

NESEA 2014



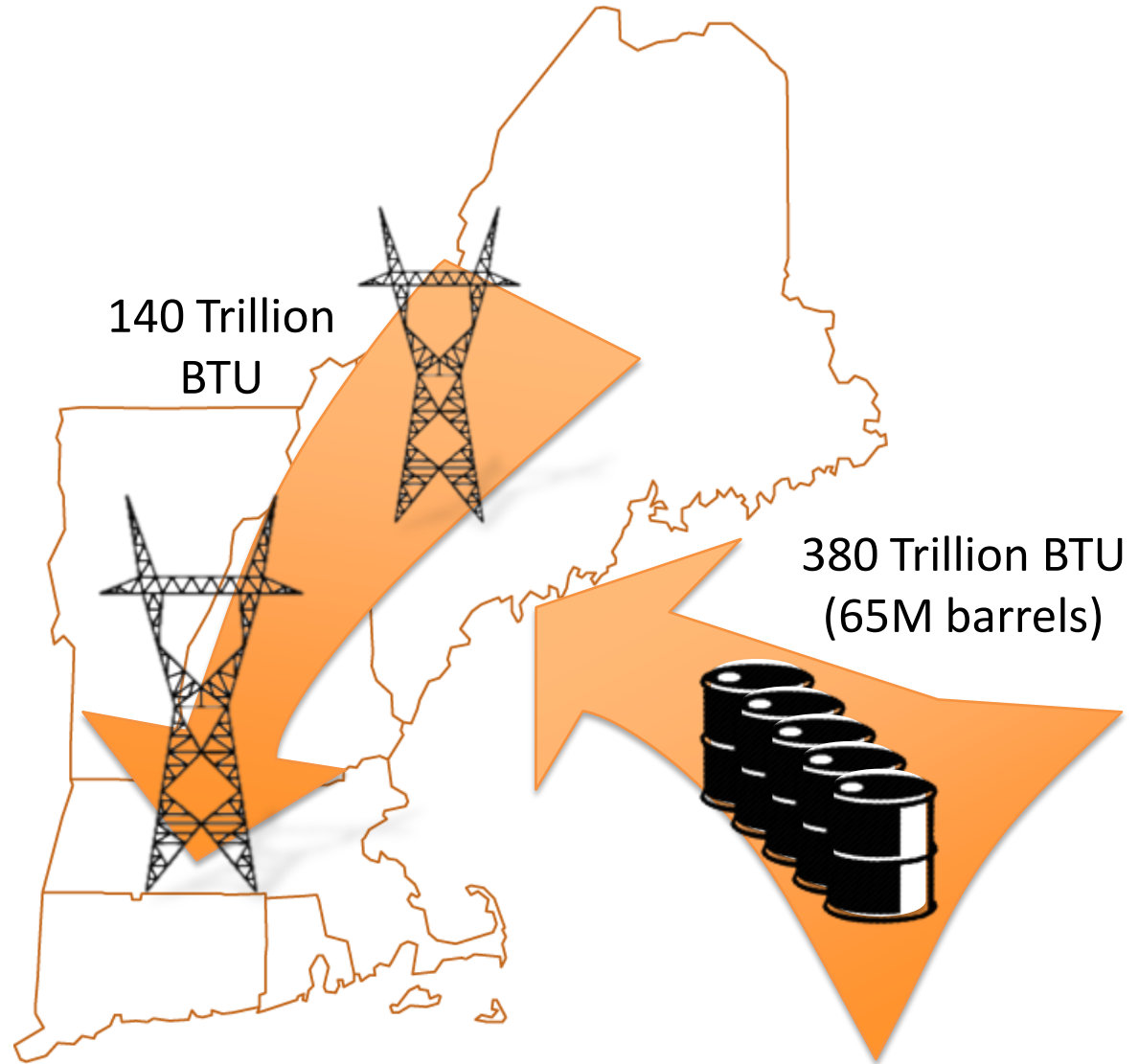
Grid-Scale
Thermal
Storage

George Baker
CEO, VCharge

New England's Paradox

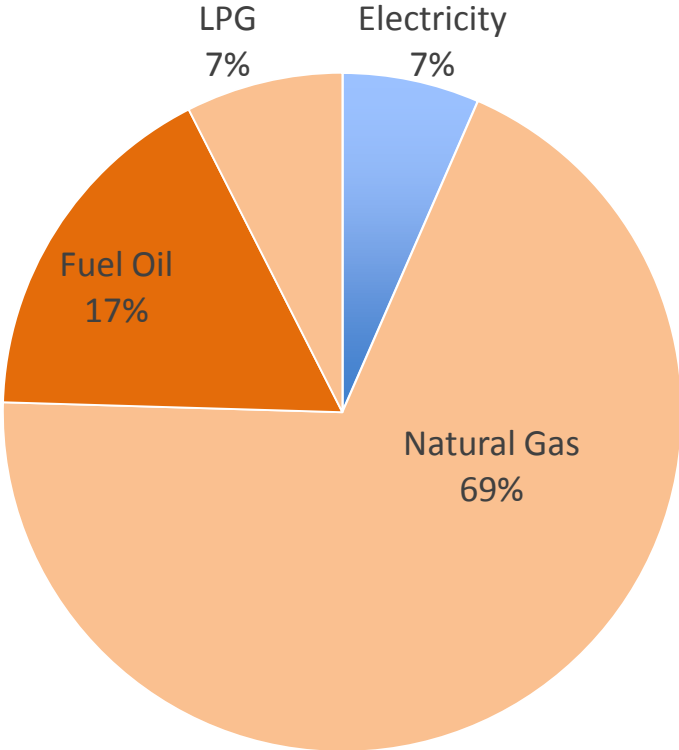
Northern New England imports oil -- for transportation and heating -- while simultaneously exporting electricity from nuclear, hydro and wind generation

And dispatching off wind!

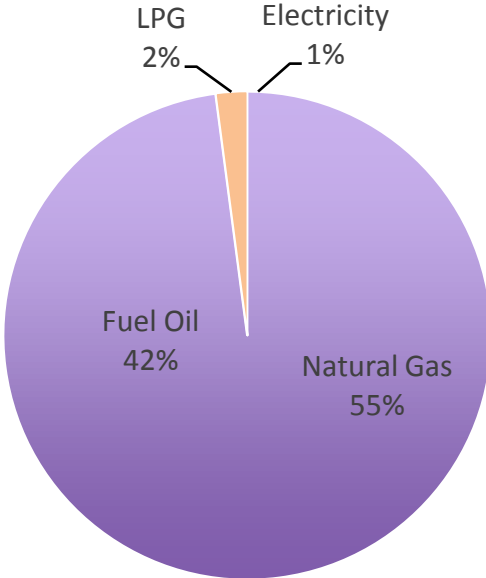


Heating Is Carbon-Intensive

US: 1,260 Terawatt-hours



Northeast: 425 Terawatt-hours



To achieve climate and renewable energy goals, we must:

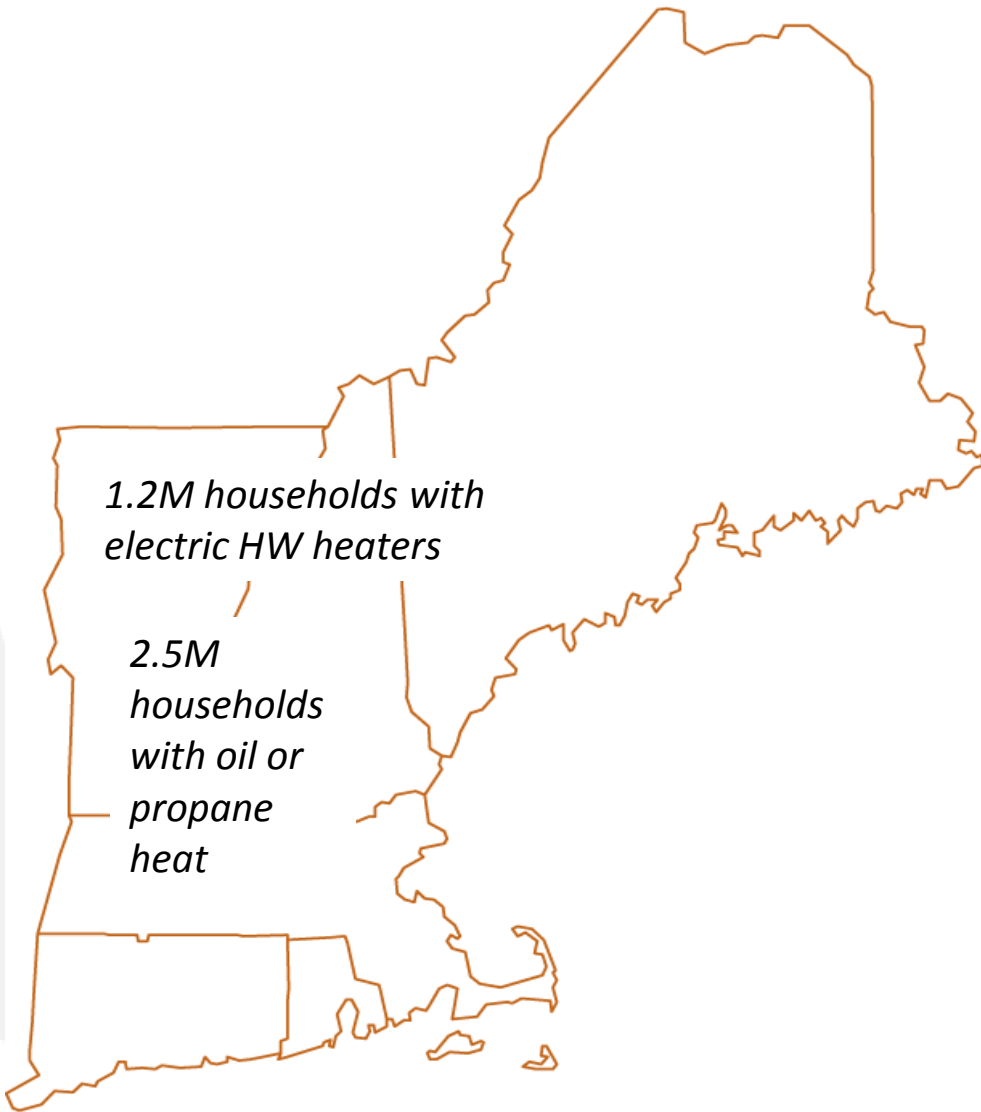
- 1) Decarbonize space and water heating**
- 2) Use smart storage technology**
- 3) Provide real time load balancing**



Can You Find The 10MWh Battery?



Thermal Load in New England



- Electric hot water heaters represent 6 Gigawatts of Transactive Load, and 3 GWh of storage, on the New England electric grid
- Thermal Storage Heat, replacing oil, represents 50 Gigawatts of load, and a whopping 300 GWh of storage

Oil Heat Replacement System: ETS



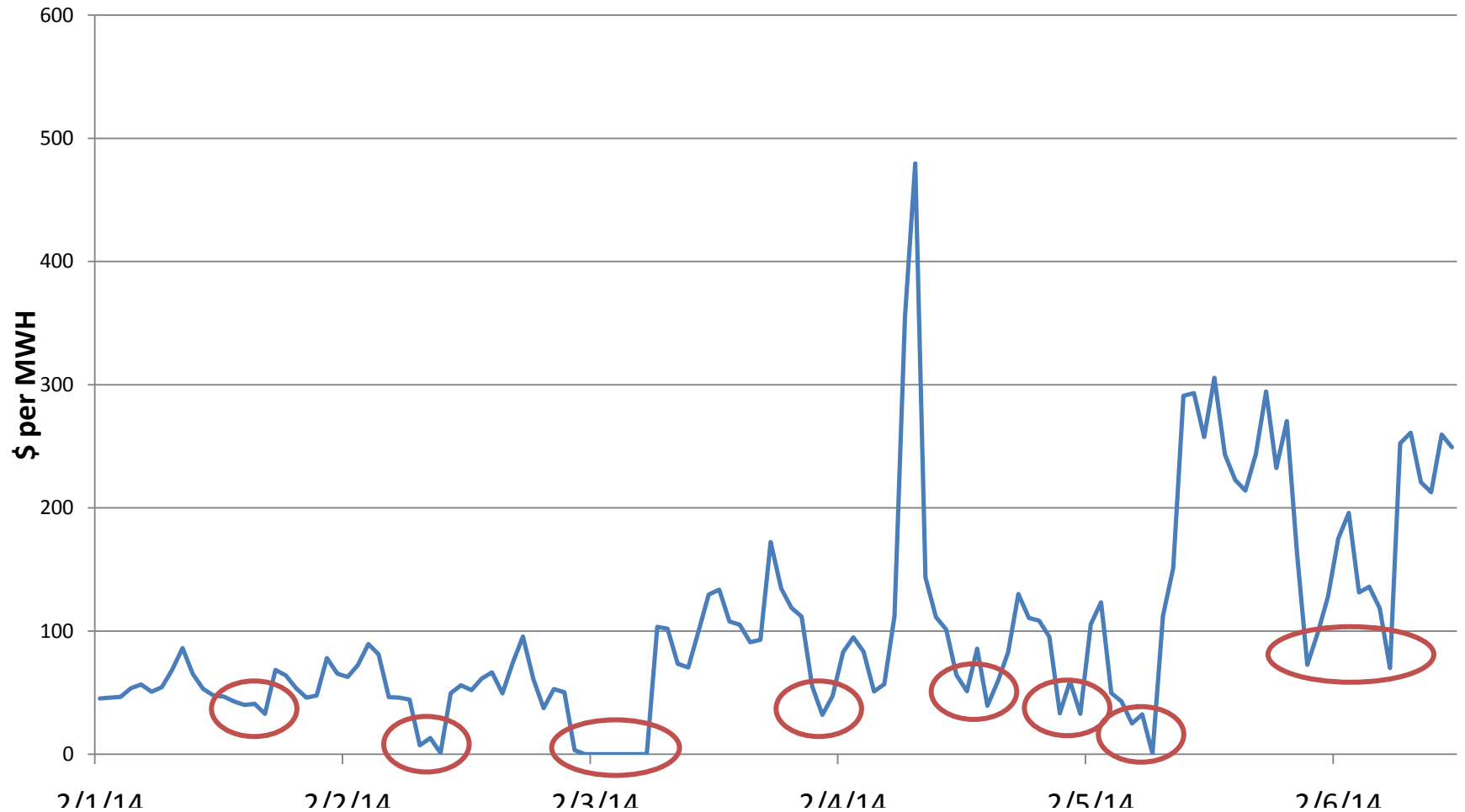
***Thermal Storage--
the Most Cost
Effective Battery
Available***

***Storage equivalent
of 300 standard car
batteries, 20 Chevy
Volts, or 2 Tesla
Model S's***

Randy Male
N. Yarmouth, ME
600 gallons, 25kW

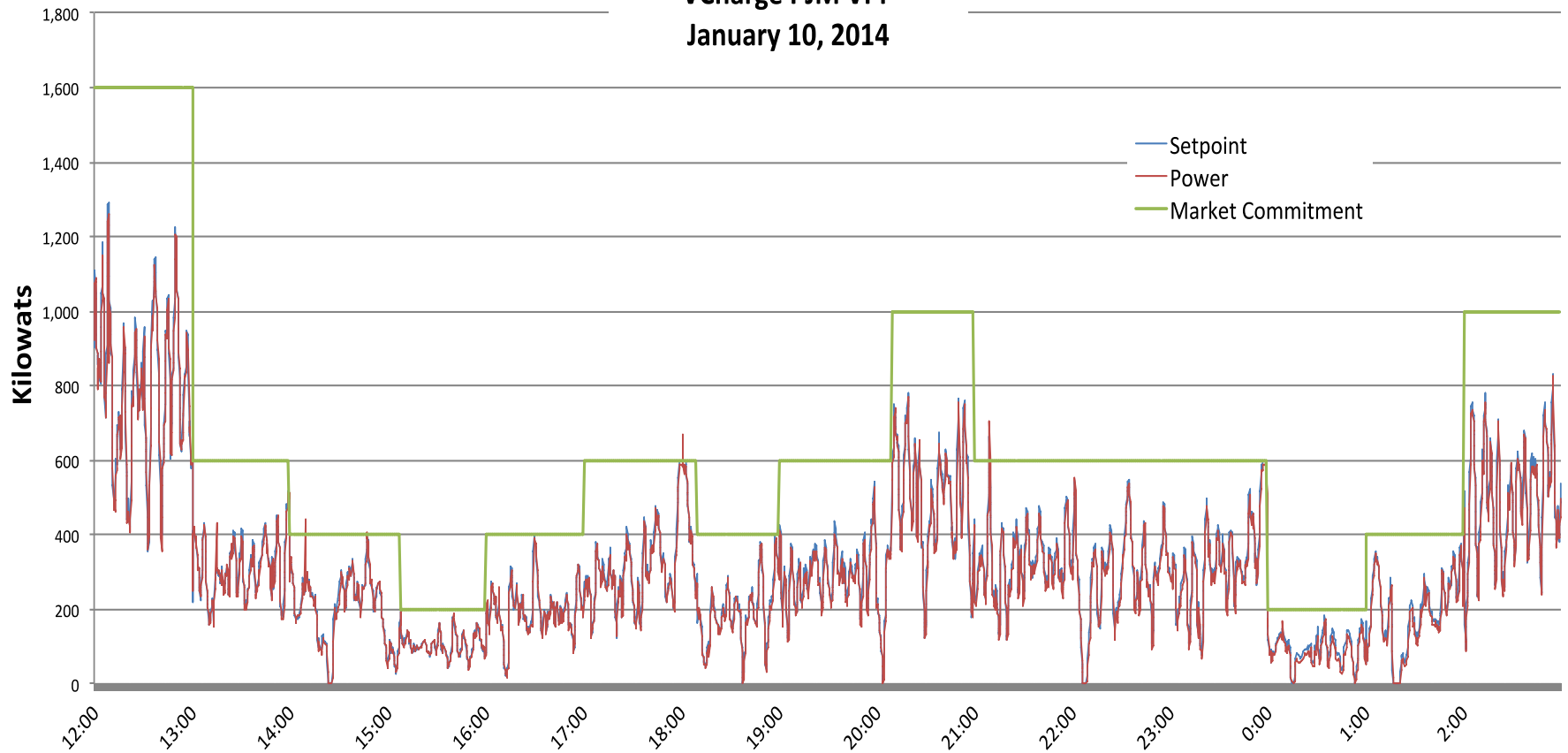
Energy Arbitrage: Buying Electricity Cheap

Wholesale Electricity Price in New England



Fast Frequency Regulation

Frequency Regulation
VCharge PJM VPP
January 10, 2014



Meets Multiple Market Needs



Consumers:

*Good, clean,
affordable heat*



Grid Operators:

*Leveled demand;
Responsive load*



Utilities:

Efficient distribution



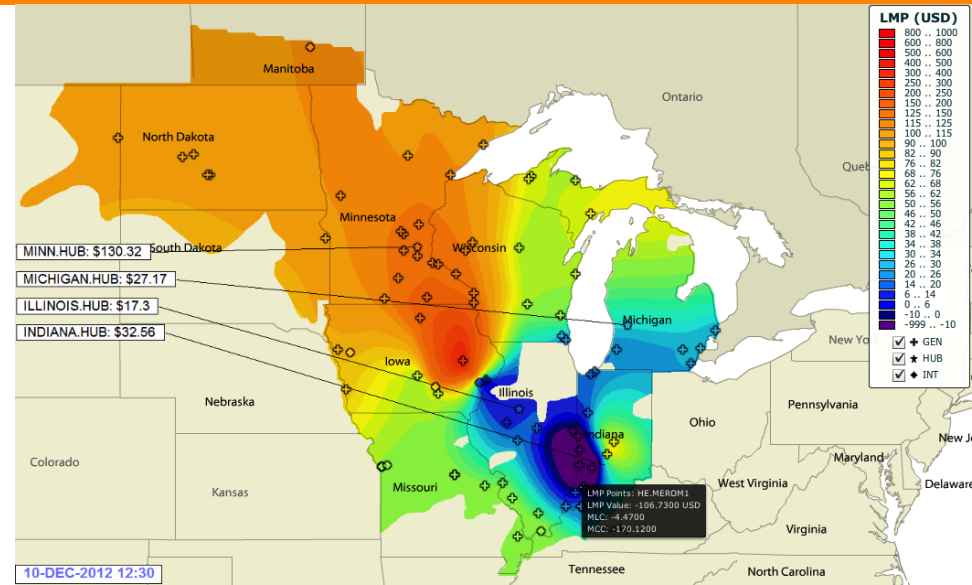
**Renewables
Developers:**

*Reduce curtailment;
Community benefit*

Mitigating Wind Curtailment

- Prices go negative in the Midwest...
- And wind gets dispatched off in New England

“During the height of last month’s heat wave, millions of people in northern New England were urged to conserve energy, and some utilities fired up expensive, dirty sources of power to meet demand. But at the same time, at least two wind farms in Maine and Vermont were ordered to reduce the amount of electricity they provided.”



Wind power systems hit hurdles

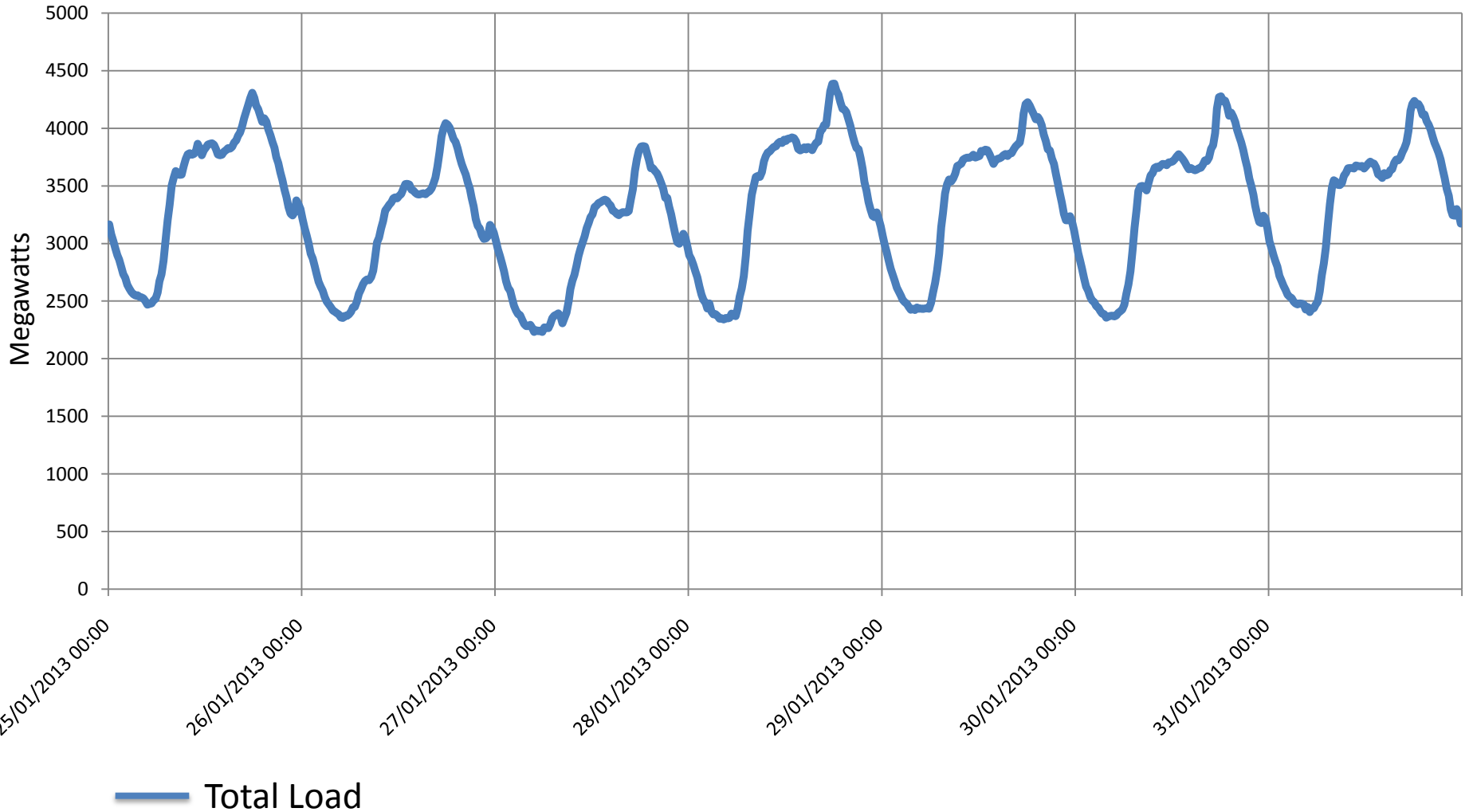
By Wilson Ring and David Sharp | ASSOCIATED PRESS | AUGUST 09, 2013

ARTICLE COMMENTS (1) SUBSCRIBE



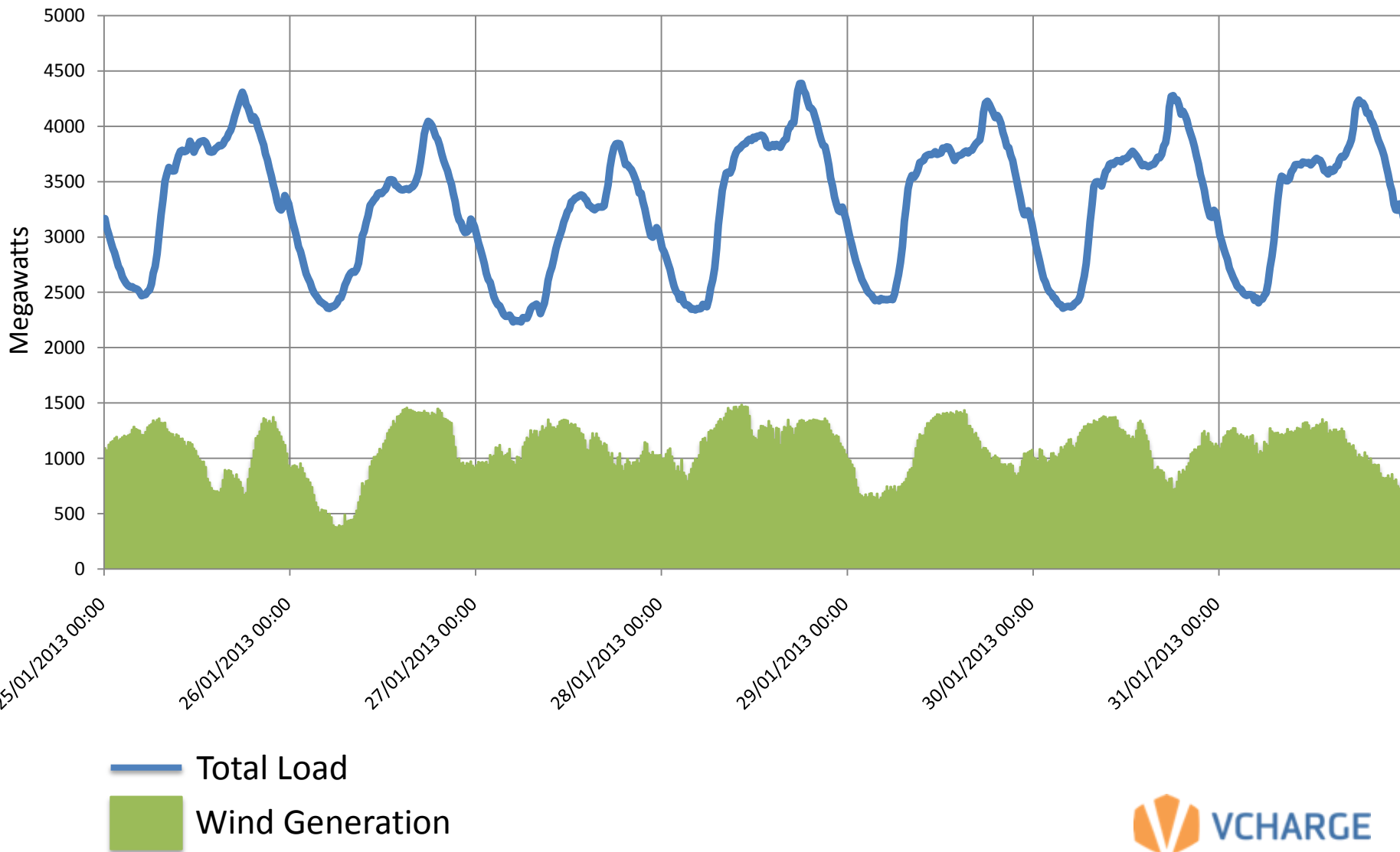
Wind Curtailment in Ireland

EirGrid: Jan 25 – Jan 31, 2013



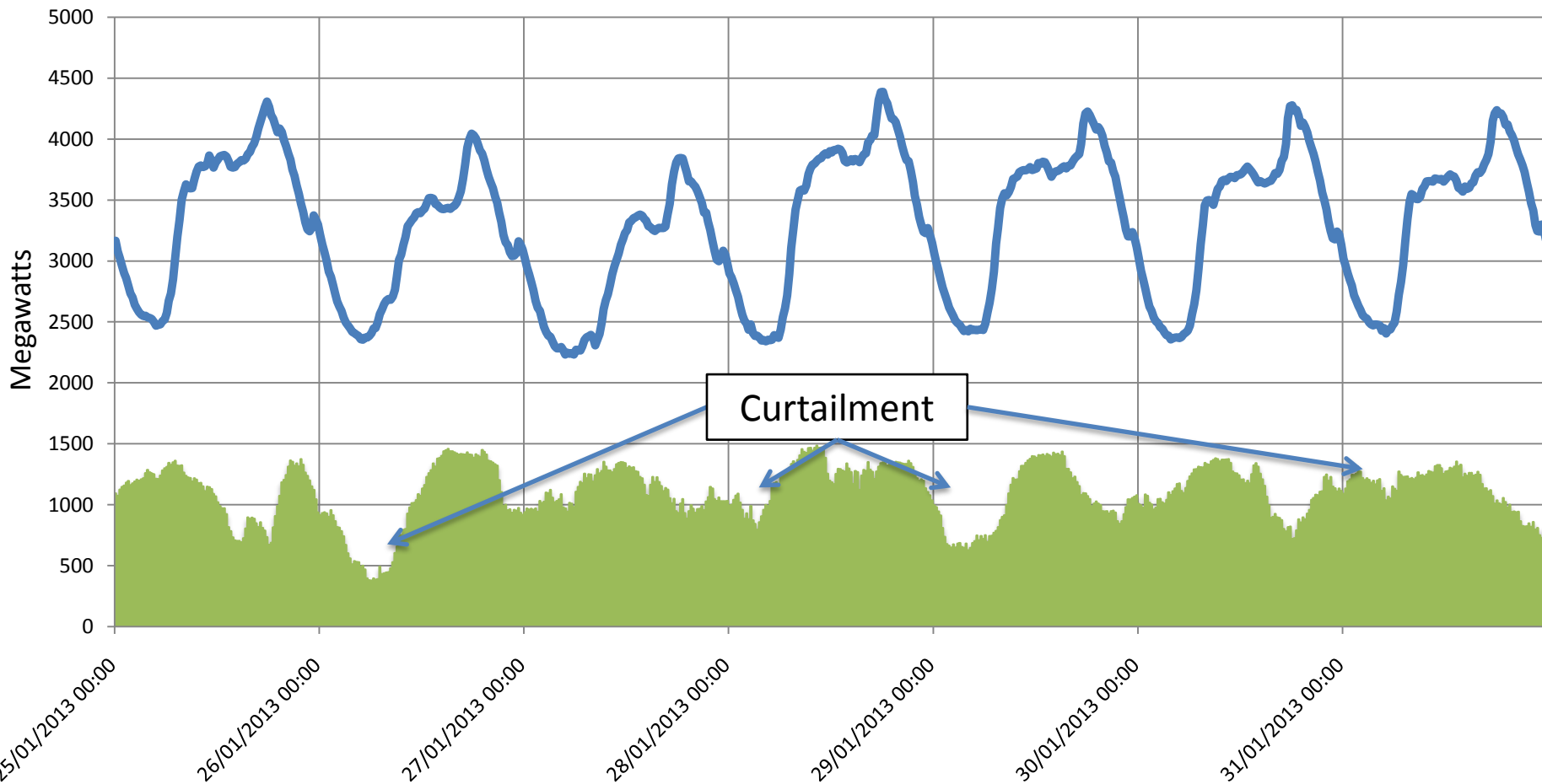
Wind Curtailment in Ireland

EirGrid: Jan 25 – Jan 31, 2013



Wind Curtailment in Ireland

EirGrid: Jan 25 – Jan 31, 2013



— Total Load
■ Wind Generation

Next Steps: Heat Pumps with PCM

- Uses 40% of the energy of resistive electric heat
- Stores the energy as heat in Phase Change modules that have twice the energy density of hot water
- Transactive controls allow the system to run only when energy is cheap, abundant, or low carbon

Carbon Intensity of ISO-NE Generation Mix

Feb 15 - Feb 19, 2014

