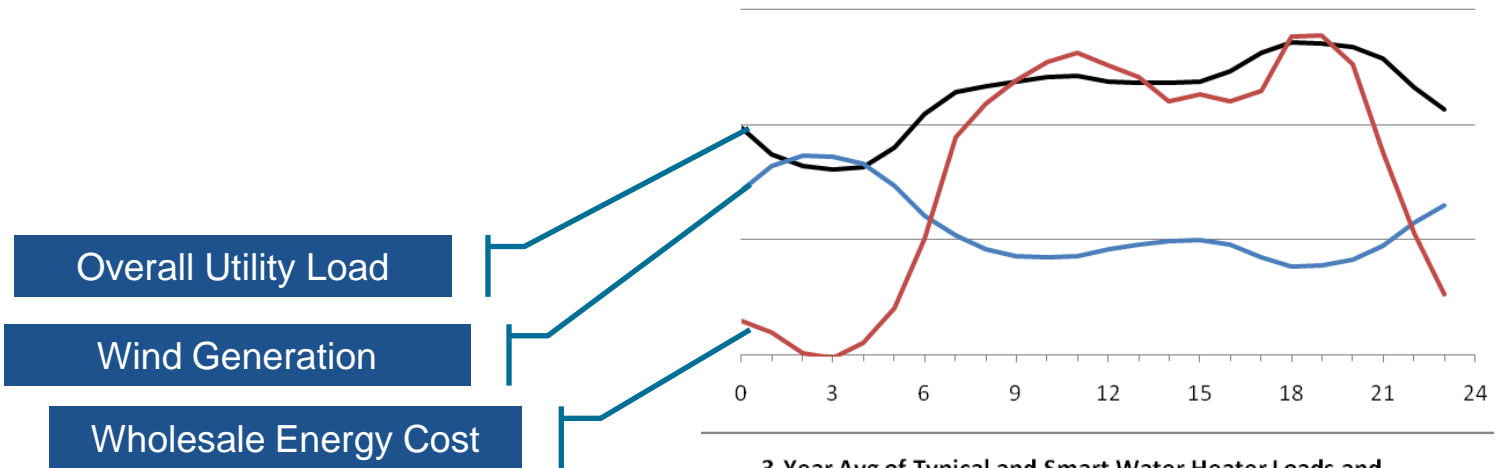


ETS Space and water heaters are grid interactive solutions

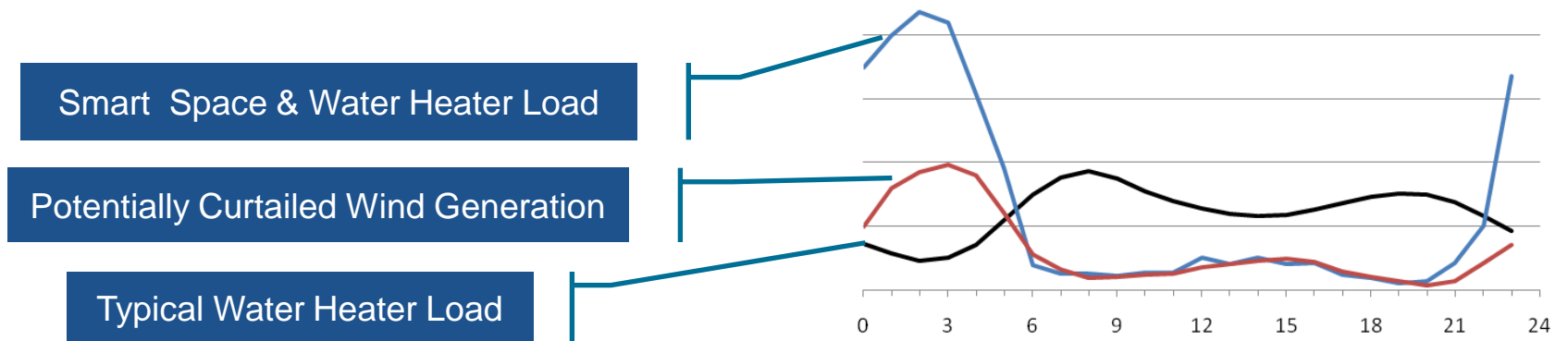


Putting It Together

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



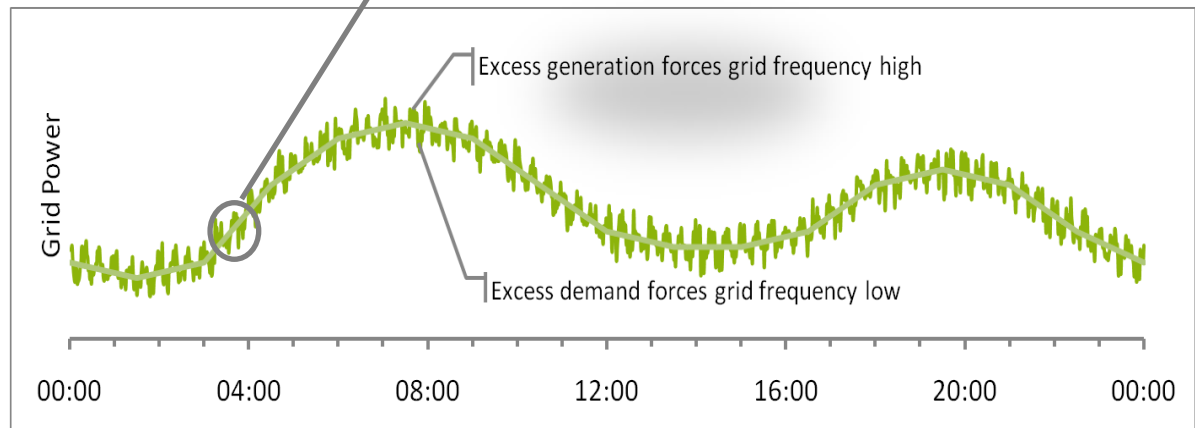
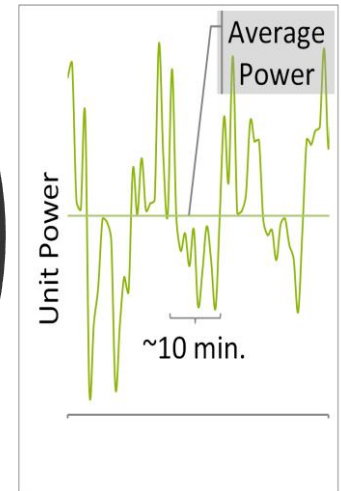
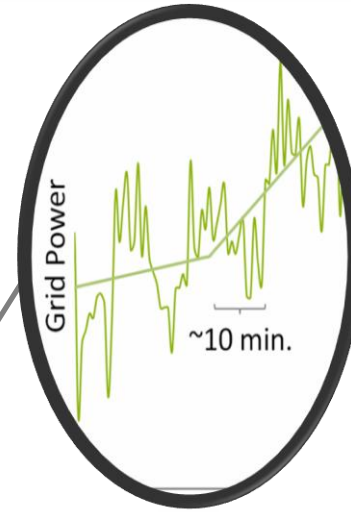
3-Year Avg of Typical and Smart Water Heater Loads and Unusable Wind





Bonus Value Regulation/Ancillary

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





Regulation Environmental Value

CO₂ Savings with GETS	
Coal (Base Load)	67%
Natural Gas (Peaker)	43%
Pumped Hydro	38%

Emission Comparison for PJM

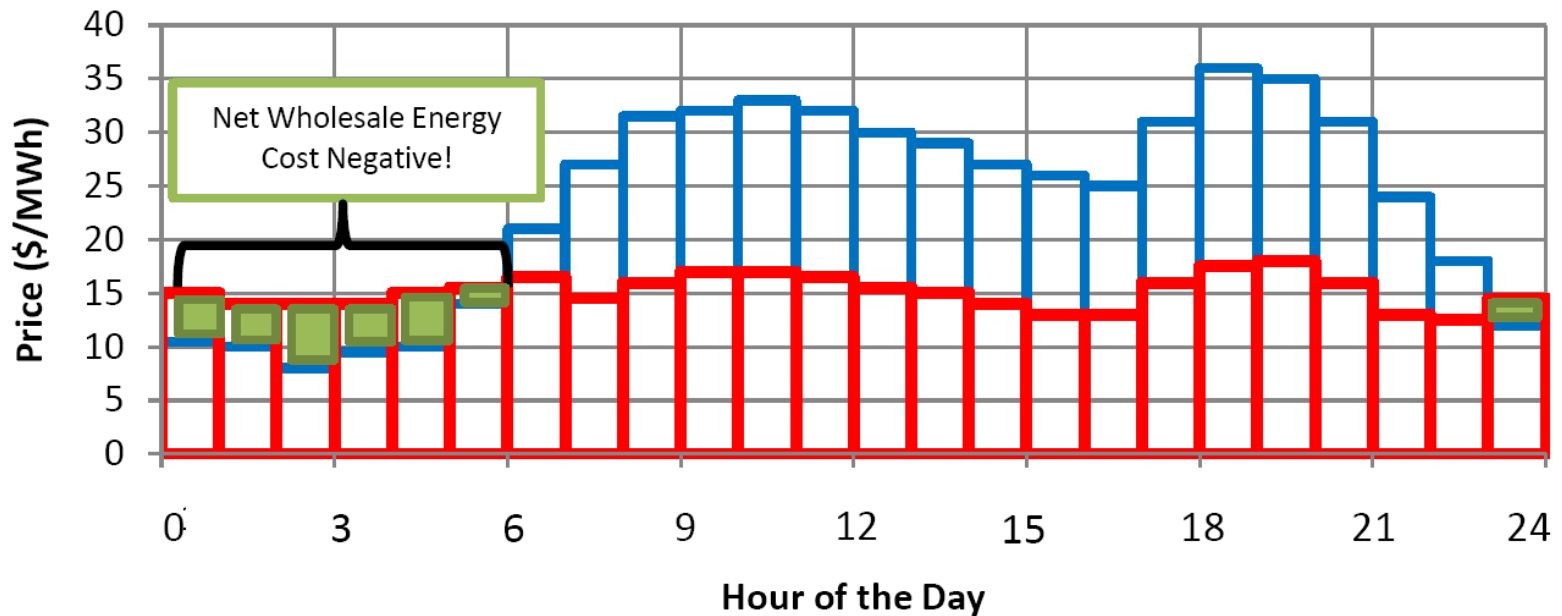
KEMA Project BPC0.0003.001



Regulation Economic Value

Typical MISO DAY

Real Time LMP VS Regulation Market Clearing Price

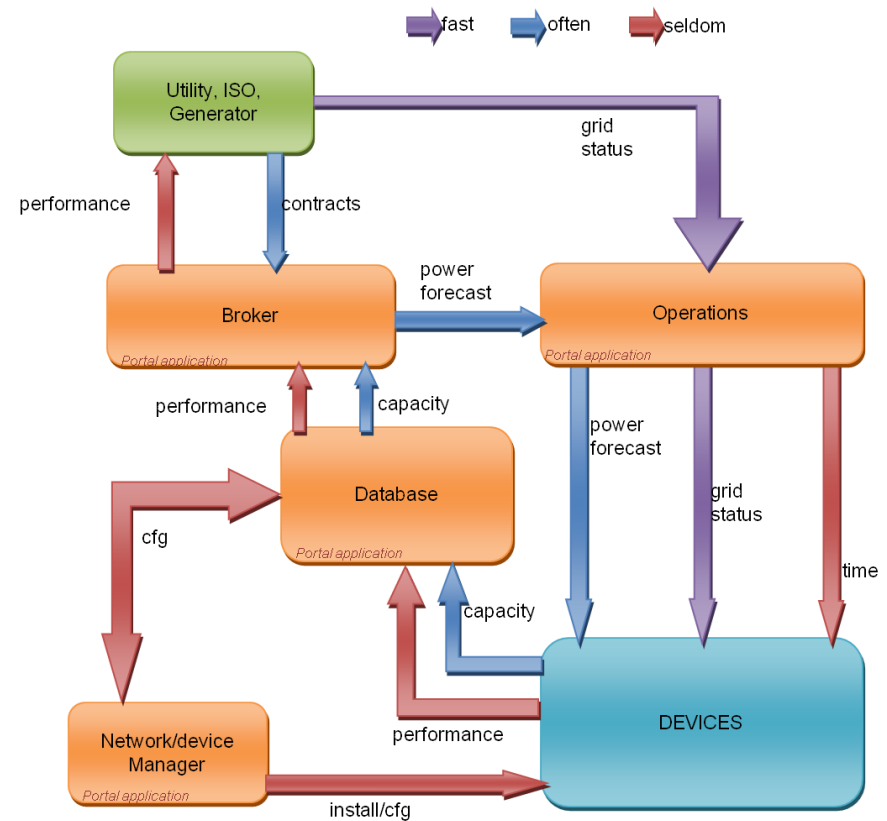


Note: Under FERC Order 755, RMCP could be much higher



Universal Mission of GETS

- An active control using real time telemetry
- Providing up and down regulation for system balance
- Reliably
- Verifiably





UTILITY AGGREGATOR

CONTROL SIGNAL
(DALMP, RTLMP, RMCP, etc.)
via secure website or other secured means.



Utility Portal Access utilizing SSL with up to 256 bit encryption will allow the utility to monitor and manage a deployed fleet of GETS equipment as well as obtain data for reporting purposes.

VPN or SSL for Utility Hosted Application such as a CIS application.

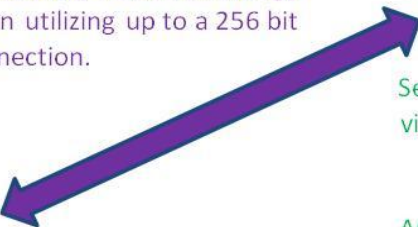


Security and access controlled via Firewall, IDS, Auditing and Logging of events, Data Validation, Role Based Authentication/Authorization, DR and Redundancy, MAC Address Filtering.

The homeowner portal will provide for feedback regarding activity as well as energy and cost information utilizing up to a 256 bit encryption SSL Connection.



OPTIONAL HOME OWNER WEB PORTAL



Phase 1 - MAC Address Filtering, Simple Encryption of a data field, Data Validation, Communication is initiated by water heater

HTTP over SSL will be implemented in future release.

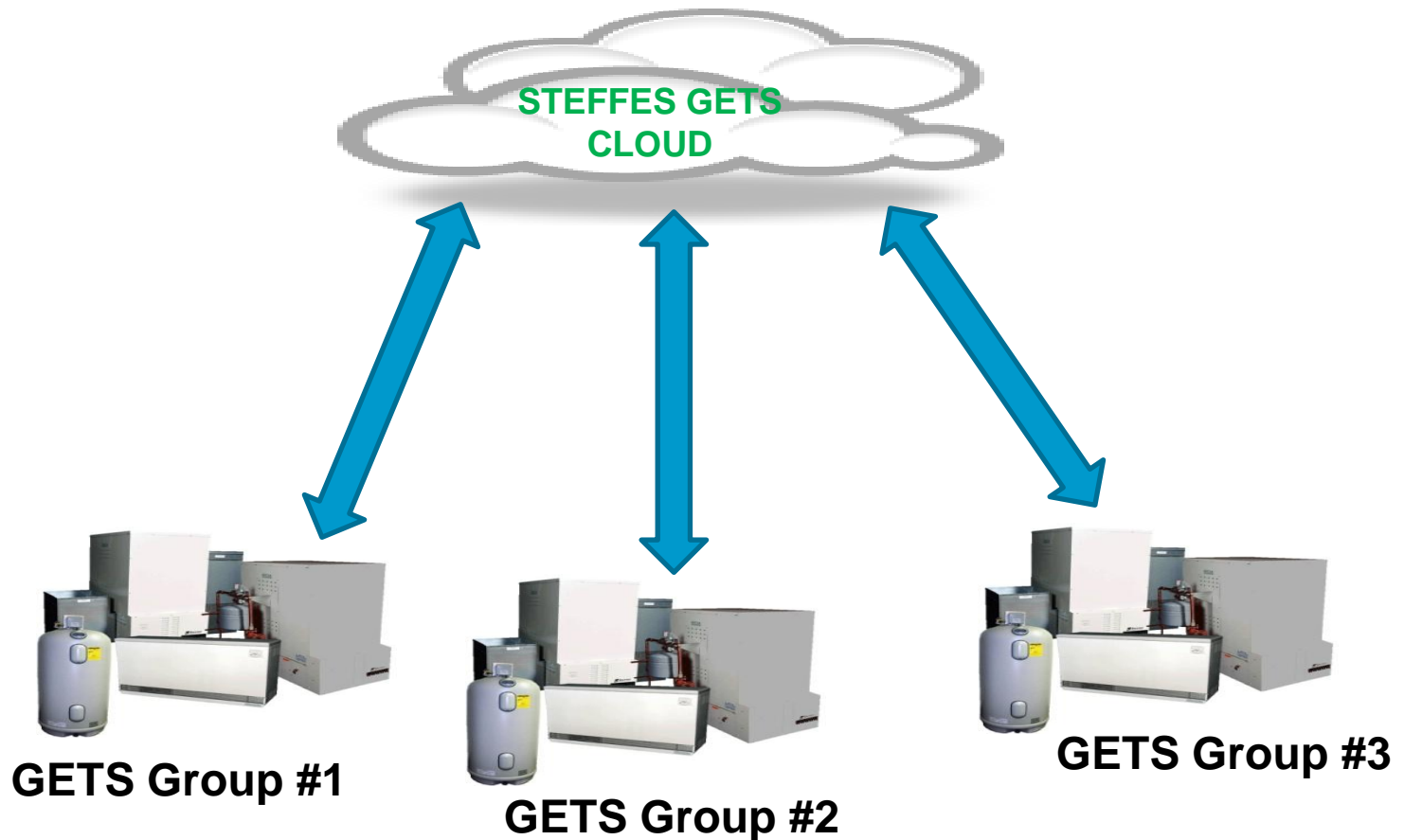


STEFFES GETS



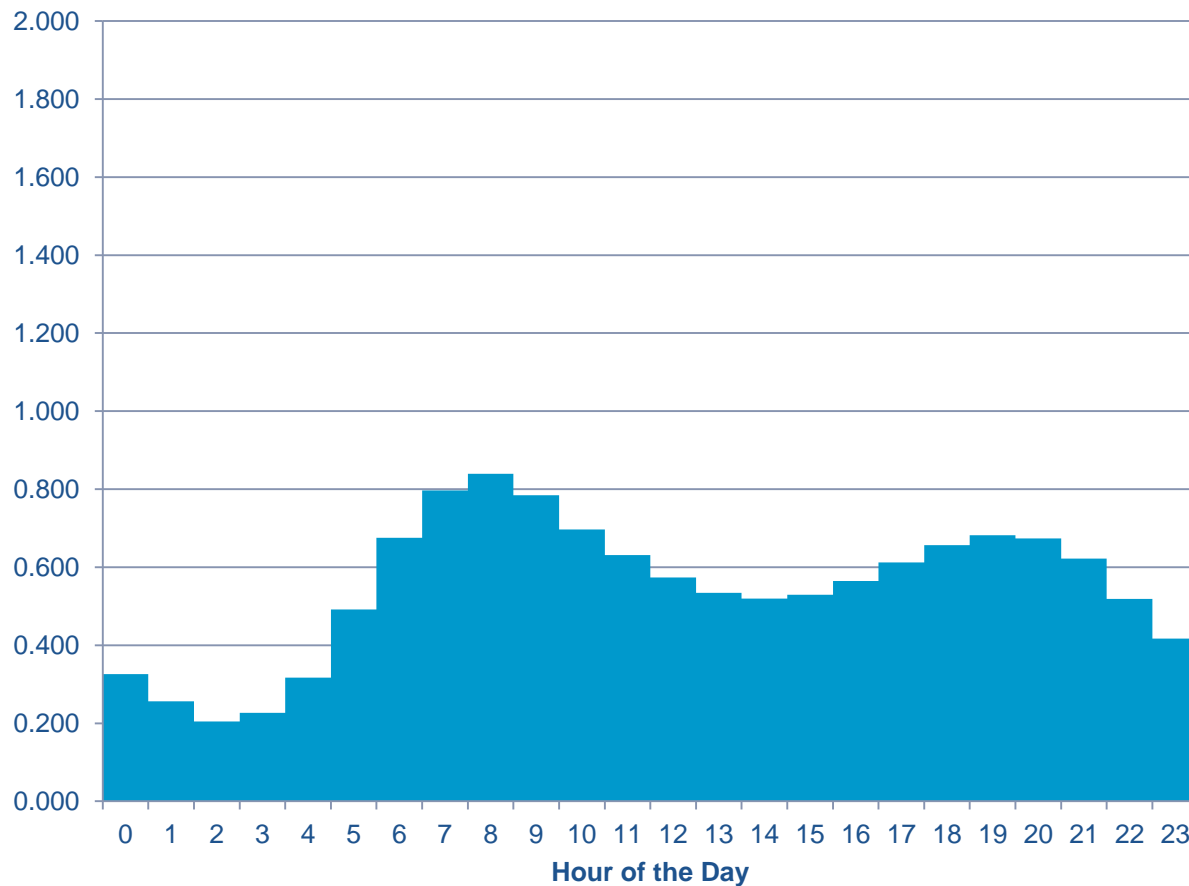
Grouping

Feeder, substation, billing node or other



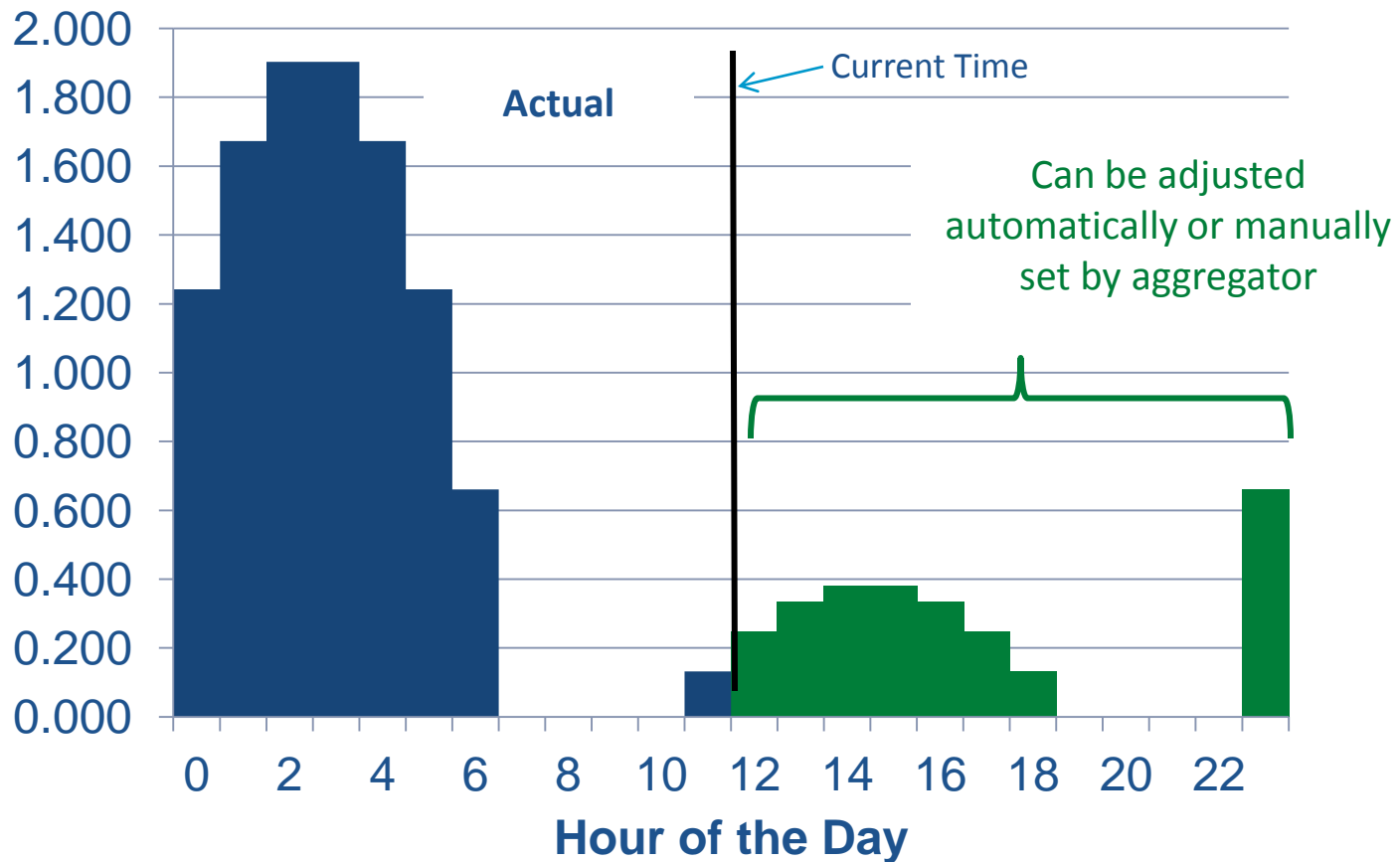
Dynamic Dispatch Step 1

Day-Ahead Aggregated Energy Delivery Forecast

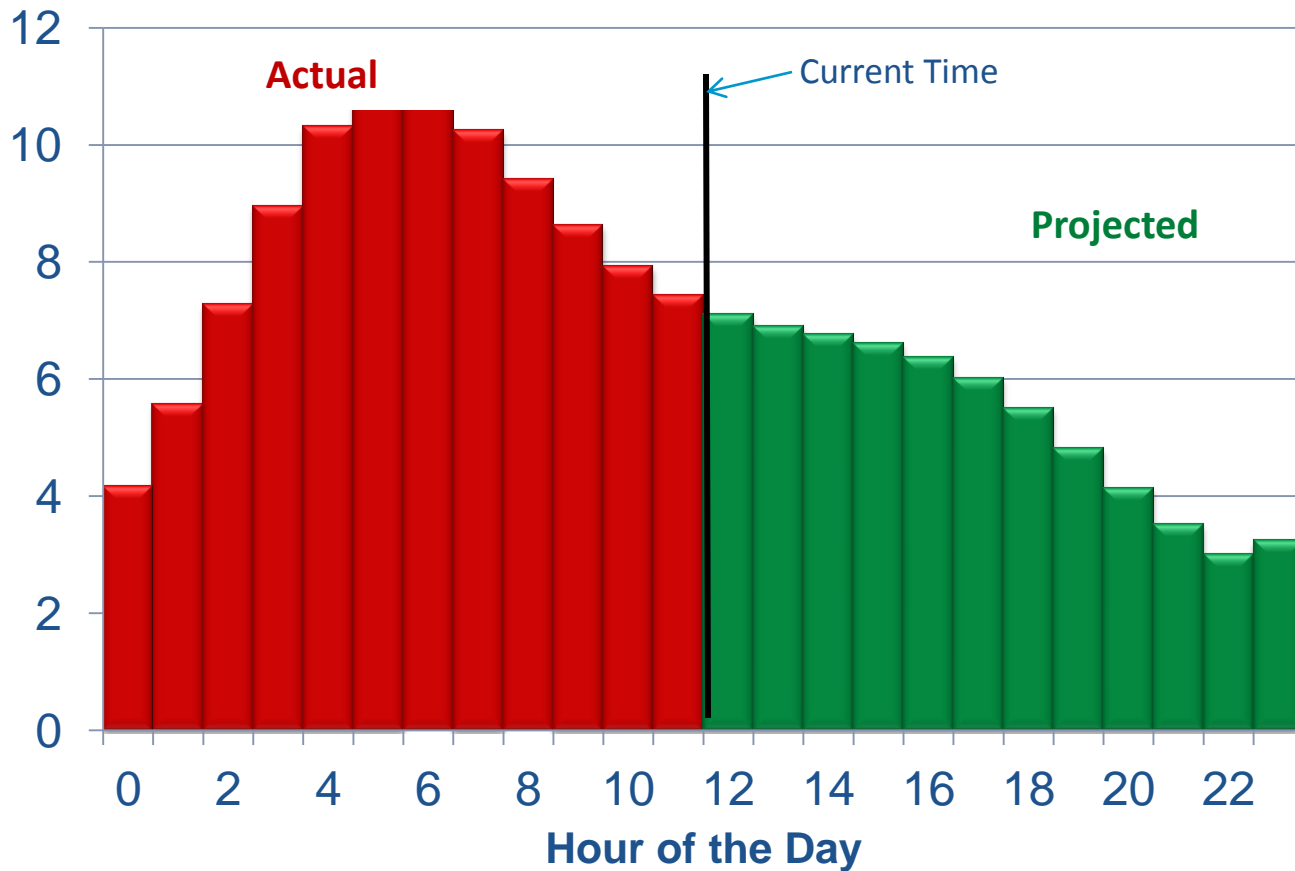


Dynamic Dispatch Step 2

Target Day-Ahead Aggregated Charging Schedule



Projected Day-Ahead Aggregated Charge Level



Dynamic Dispatch Step 4

Unit Energy Proportioning (selective charging)



High Usage

VS



Low Usage

Seamlessly assign preferential load levels to end points with lower reserve capacities



End Point Overrides

Automatic and manual overrides based on local conditions, including:

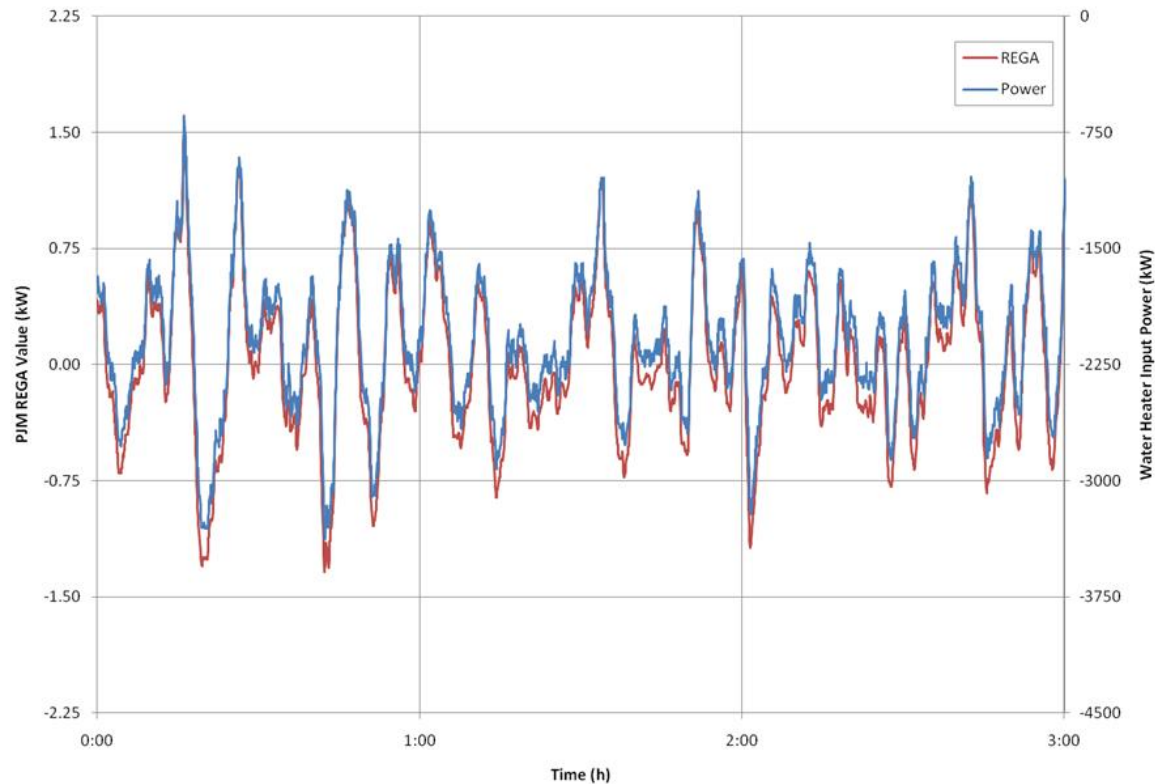
- *GridGuard* – end points continuously monitor local frequency to override central control if required by local grid conditions
- *Black Start* – end points delay and ramp to desired load in the event of lost power
- *Manual Override (optional)* – customers may temporarily override end point operation
- *Comfort Assurance (optional)* – end points may automatically override central commands if the storage temperature goes below the specified threshold without inconveniencing customers
- *Lost Communication* – end points can optimize behavior based on the forecast and local conditions if communication is lost



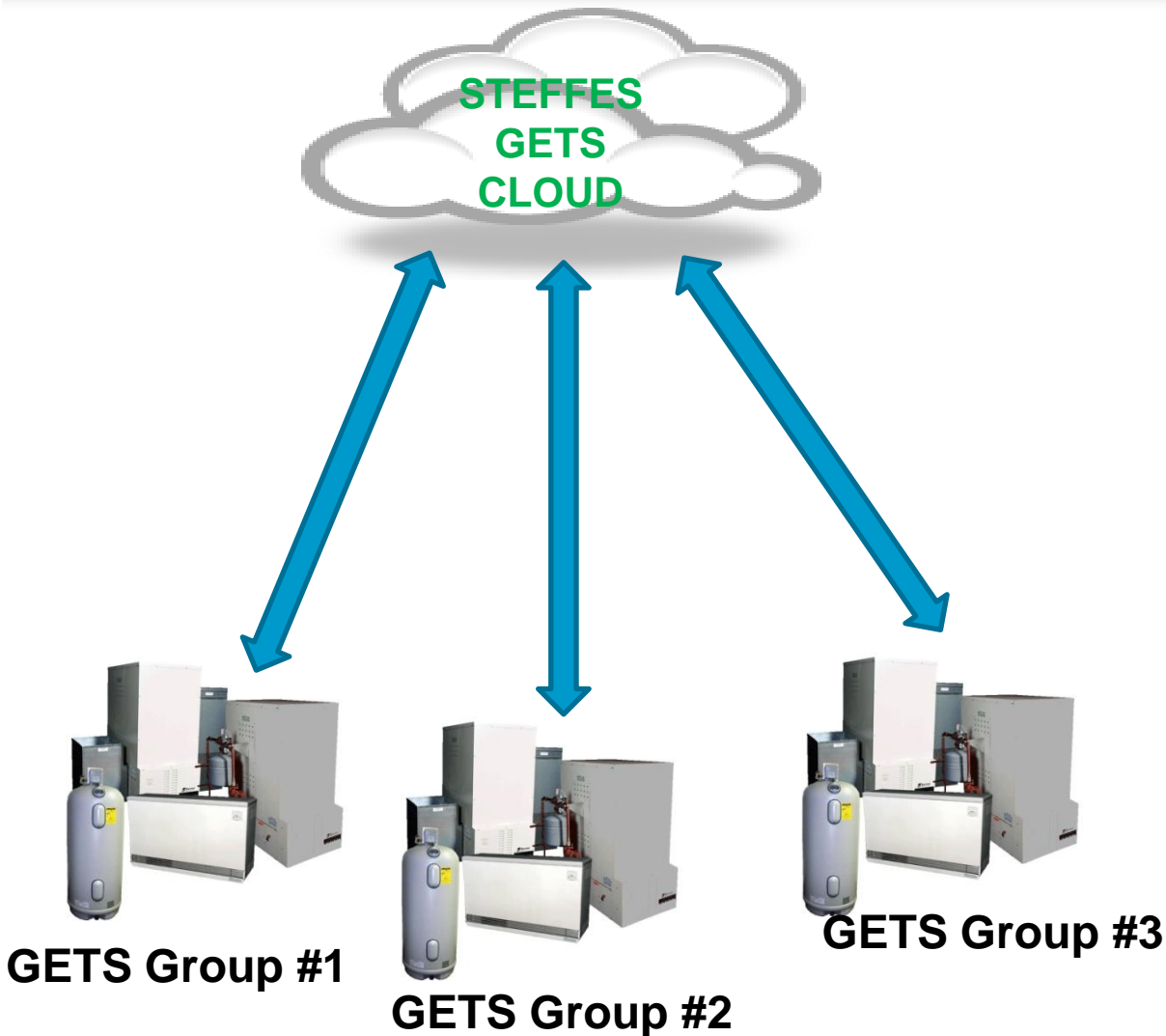
Dynamic Dispatch Step 5

Alter GETS Charge Rate in Real Time

Water Heater REGA Signal Following



Measurement and Verification



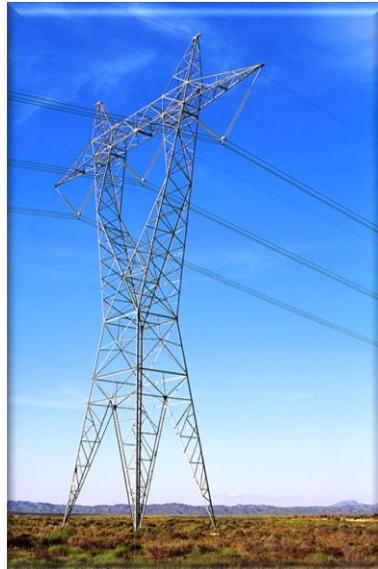
- Power Measurement – Revenue Grade Accuracy
- Real-time performance feedback
- Performance archiving and retrieval



Grid-interactive ETS (GETS)

Provides

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



Benefits for

- Environment
- Consumers
- Conservation
- Efficiency
- The Grid



Successful ETS Programs

Win – Win – Win

G&T, Cooperative, Member



Successful ETS Programs

- ◆ **G&T**
 - ◆ **Gives Strategic Direction**
 - ◆ **Ensure Continuity**
- ◆ **Distribution Coop Understands Benefits**
- ◆ **Electricity Price is BTU competitive**



AI's Blog

Steffes Blog - Windows Internet Explorer

http://www.steffes.com/_blog/Off-Peak_Electric_Heat_Blog

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Off-Peak Electric Heat Blog

Renewable Integration with Low-Cost Storage

Lisa Myran - Monday, April 11, 2011

Recently Paul Steffes did a webinar presentation on the benefits of Steffes space and water heating with smart controls. You can view this 10 minute presentation [here](#).

His main points are that with smart controls, Electric Thermal Storage (ETS) can adjust to renewable or grid signals by:

- Adjusting storage temperatures up and down
- Adjusting kW input
- While providing comfort assurance to the home owner

Recent Posts

- [Renewable Integration with Low-Cost Storage](#)
- [Wind Assisted Heating](#)
- [Remote Room Temperature Set Back](#)
- [Which ETS system is most appropriate for your new home?](#)
- [Standard Electric Heaters that promise BIG SAVINGS – Buyer beware...](#)
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Questions?



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