

STEFFES

Energy Storage Systems

with Precise Visibility, Controllability & Verification

MARC
MAY 2014

GRID-INTERACTIVE ELECTRIC THERMAL STORAGE

*Cost-Effective
Scalable Energy Storage
Delivering Space & Water Heat*



ADVANCED DEMAND RESPONSE
Renewable Integration
Fast Regulation
Smart Thermal Energy "Batteries"

Why Energy Storage ??

- **IEEE ***
 - ***Without good options for storing excess power, any extra supply is essentially lost***
 - ***Excessive amounts of renewable wind and solar are already going to waste***

* Dave Levitan IEEE May 29, 2012

What type of Energy Storage ??

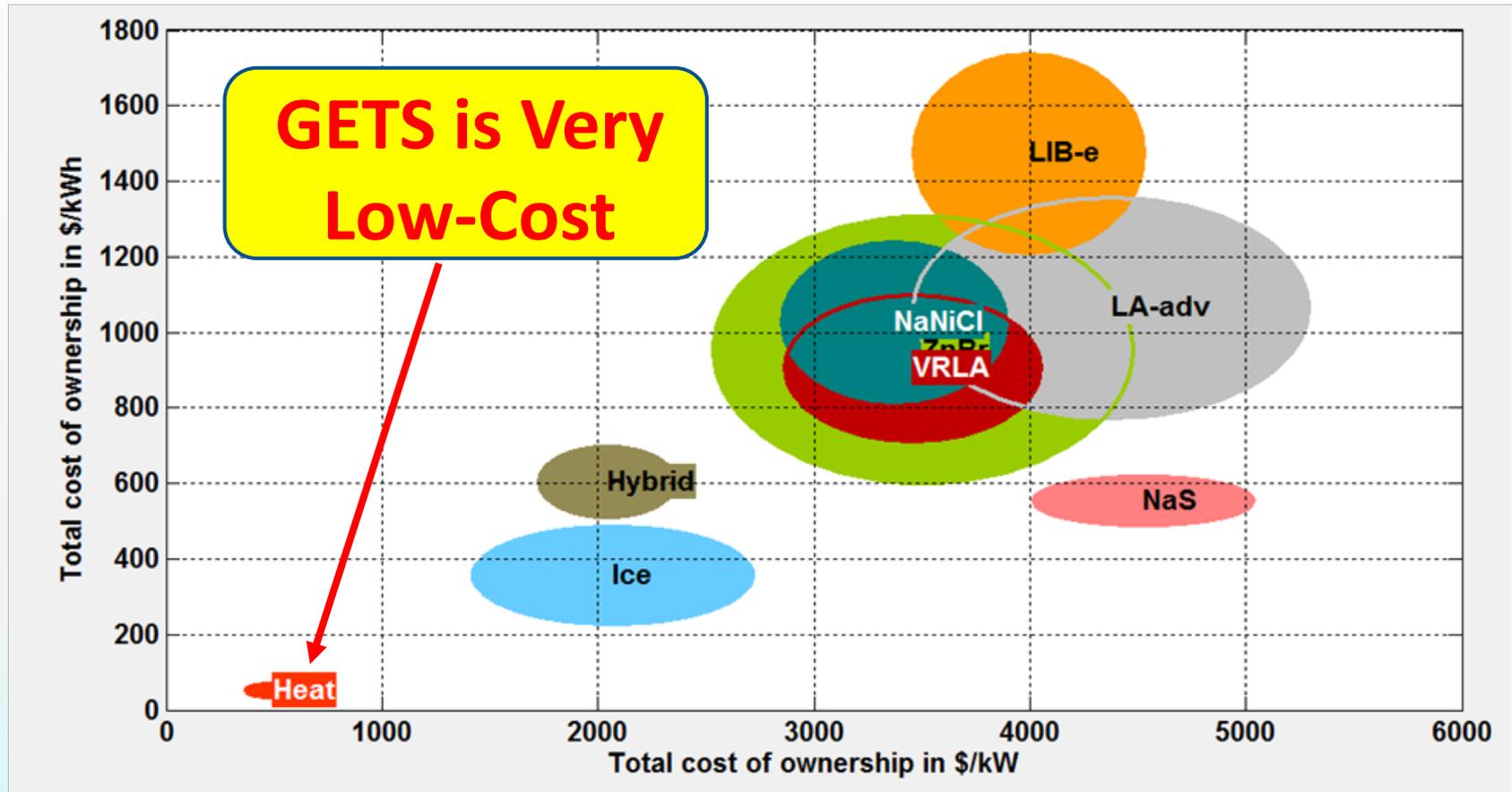
- ***Terry Boston ****
 - ***Energy storage technology is the silver bullet that helps resolve the variability in power demand***
 - ***... take technology as old as electric water heaters, add communications and real-time rates and pricing and turn it into a grid storage device***

* Terry Boston CEO of PJM – the World's Largest Wholesale Electricity Market

Water Heaters for Energy Storage

- ***Terry Boston – CEO - PJM***
 - ***“Electric water heater storage is the most cost-effective form of energy storage available ... “***

High and Low Cost Energy Storage



TOTAL COST OF ENERGY STORAGE - SANDIA

Energy Storage – Who Benefits ??

- ***Everyone***
 - ***Cost-effective Grid Stabilizer***
 - ***Utilities can sell kWh that is increasingly being curtailed***
 - ***Consumer – reduced energy costs***
 - ***Society – more renewable energy and less emissions***

Energy Storage – Bottom Line

- ***Savings across the electrical production and distribution system***
 - ***Builds efficiencies***
 - ***Better utilizes renewable energy***
 - ***Lowers costs***
 - ***Saves ratepayers money***
 - ***Lowers rates***

Steffes – GETS - Background

- *2 dozen water and space heater trials*
- *The largest GETS deployment to date - New Brunswick - Eastern Canada*
 - *5 MW, 40 MW·h*
- *Largest aggregated group to-date*
 - *4 MW, 32 MW·h*
- *GETS integration with a real load control signal from 2 Virtual Power Plants*

Steffes – GETS - Strategy

- ***Strategies***
 - ***optimize load based on wind and solar production***
 - ***integrate power and energy forecasts – modify in real-time via local control actions***
- ***Distribute energy***
 - ***according to grid need***
 - ***while serving end-use customer hot water needs***

Steffes – GETS – Size and Speed

- *Large-scale deployments of grid-interactive water heaters follow load targets precisely*
 - *Typically within $\pm 3\%$ of requested power*
- *Response is very fast*
 - *Response latency is < 10 seconds*
- *Provide grid stability via frequency regulation*

Steffes – GETS - Verification

- ***Enhanced load Measurement and Verification (M&V)***
 - ***Increased accuracy of power capacity calculations***
 - ***Added an instantaneous power parameter for logging***
 - ***Enhanced detection of differences between requested versus actual loads***

Grid-interactive Electric Thermal Storage (GETS)

Distributive Energy Storage that Dynamically couples consumer usage to real-time grid needs

Space Heating



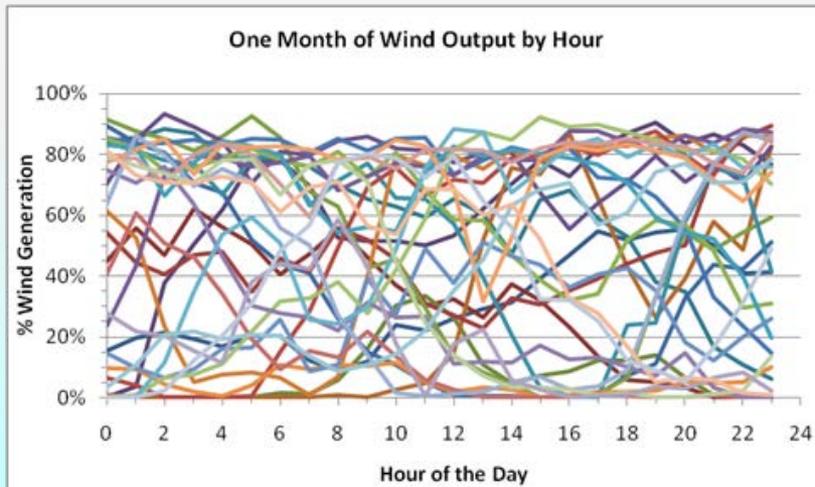
Water Heating



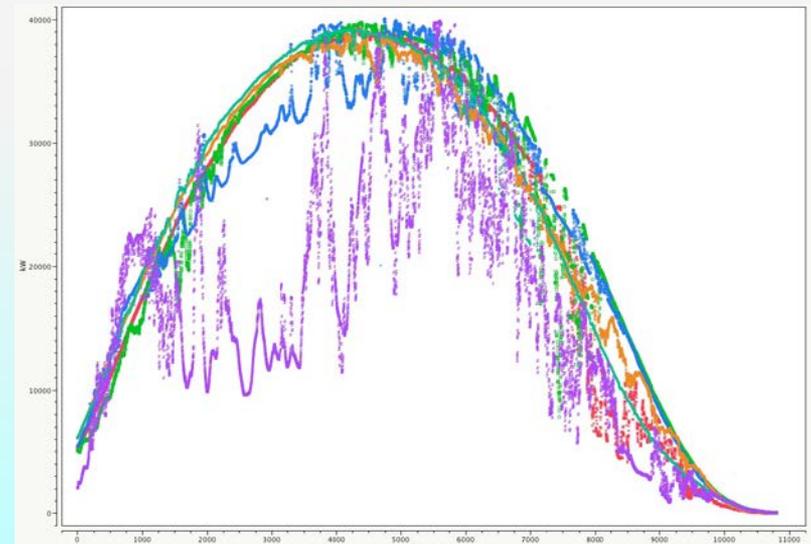
Renewable Generation Variation



Hourly Wind Output (30-days)

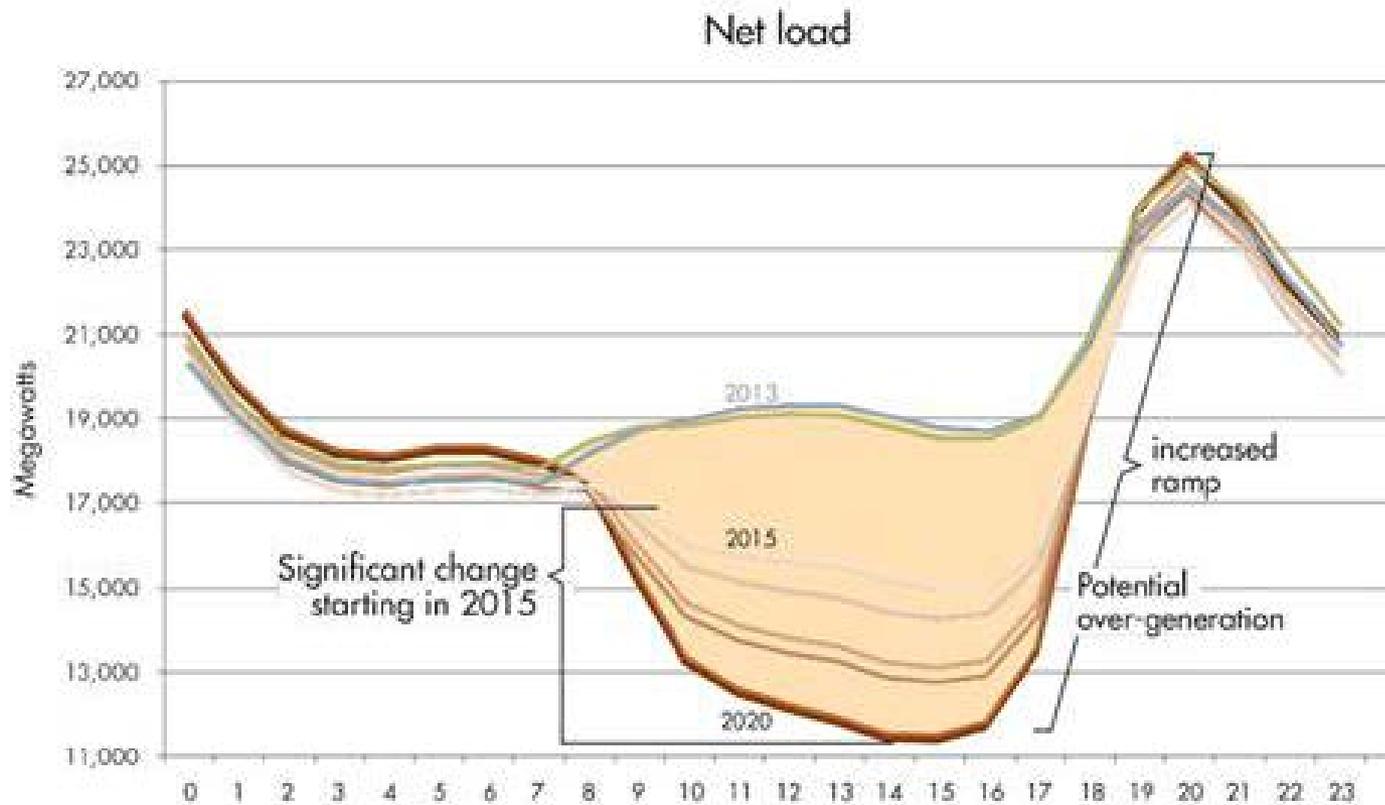


Solar Daily Output



Impact of DG to Net Load

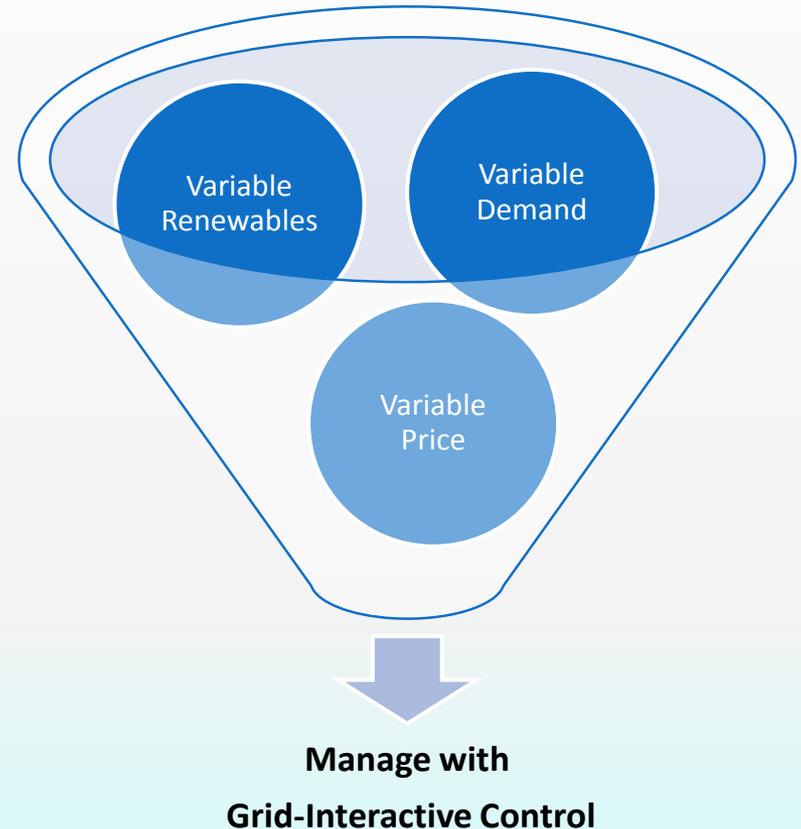
Growing need for flexibility starting 2015



It's a Balancing Act...

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

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



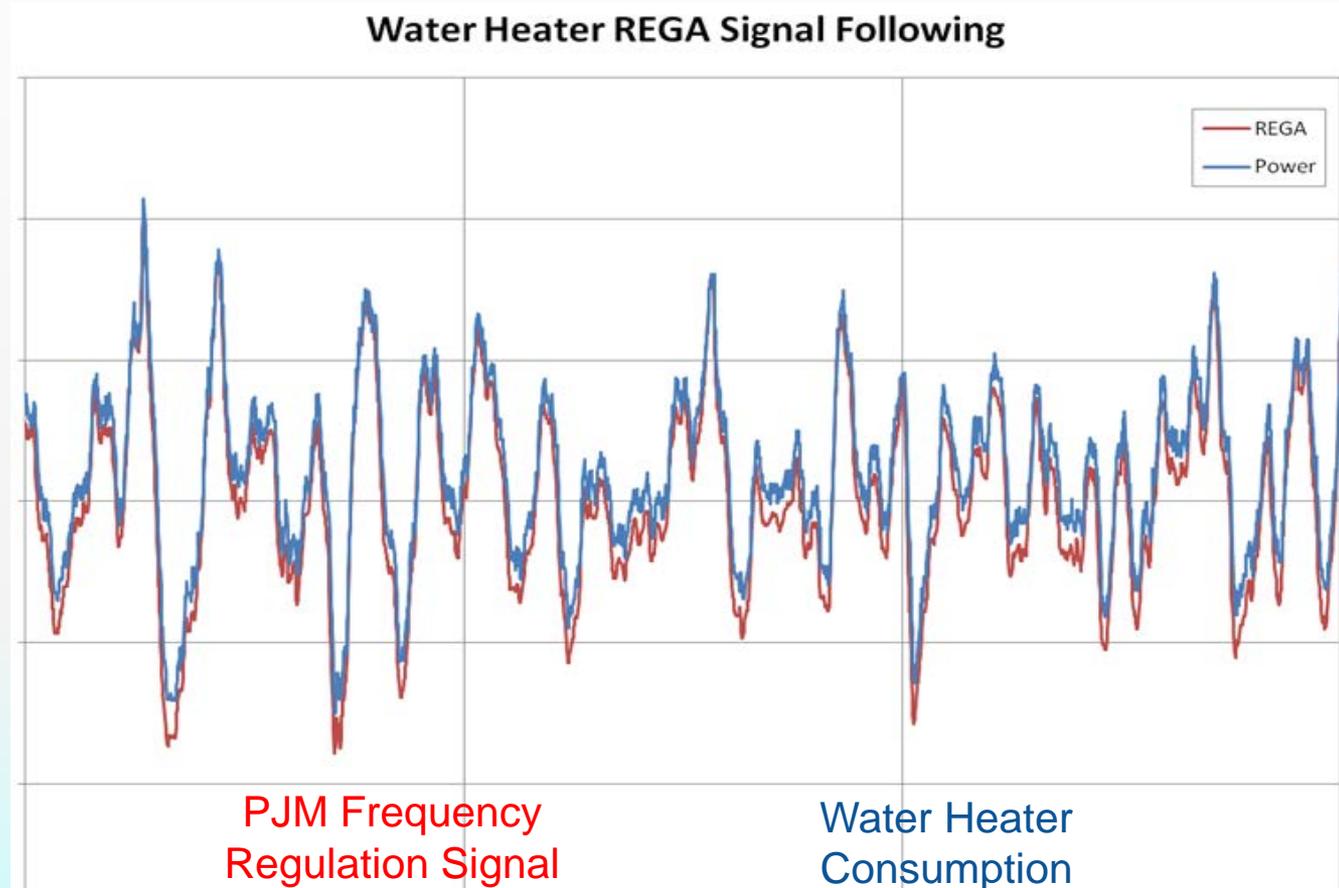
ETS Space and water heaters are grid interactive solutions

Fast Regulation & Renewable Integration

Speed Matters...

A very fast grid-interactive water heater

Not only can the water heater keep up – it does so very accurately



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

Grid-Interactive Space & Water Heaters Are...

“THERMAL BATTERIES”



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

Grid-Interactive ETS (GETS)

Provides “Double Green” benefits:



Economic

And



Environmental



Steffes – GETS - Contacts

- **Paul Steffes**

- CEO, Steffes Corporation
- psteffes@steffes.com
- 701-483-5400

- **Kelly Murphy**

- Smart Grid Business Development Specialist, Steffes Corporation
 - kmurphy@steffes.com
 - 701-690-7428
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