

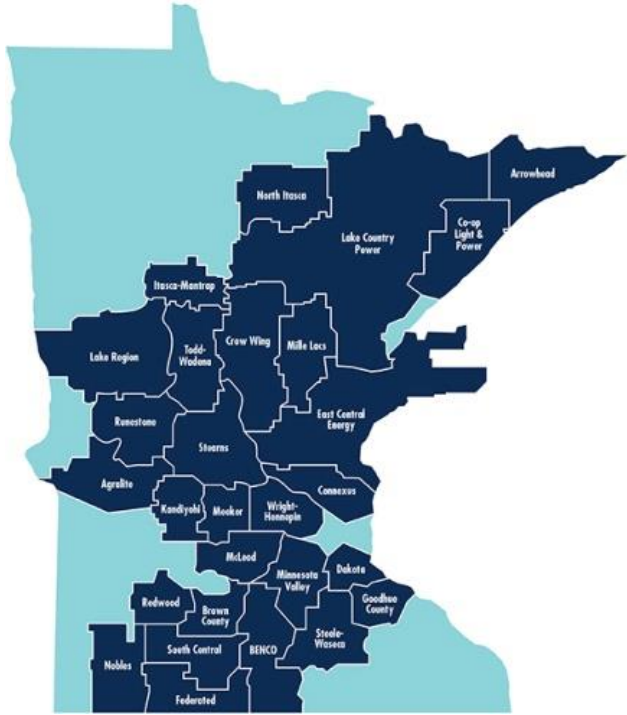
Electric Thermal Storage Water Heating

The Battery in Your Basement

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Great River Energy



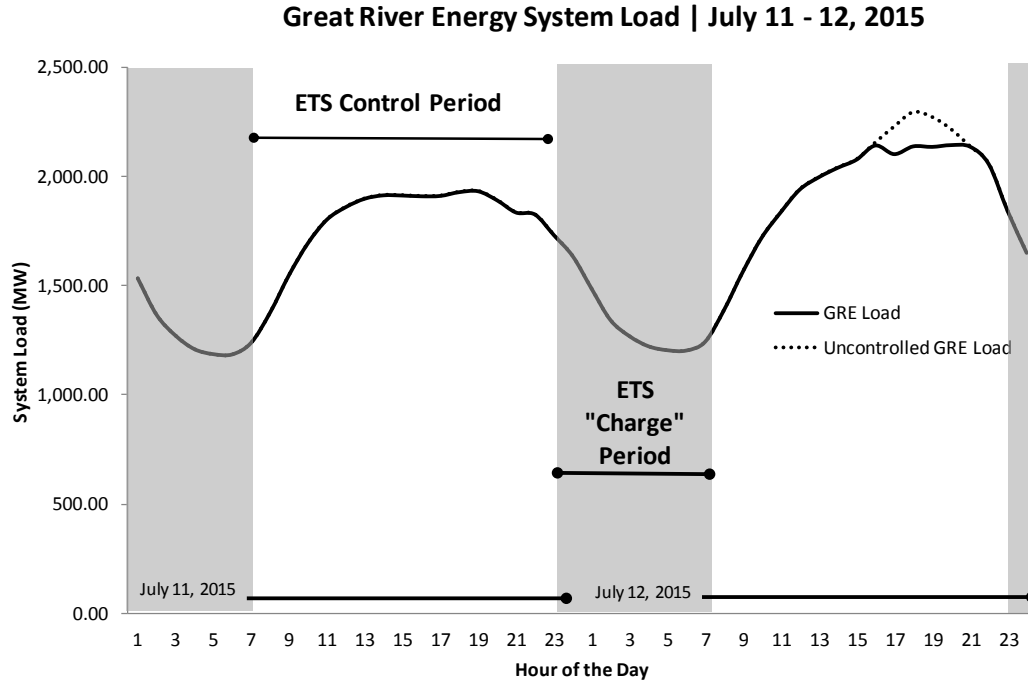
- ▶ Not-for-profit electric cooperative providing wholesale power to 28 distribution cooperatives
- ▶ Our member cooperatives distribute electricity to about 1.7 million people in Minnesota and Wisconsin..

Electric Thermal Storage (ETS) Basics



- ▶ ETS Requires a large capacity water heater, typically 85 to 105 gallons.
- ▶ Heat water between 11 pm and 7 am.
- ▶ Tank temperature can be increased with the use of a mixing valve.
- ▶ GRE controls more than 65,000 ETS water heaters throughout its member service areas.

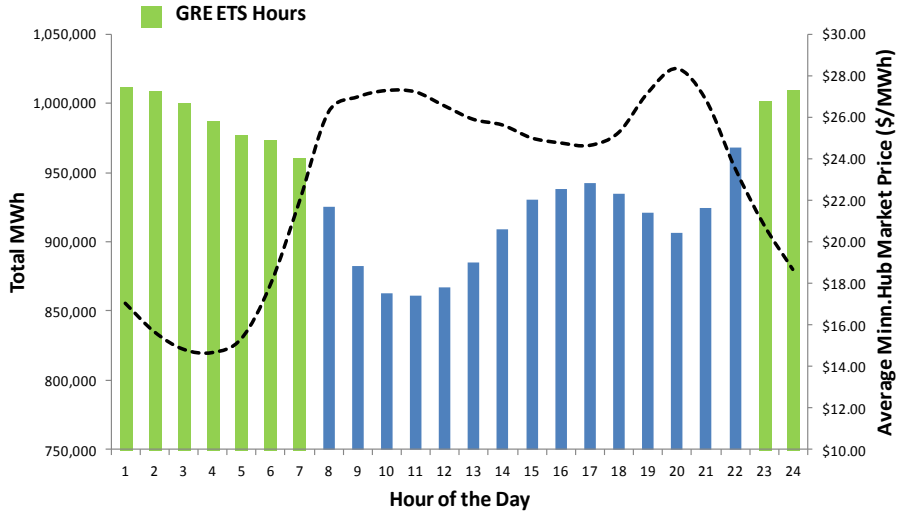
Hot Water “Chemical” Battery



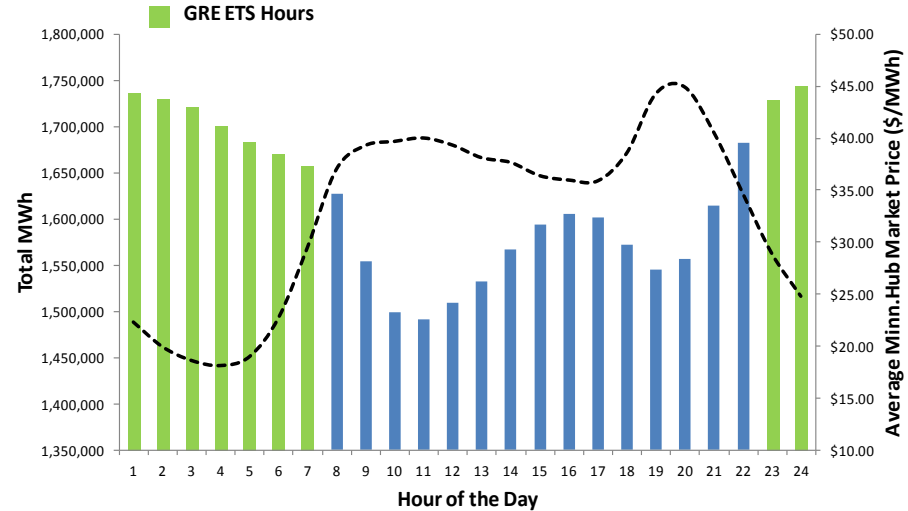
- 26 kWh nightly storage capacity
- Average of 13 kWh
- Over 300 GWh /year!

Delivering Value and Utilizing Wind

MISO Wind Energy | Total MWh by Hour 2015 YTD



MISO Wind Energy | Total MWh by Hour 2014

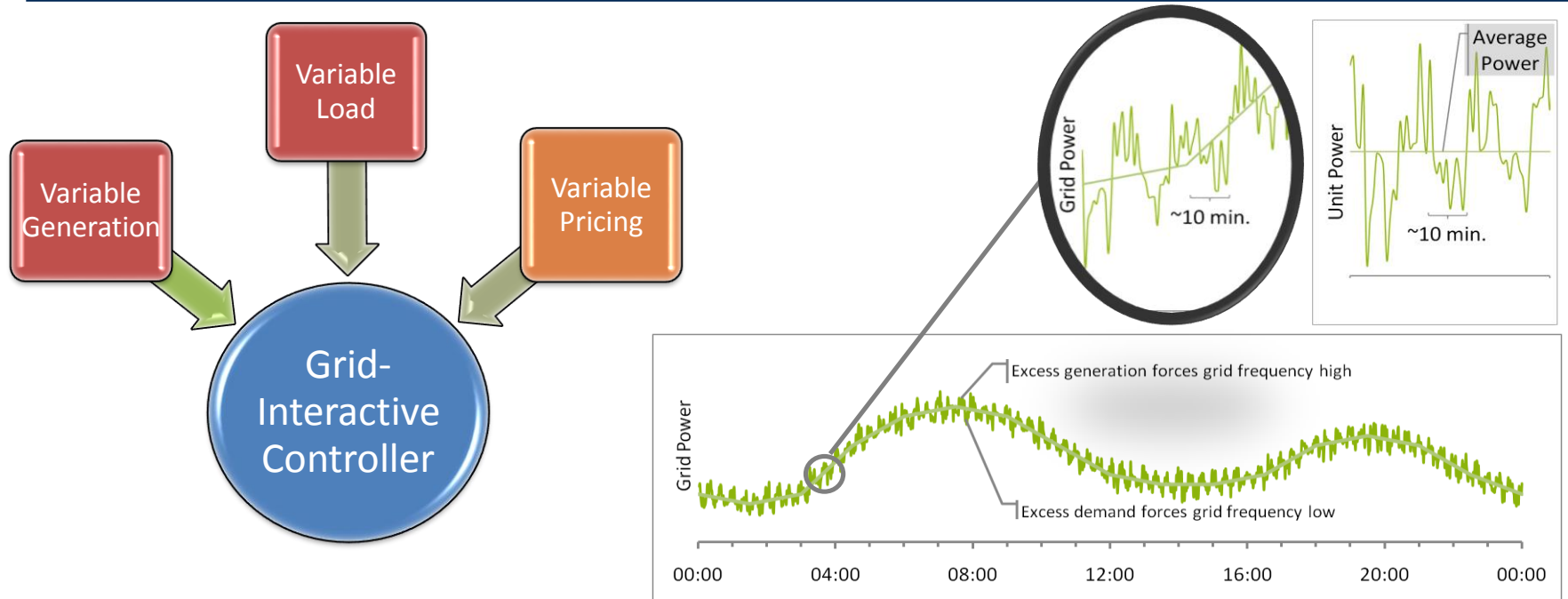


Adding Grid-Interaction to ETS

- ▶ Adjusts the temperature in response to price or availability of renewable energy
- ▶ Varies the wattage to water heater electric elements
- ▶ Assures comfort is never compromised – *home always has hot water*



Balancing the needs of the grid



Low Cost Storage | \$110 - \$300 per kW (<http://www.esource.com/ES-WP-18/GIWHs>)

Wholesale Cost of an 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** Typically there is no additional transmission or demand cost during low demand hours when LMP is low
- **Grid-Interactive with Regulation: Consumes energy when LMP is low and provides regulation.** This option also provides a 70% reduction in CO₂ emissions, independent of the renewable integration value.

Note: PJM has a need for about 700MW of up and down regulation.

Thank You!

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