Balancing the Grid through Electrification

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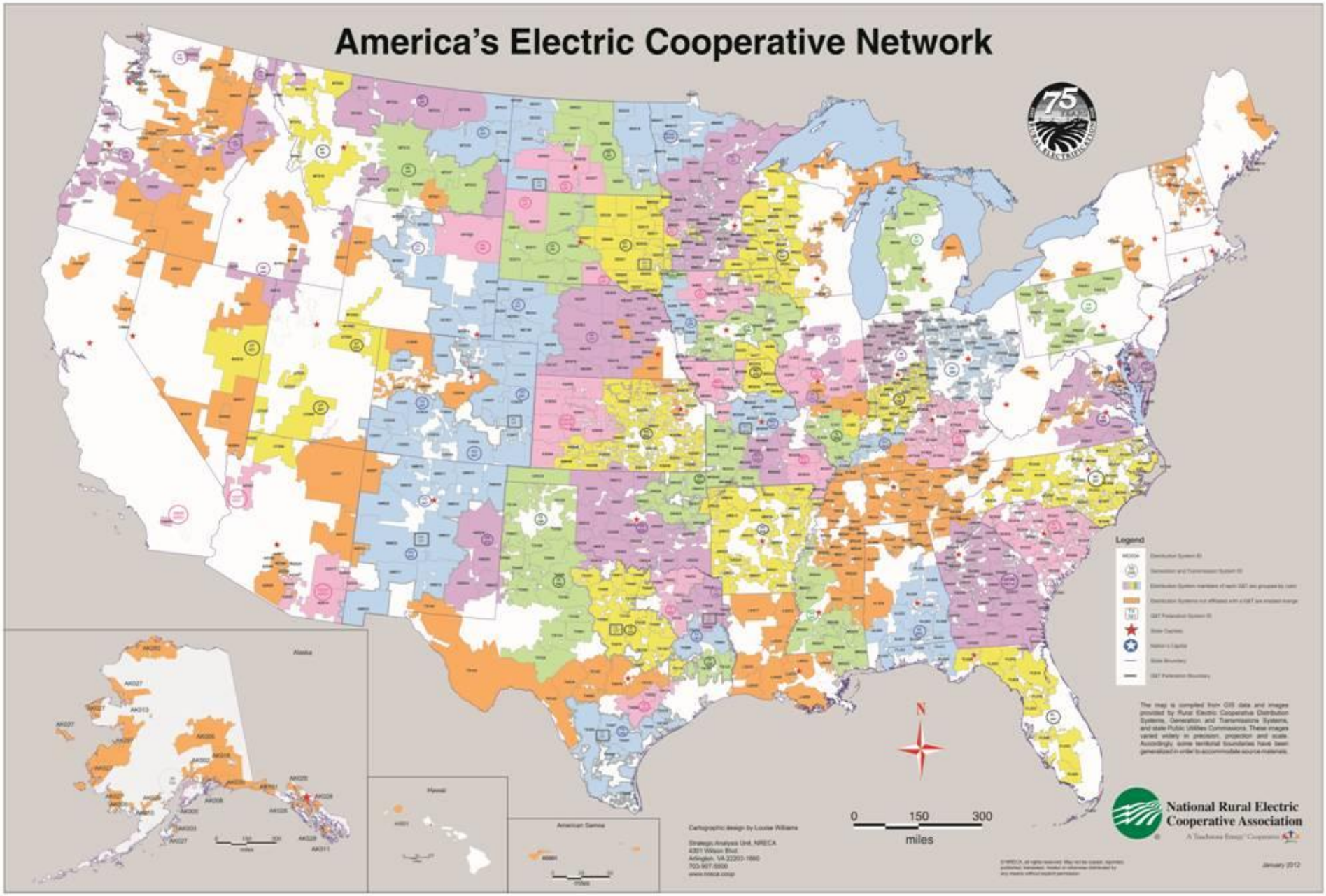
75 Years of Service
NRECA
America's Electric Cooperatives

America's Electric Cooperative Network



Introduction: What is "Beneficial Electrification?"

Beneficial Electrification League:

"The application of electricity to end-uses that would otherwise consume fossil fuels (e.g., natural gas, propane, oil, gasoline) where doing so satisfies at least one of the three following conditions, without adversely affecting the other two:

1) Benefit the environment and reduce greenhouse gas emissions;

2) Save consumers money over time;

3) Foster a more robust and resilient grid."

First Law of Balancing the Grid through Electrification…

CONSUMERS MUST CHOOSE ELECTRIC PRODUCTS!

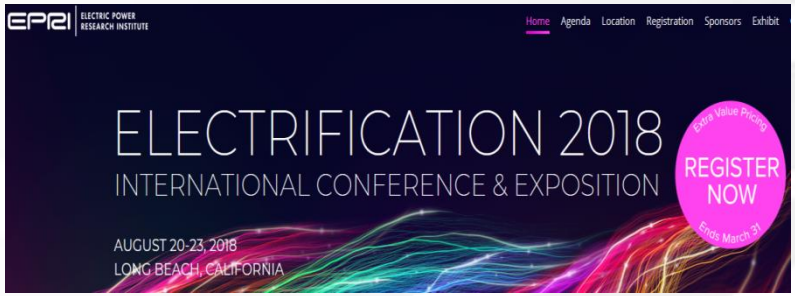
People Are Talking … What is the Message?

Utility DIVE Home Events Library Jobs Viewpoints Topics

FEATURE

Brattle: Wider electrification key to averting both climate change and utility death spiral

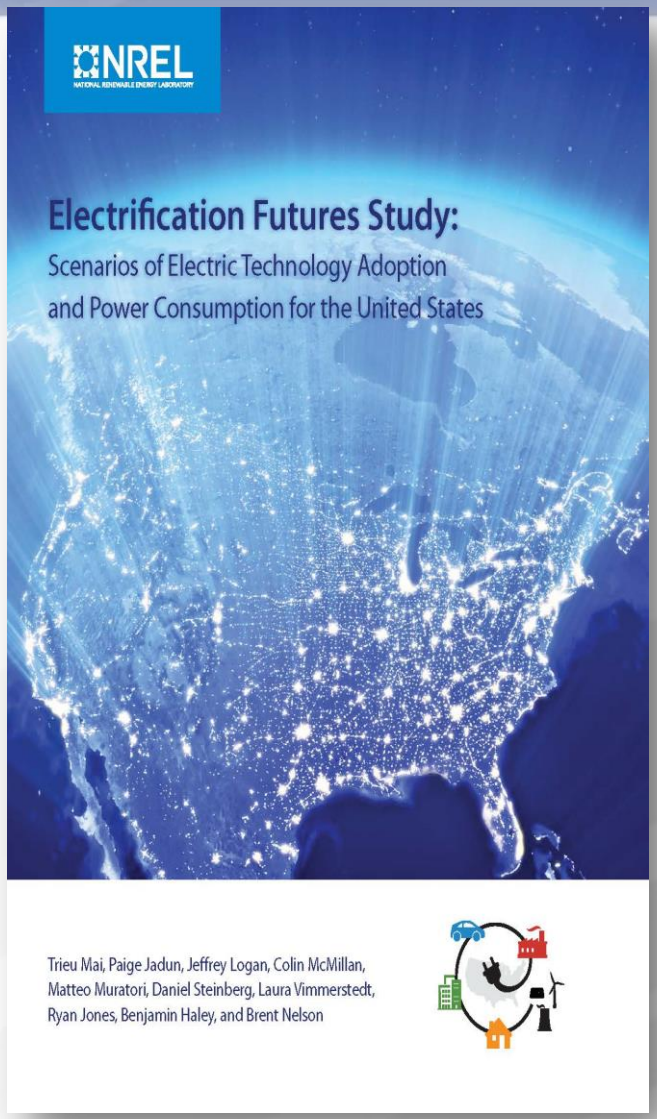
Tapping new power demand from EVs and heating can help the industry thrive as it pushes toward deep decarbonization



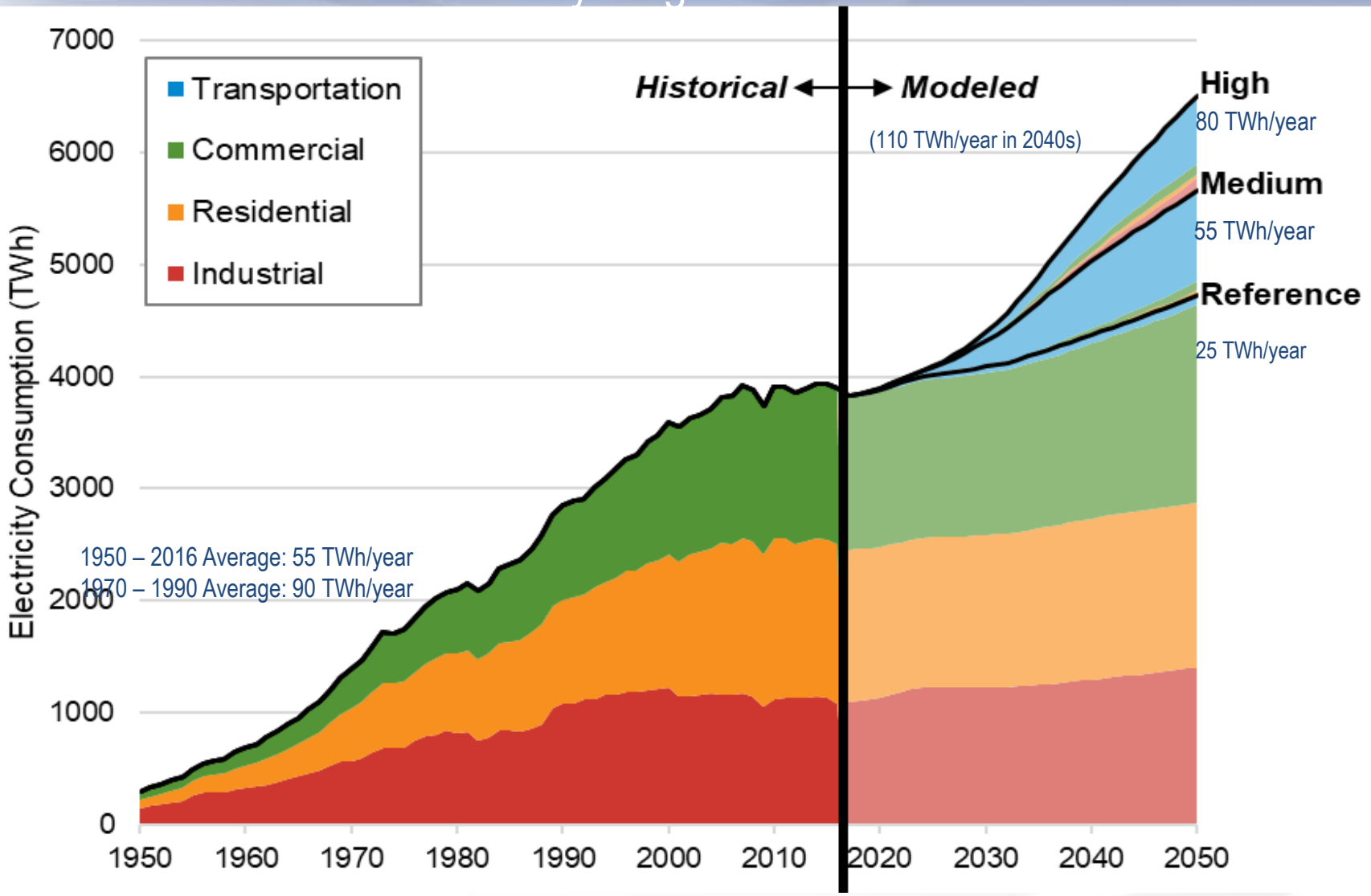
Demand-Side Scenarios Report

(June 2018)

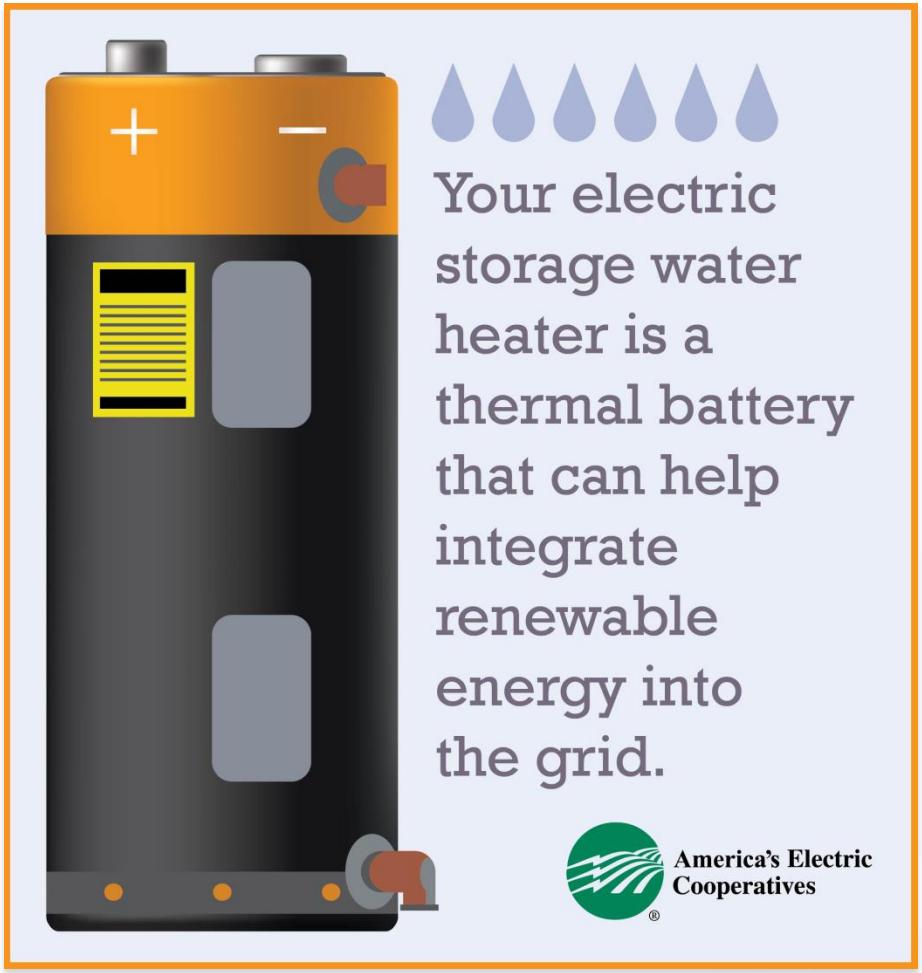
https://www.nrel.gov/docs/fy18osti/71500.pdf



Dramatic increase in demand led by transportation; unprecedented 80-110 TWh/year growth rates



Enter the Community Storage Initiative/Concept!



APPA American Public Power Association
PublicPower.org

NRDC

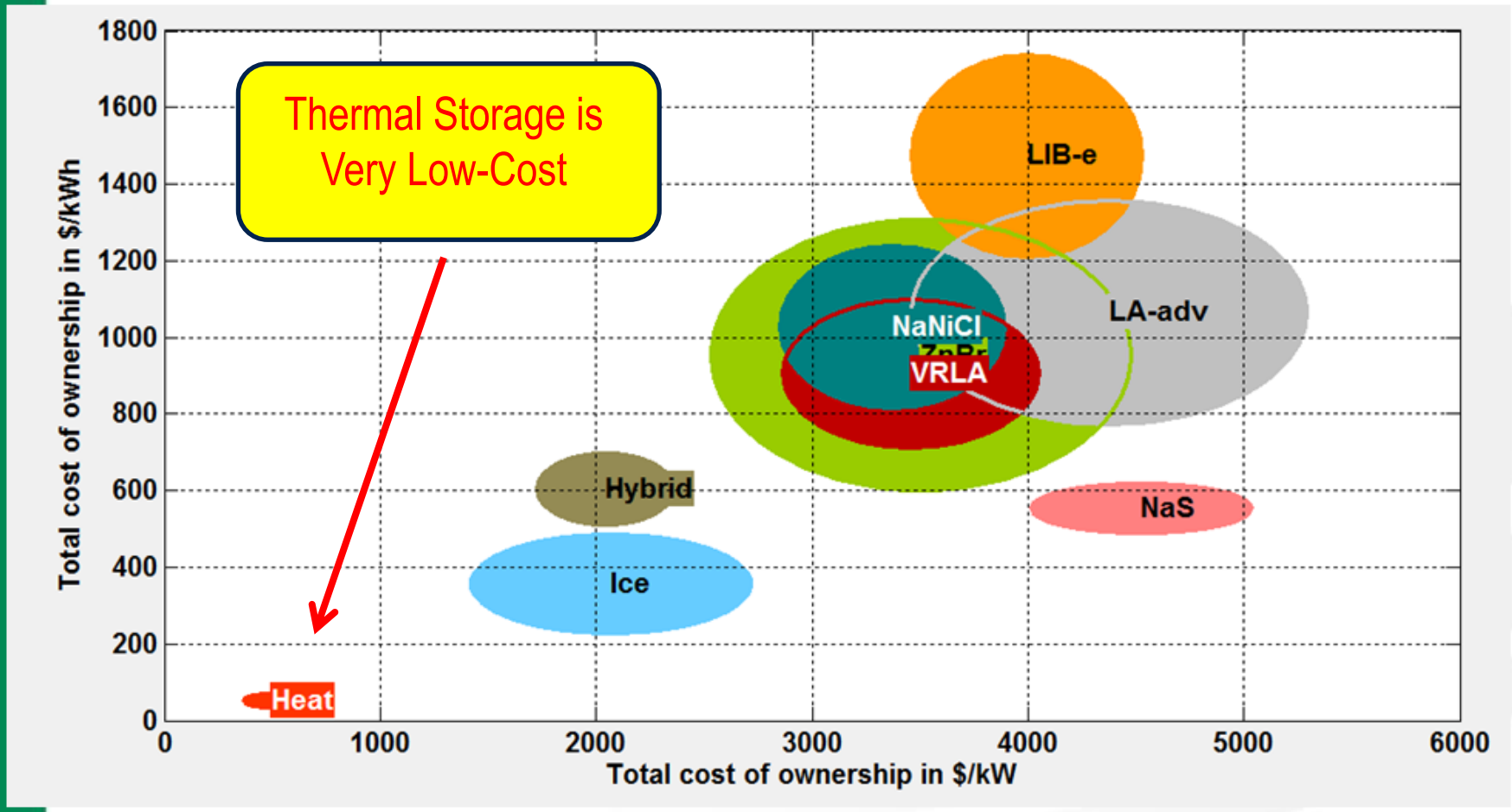
PLMA
Demand Response Leadership Since 1999

EEI

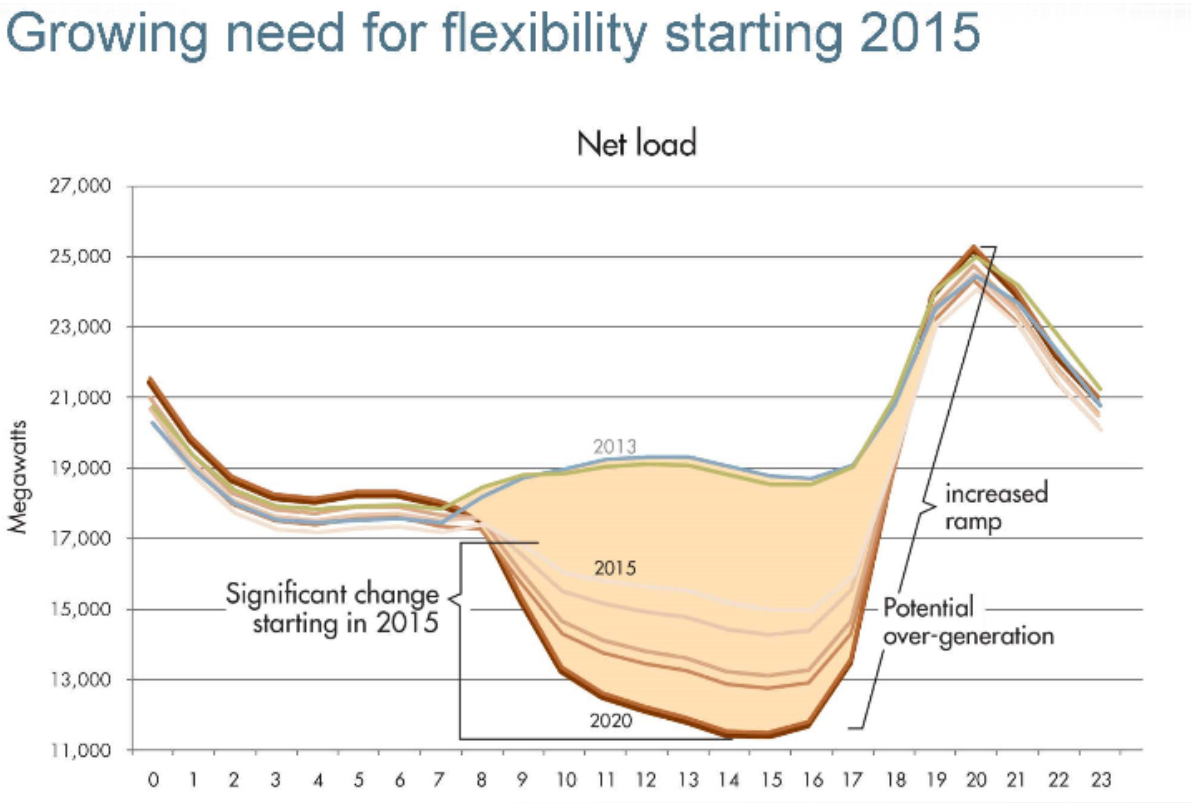
GREAT RIVER ENERGY®

Water Heaters – The Most Cost-Effective Storage

- Not flashy, but has been reliable for decades and is cheapest solution available, and is HERE!!!!



Using Electric Water Heaters to Teach CA's "Duck to Fly"

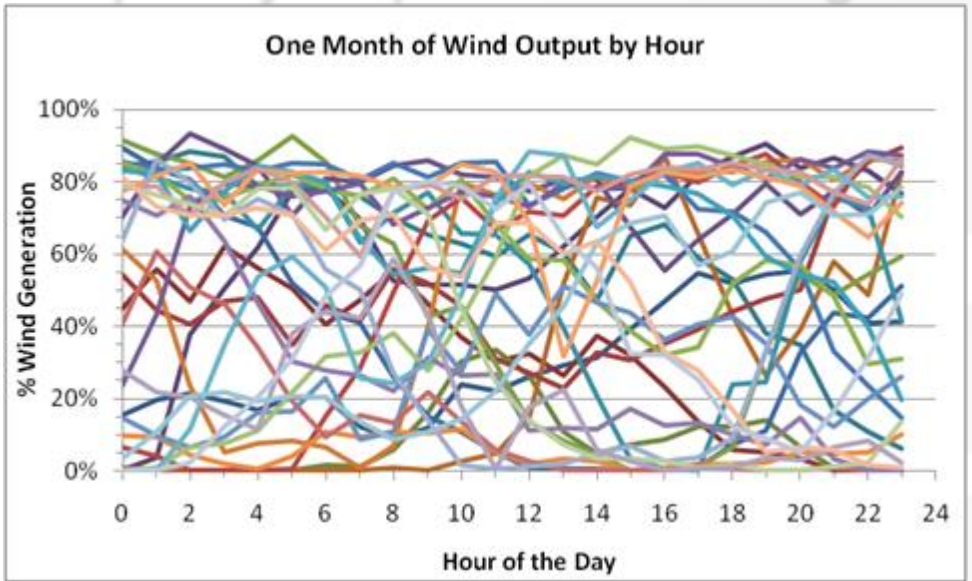


"1 million electric water heaters means that up to 4,000MW of load could be dispatched as needed, and that up to 10,000MWh per day could be shifted as needed." – Regulatory Assistance Project

Source

Elec. Thermal Storage, DR / Load Control

- Some DR cuts load when energy use is high or supply is low.
- Thermal storage can make use of energy when it is available and stores it for later – ***can cut use or add it: perfect for renewable integration.***
- Grid Interactivity can take it even further, with water heaters proving frequency response and acting like a peaker plant.



The Hidden Battery

Opportunities in Electric Water Heating

PREPARED FOR

NRECA
A Touchstone Energy® Cooperative

NRDC
NATURAL RESOURCES DEFENSE COUNCIL

PLMA™
Demand Response Leadership Since 1999

Three DR strategies were modeled for ERWHs

Strategy #1: Peak Shave

- The water heater is curtailed only on a limited number of days of the year (typically 10 to 15) when the system peak is likely to occur, and for a limited number of hours on those days (typically 2 to 4, depending on the duration needed to confidently capture the hour of the system peak)
- The water heater is not controlled on the other days of the year
- This strategy is used largely to capture capacity value

Strategy #2: Thermal Storage

- Every day, the WH heats at night and then is curtailed during highest priced hours of day; the total number of hours curtailed during the day will depend on the size of the tank and the amount of hot water it can store
- This strategy is used to capture energy value through price arbitrage
- We assume that the strategy would also include curtailment of the water heater to provide capacity value, in addition to the energy value

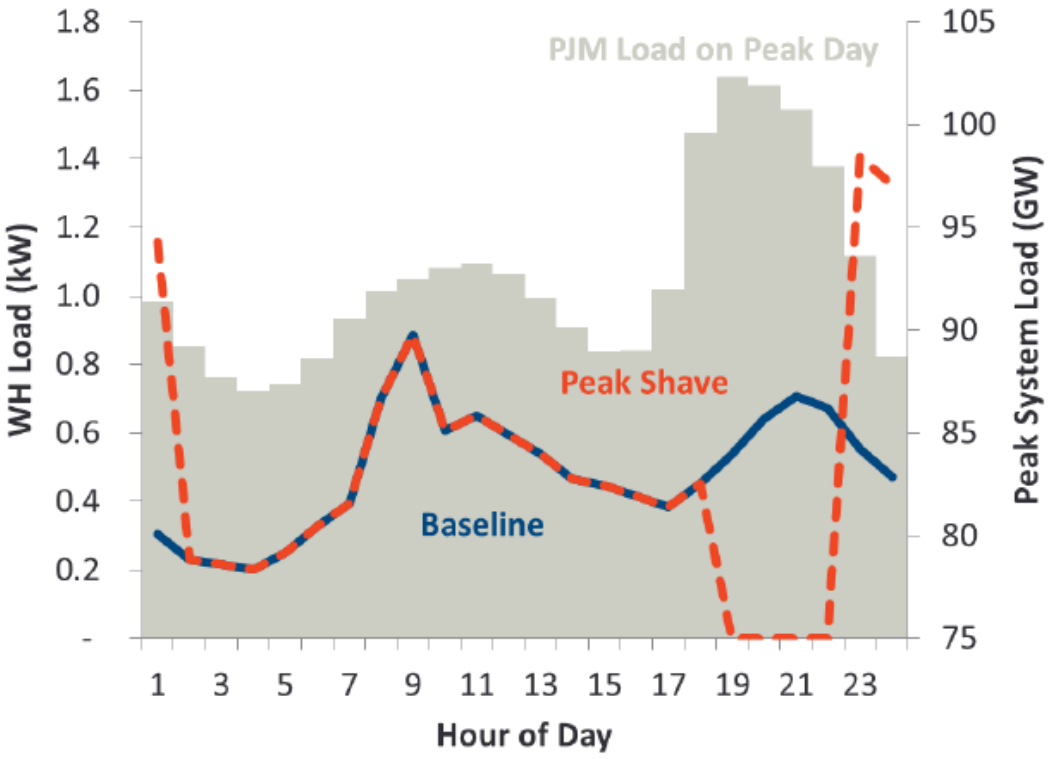
Strategy #3: Fast Response

- The water heater offers frequency regulation into the wholesale ancillary services market when heating water during off-peak hours, on a daily basis
- It responds to a signal from the system operator in a matter of seconds and can increase or decrease load depending on the need, consistent with the requirements of PJM's Dynamic Regulation ("RegD") market
- As it is modeled in our analysis, we also assume that the water heater is controlled to capture additional energy and capacity value, although the dispatch is not perfectly optimized across these three revenue streams

The strategies are modeled for both 50- and 80-gallon water heaters, to explore the economic impacts of increasing the storage capability of the water heater

The peak shave strategy reduces water heating load during peak hours of the year

The Peak Shave Load Control Strategy (50-gallon)



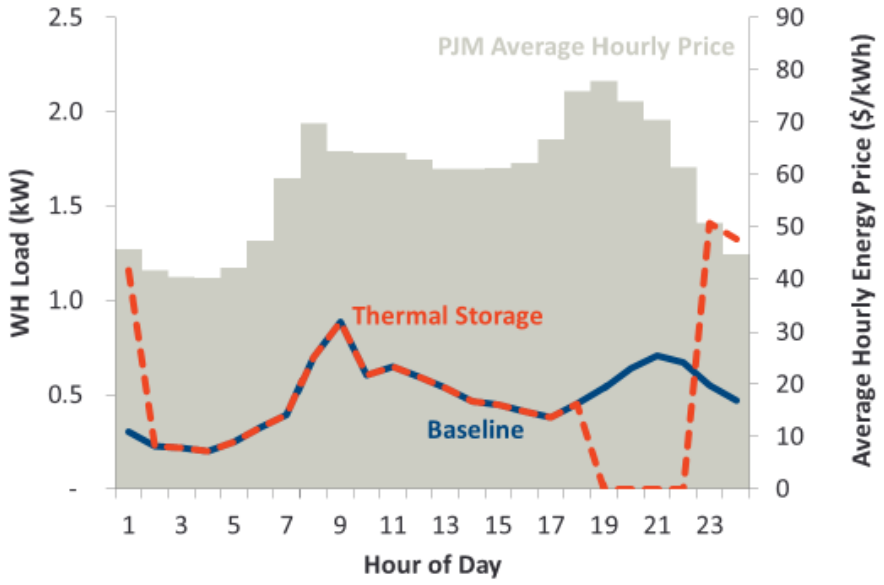
Source: Hourly load data for PJM RTO from Ventyx Energy Velocity Suite.

Comments

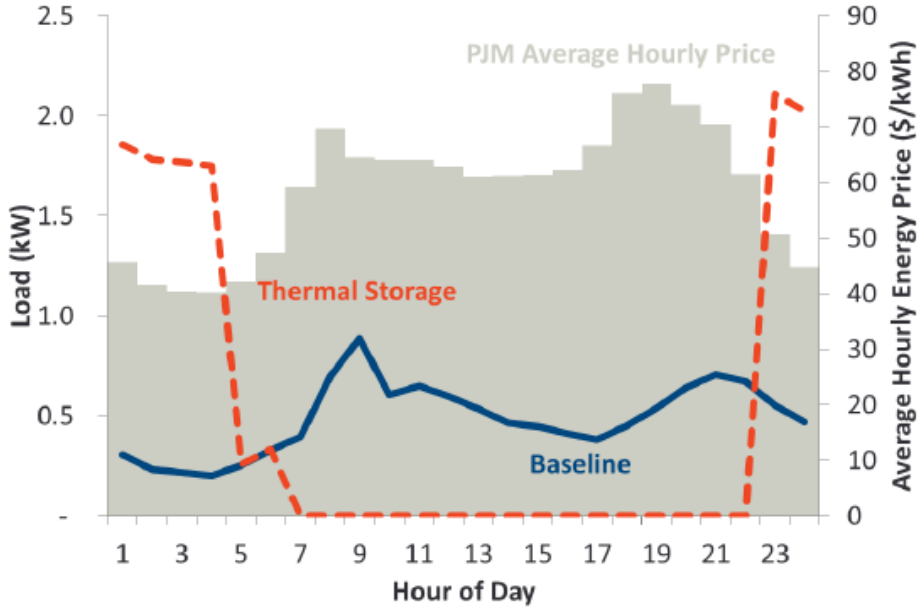
- A 50-gallon tank can be interrupted for up to 4 hours with little risk of hot water runouts across a range of customers with diverse hot water needs
- This requires the installation of a mixing valve and heating the water in the tank to 160 degrees
- System peaks are typically in the afternoon; however this strategy interrupts charging during peaks, regardless of time of day they occur
- System coincident peak demand reduction associated with this strategy is 0.5 kW per water heater
- This is the average load of the baseline water heater during the peak hours when the load is curtailed

The Thermal Storage strategy captures energy benefits in addition to capacity

50-gallon Tank



80-gallon Tank

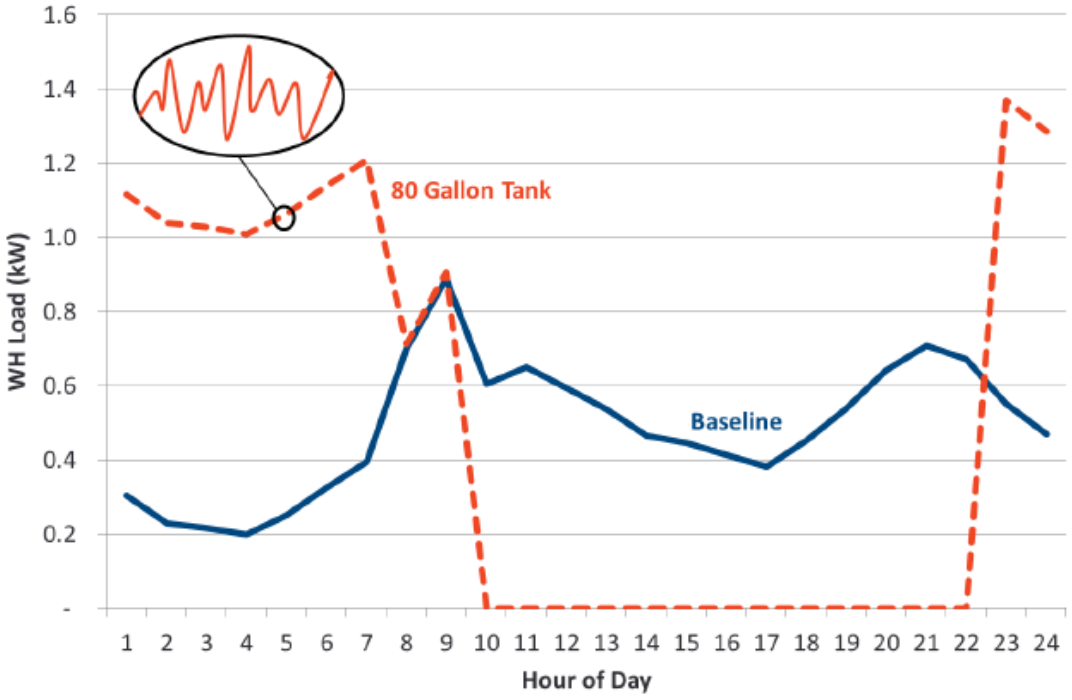


Source: Hourly day ahead wholesale price data for PJM East Hub from Velocity Suite.

- With the Thermal Storage strategy, water is heated to a maximum acceptable temperature at night and then heating is still curtailed to reduce load during hours with high energy and capacity prices
- The storage capability of the 50-gallon tank allows for curtailments of up to 4 hours per day; longer curtailments would either lead to an unacceptable risk of hot water runouts or require that the water in the tank be pre-heated to unacceptable levels
- The larger storage capability of the 80-gallon tank allows it to be curtailed up to 16 hours per day without violating the constraints described above; for more information about these assumptions around WH operations, see accompanying analysis by Dr. Carl Hiller
- Note that, with the larger tank, in some select cases customers would need to be equipped with a ~100-gallon tank in order to achieve the full 16 hours of curtailment with minimal risk of hot water run outs. Both tank sizes also require a mixing value, which allows the max temperature of the water in the tank to be increased, therefore reducing the possibility of hot water runouts when curtailing on a daily basis

The Fast Response strategy provides real-time response to fluctuations in supply

Illustration of the Fast Response Strategy



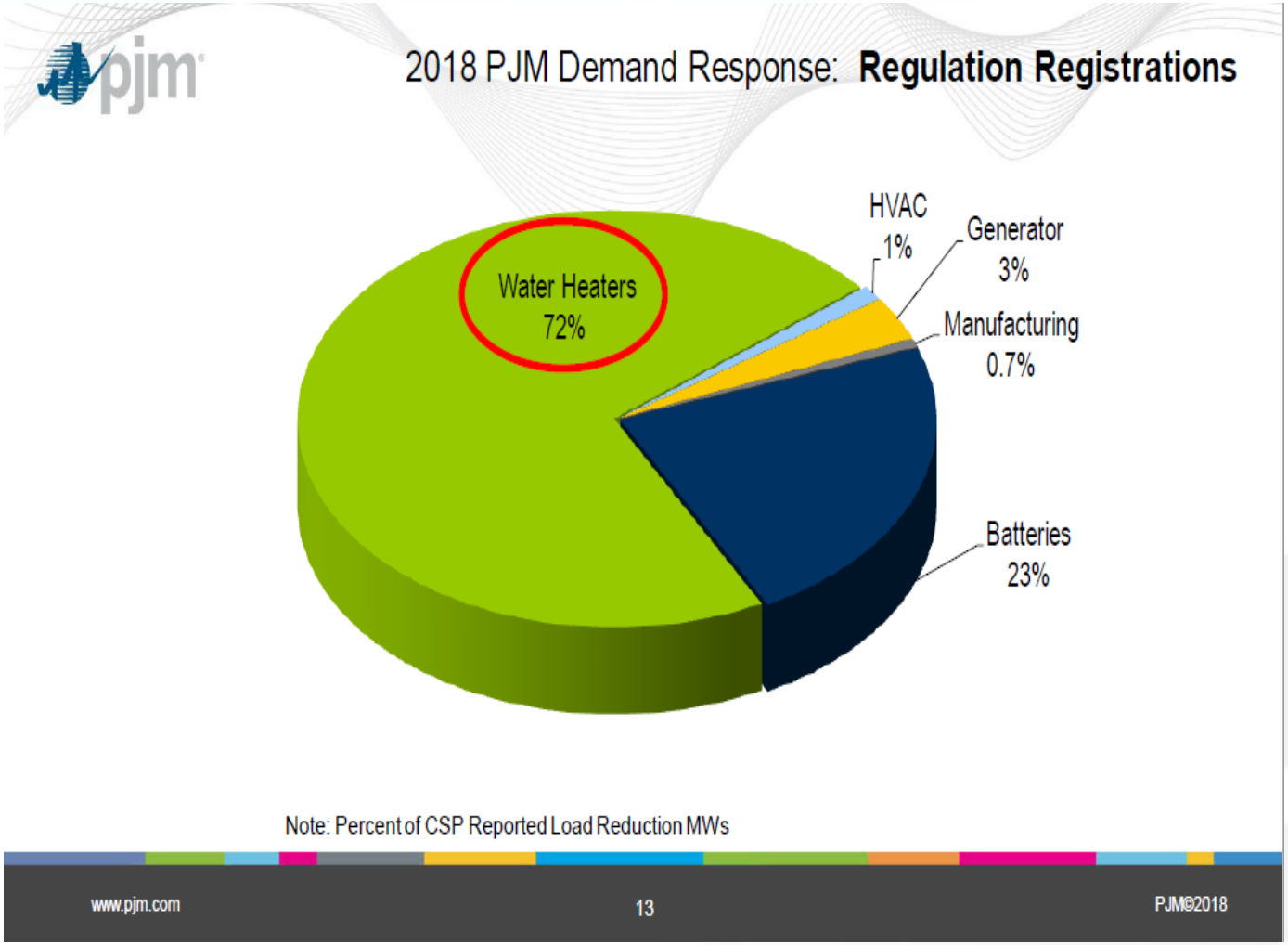
Note: Regulation line is illustrative, not real data.

Comments

- The Fast Response strategy has a charging profile that is somewhat similar to the Thermal Storage strategy, but with short-duration, high-frequency fluctuations in load around the average charging profile
- As defined by the PJM RegD product, these fluctuations are "energy neutral" on an hourly basis, so there is no significant additional concern about over- or under-heating the water in the tank
- These fast response services would be provided on a daily basis

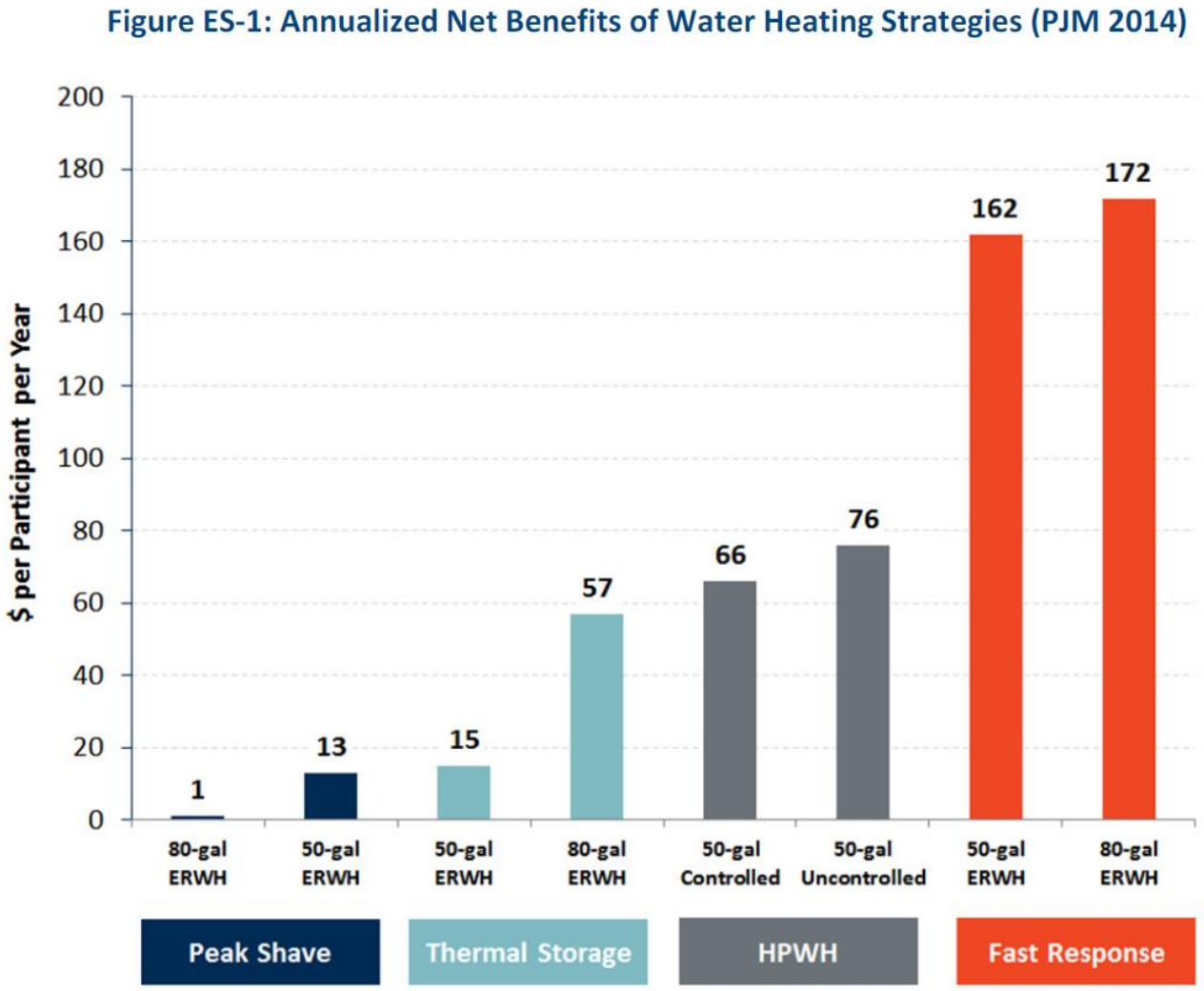
As with the Thermal Storage strategy, water heating load is also curtailed to reduce the system peak on the limited number of days when it is likely to occur

Electric Water Heaters for DR in PJM

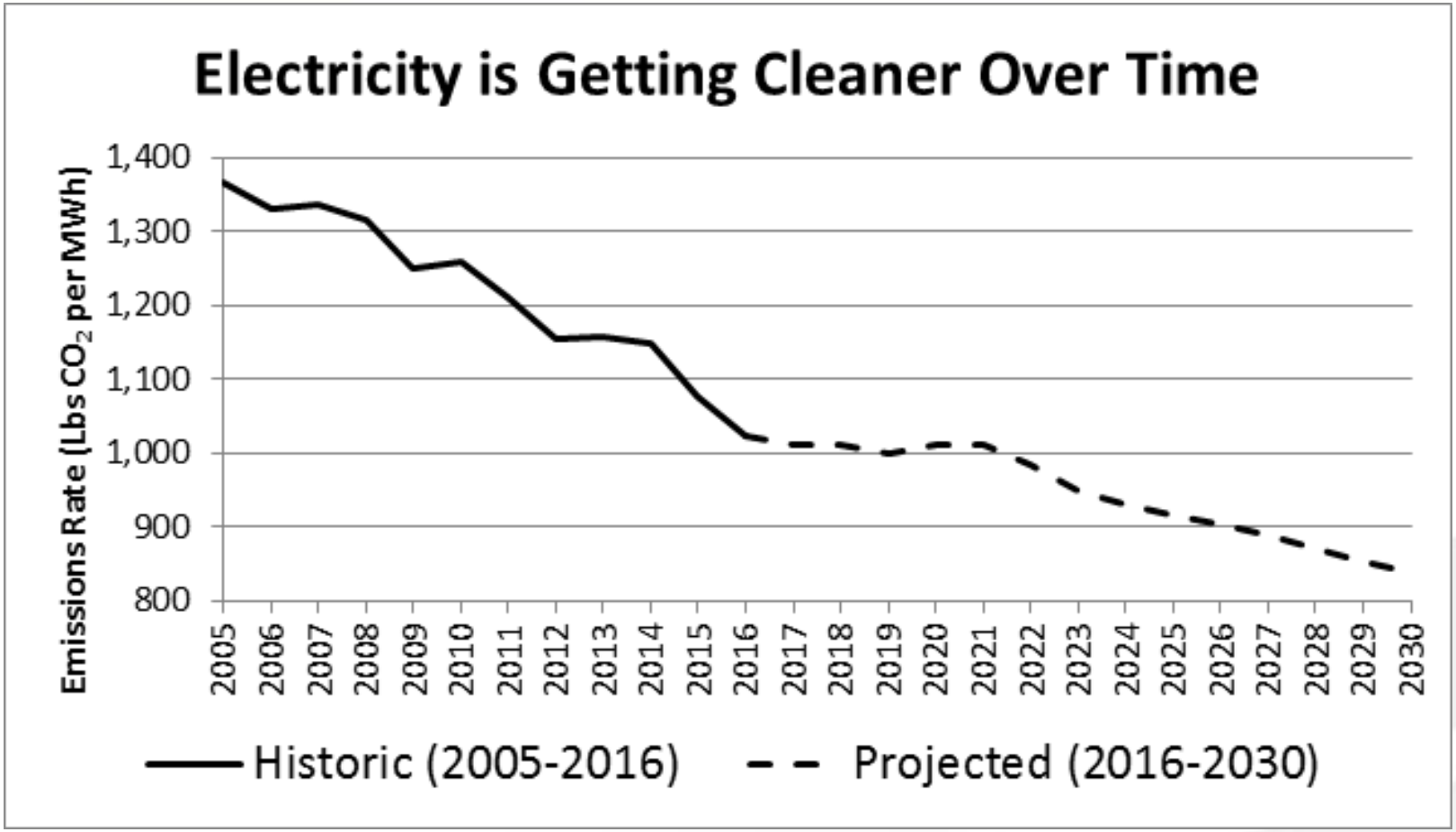


Energy Systems Integration Group (ESIG)
Fall Technical Workshop Denver Oct 3, 2018
Innovative Methods to Improve Flexibility in PJM – Ken Schuyler

Conclusion– Lots of Options to Save $



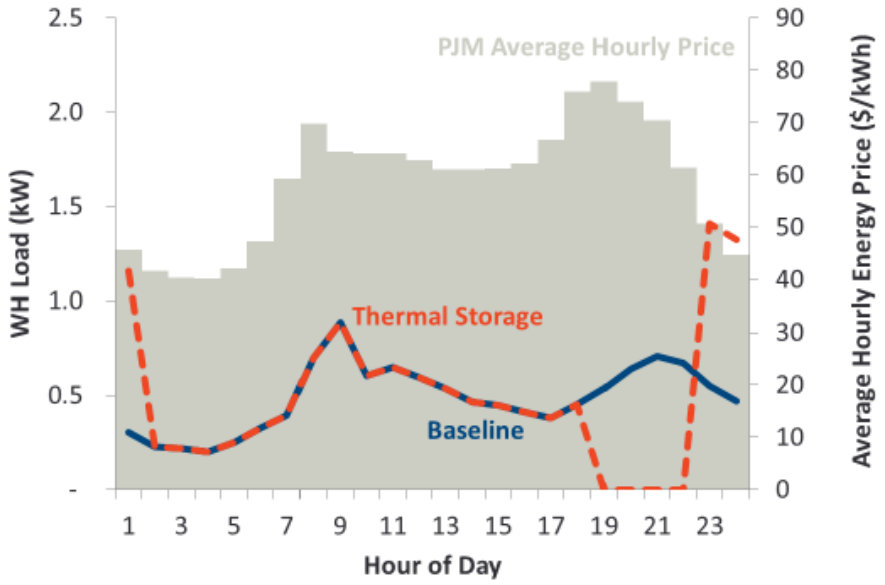
Opportunity for "EBE" to Improve "Emissions Efficiency"



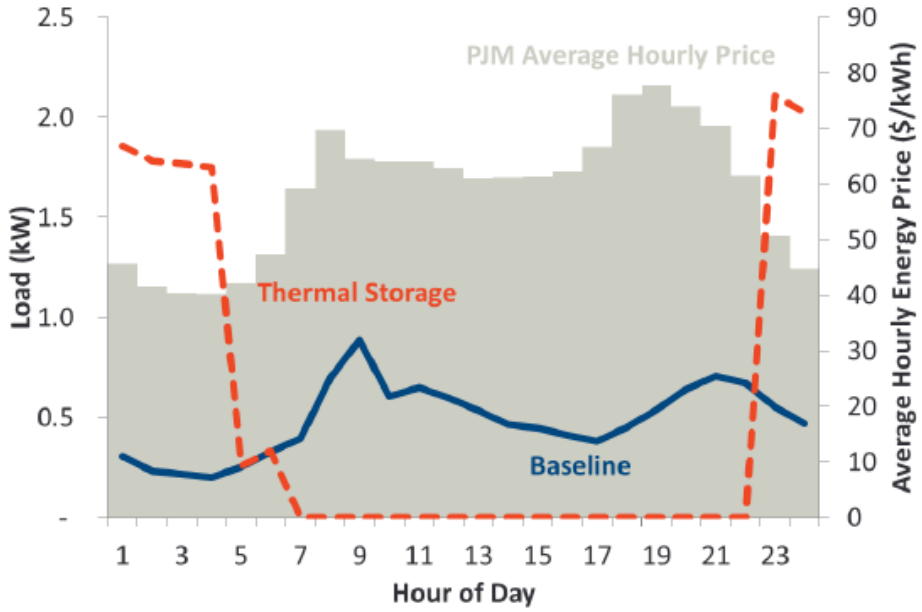
While the energy efficiency of devices will not change once installed, the ***emissions efficiency*** (or "***emiciency***") will improve over time

Using Electric End-Uses Smartly is Energy Efficiency

50-gallon Tank



80-gallon Tank



- Electric water heaters can be used as thermal storage to save consumers money, manage the grid, and lower emissions through using energy wisely.
- Energy “efficiency” should include options like smart water heating that changes time of when energy is used. Unlike kWh saved, CO_2 emissions saved are all equal.
- Dual fuel options similarly are beneficial to grid, consumers, and environment
- Source energy and kWh are increasingly outdated metrics for “energy efficiency”

Down The Road – More Electric Tractors and Broadband/Technology Enabled Water Management

John Deere unveils latest all-electric tractor prototype for zero-emission agriculture

Fred Lambert - Dec. 5th 2016 5:30 am ET @FredericLambert

ELECTRIC TRACTOR JOHN DEERE

Example: Piedmont EV Consumer-Cost Savings

Super Off Peak Rate: 2.79 cents

On-Peak Rate: 26 – 34 cents

→ Rates that allow co-ops to recover costs and achieve desired night load

Electric Car: Annual car charging costs as low as $129 for consumers or as high as ~$1,200 → Co-op has a new consumer load, consumer has ability to manage costs

Gas Car: Annual gas consumption for regular gasoline car $1,154 → Co-op has no new load, consumer has no control over gas cost

Ford Focus gas vs. electric

Example: Steele-Waseca Water Heaters and Solar

THE SUNNA PROJECT

Buy a 410 watt panel in the SUNNA project and get a free electric thermal storage water heater

- $170 panel cost to consumer
- No sighting issues
- No maintenance issues
- Hedge against future energy hikes

Example – Dakota Electric School Bus

America's schools spend roughly $2 billion on fuel each year for transportation.

Transitioning to electric-powered school buses could cut these costs *in half*, down to $1 billion.

What is the Future of Smart Homes?

Image source: Tesla Motors

Who will survive?

wemo

SAMSUNG SmartThings

hue PERSONAL WIRELESS LIGHTING

INSTEON

IRIS by LOWE'S

HomeKit

tp-link

works with nest

ecobee

wink

amazon echo

What is Next?

Welcome the “Beneficial Electrification League”!!!

- A new non-profit dedicated to promoting the benefits of beneficial electrification
- www.beneficialelectrification.com
- Supporters include: Natural Resources Defense Council (NRDC), National Rural Cooperative Association (NRECA), Environment and Energy Institute (EESI), WECC, Great River Energy, Oglethorpe Power, Jackson EMC, and more.

Further Contact Information

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Beneficial Electrification League