Pacific Northwest
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Regulatory Research and Outreach

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2026 OE Energy Storage Program Peer Review

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Acknowledgment

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Agenda

- Project Overview
- Energy Storage and the Law of Averages
- Long-Duration Energy Storage for Thermal Integration
- Reclassifying Energy Storage as a Grid Function
- Outreach Efforts
  - State Assistance
  - Other Engagements

Project Overview

Project Duration: Ongoing
Verticals: Analytics, Safety & Reliability
Alignment: Stabilize, Optimize, and Grow

Goal

Serve as an **objective** and **reliable** source of analysis and information for regulators, state energy officials, and other energy system decision makers as they build frameworks that will create opportunities for energy storage in their jurisdictions.

Why

State agencies have heavy workloads with statutorily fixed timelines, often leaving them unable to divert staff and resources toward studying emerging topics and technologies. This work extends the capacity of state agencies to analyze and incorporate storage technologies.

Approach

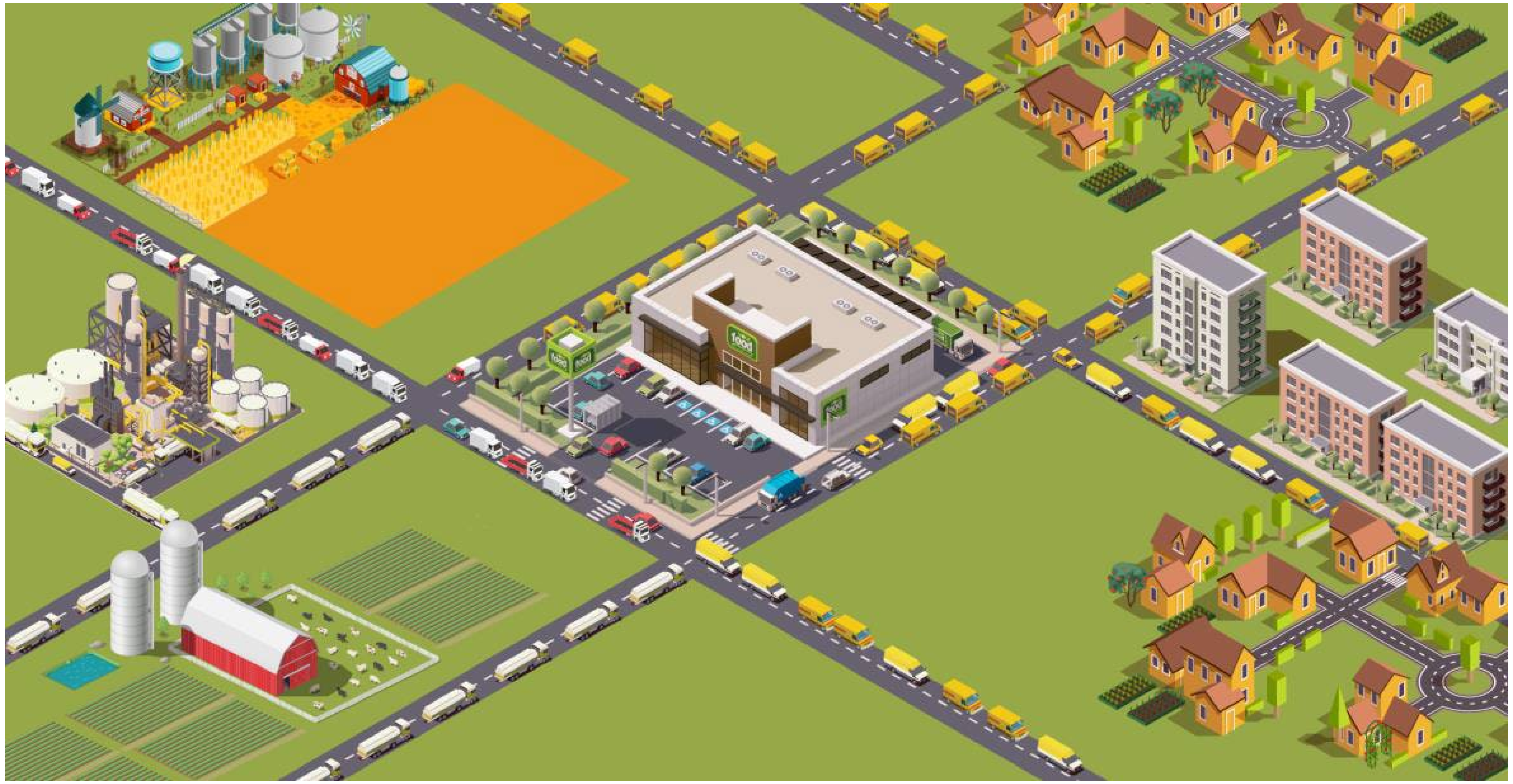
- **Develop** strong relationships with state agencies
- **Study** regulatory proceedings, planning processes, project developments, etc. that affect storage deployment and usage
- **Publish** research on emerging regulatory topics and issues
- **Disseminate** research findings at workshops, conferences, and other public proceedings
- **Provide** direct technical assistance to states as they work through the complicated topics related to energy storage regulation
- **Inform** through objective analysis that does not advise or make recommendations

Energy Storage and the Law of Averages:
How Storage Can Make Electricity More Affordable

Problem: The electric grid is designed and built based on peak demand, resulting in underutilized infrastructure that drives up costs

Approach: Describe how energy storage can reduce electric system costs by averaging out supply and demand, supported by a clear narrative and real-world examples

Imagine if You Couldn't Store Groceries



What the world might look like if groceries could not be stored

- Free daily delivery of everything you need for that day
- Lots of nearby production (farms, mills, ranches, factories, etc.)
- Large shipping fleet to get the food to the grocery store each night
- Lots of delivery drivers on the road each morning
- Some gardening, but difficult to find markets and drivers to sell and deliver the excess

From the Grocer to the Grid

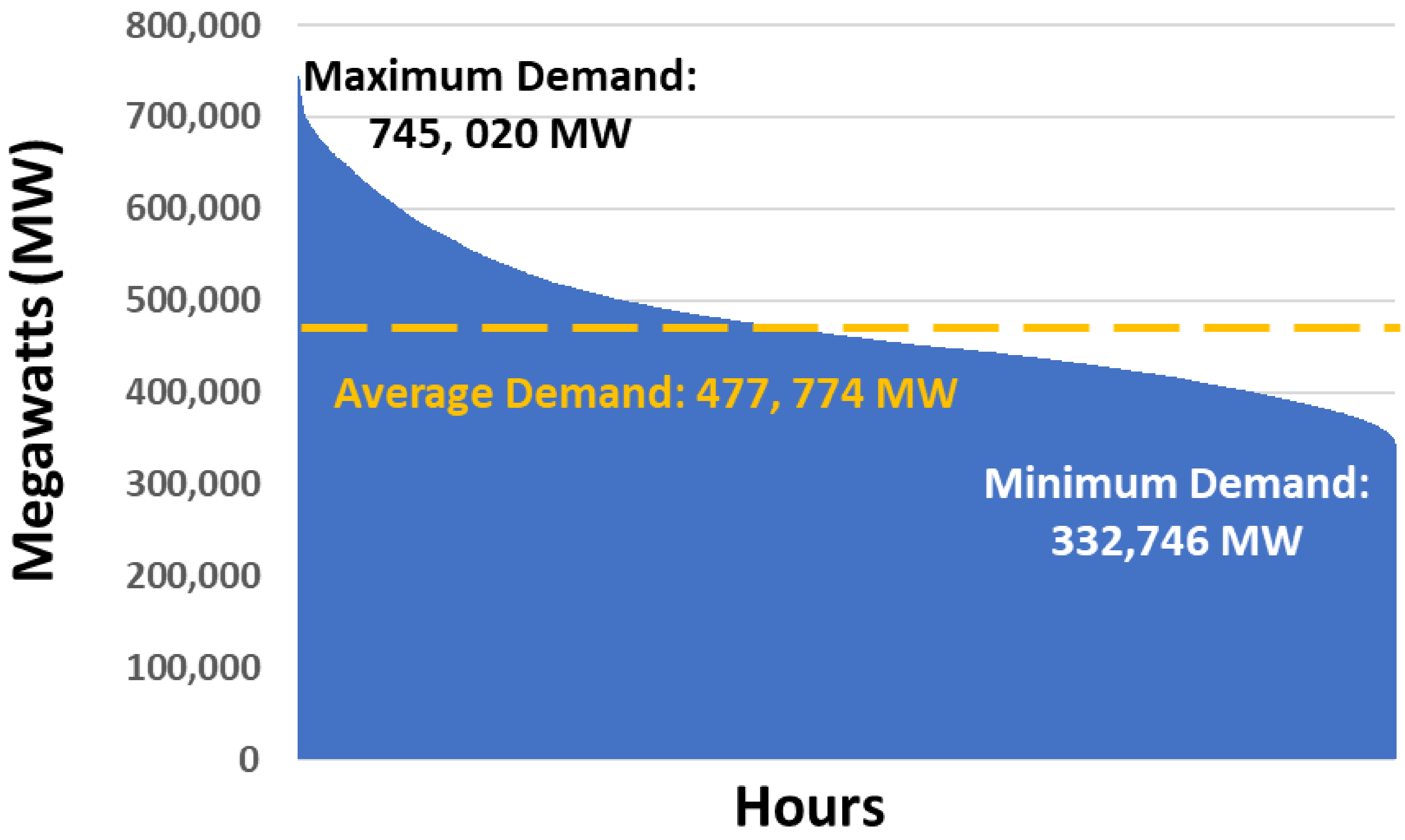
This would be an odd way to buy groceries. But there is something else we buy every day that works exactly like this: electricity.

- Production facilities = generators
- Shipping trucks = transmission
- Delivery drivers = distribution
- Gardens = distributed resources
- Grocer = utility

Electricity is the only thing we buy that does not have storage built into its supply chain. The ability to start building storage into that supply chain has profound implications for electricity costs.

The Cost of Building for Peak

- This load duration curve shows hourly total electric demand for in the U.S. for every hour of 2024, ranked from highest to lowest
- Peak demand was 56% higher than average demand
- That's 267 **gigawatts** of capacity built to follow load – the equivalent of building Plant Vogtle (the largest nuclear plant in the U.S.) **57 times**



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Results: Tangible Examples of Savings

Generation

Ancillary Services	**PJM**: Saved $1.2 million on ancillary services and freed up generators for the capacity market by employing storage for regulation service
Arbitrage	**Texas**: Energy storage reduced energy market prices by almost 50% during an August 2023 heat wave
Peak Shaving	**California:** Behind-the-meter energy storage will provide 1,300 MW on peak by 2028, saving between $28 million and $206 million

Transmission

Transmission Deferral	**Massachusetts**: Saved more than $120 million by deploying storage and diesel instead of a third transmission line on Nantucket Island
Outage Mitigation	**Wisconsin:** Saved about $3 million by using storage to prevent potential service outages during contingency events near Waupaca
Generation Avoidance	**California:** Storage helped support local reliability after a generator retirement while saving more than $400 million

Distribution

Voltage Support	**Utah:** Storage provides a bridge by supporting voltage and saving $300,000 in a rural area while a long-term solution was developed
Uncertainty Hedging	**Maine:** Storage and distributed generation, and energy efficiency saved customers $12 million when forecasted peak growth did not occur
Peak Management	**California:** Storage provides cost-effective support on a heavily loaded feeder while deferring a reconductoring project

Customer

Demand Management	**Virginia:** Onsite generation and storage save Richmond Medical Center about $460,000/year
Peak Shaving	**Vermont:** Fleet of behind-the-meter storage saves customers $3 million
Backup Power	**Maryland:** Storage and onsite generation at an affordable housing facility save $100,000 per year and provide resilience

Paper: Energy Storage and the Law of Averages

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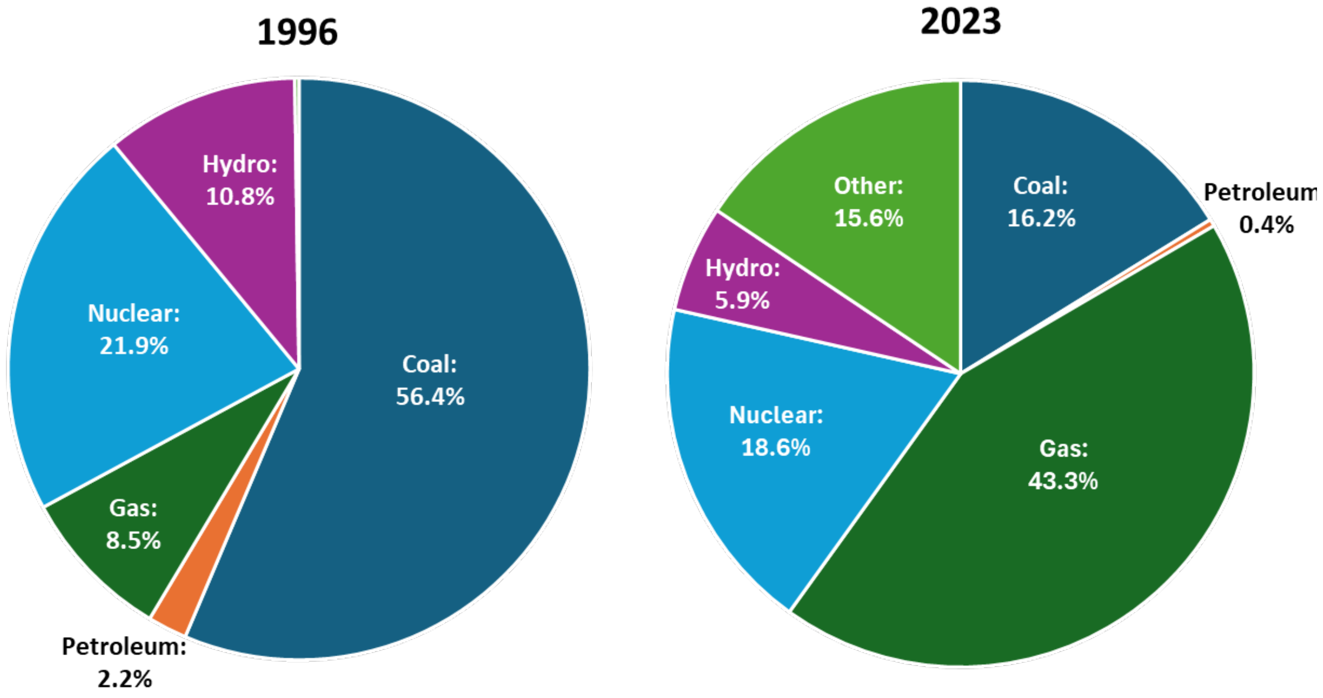
Long-Duration Energy Storage for Thermal Integration

Problem: New, long-duration energy storage (LDES) technologies can help integrate thermal generation sources, but those connections and benefits aren't well documented

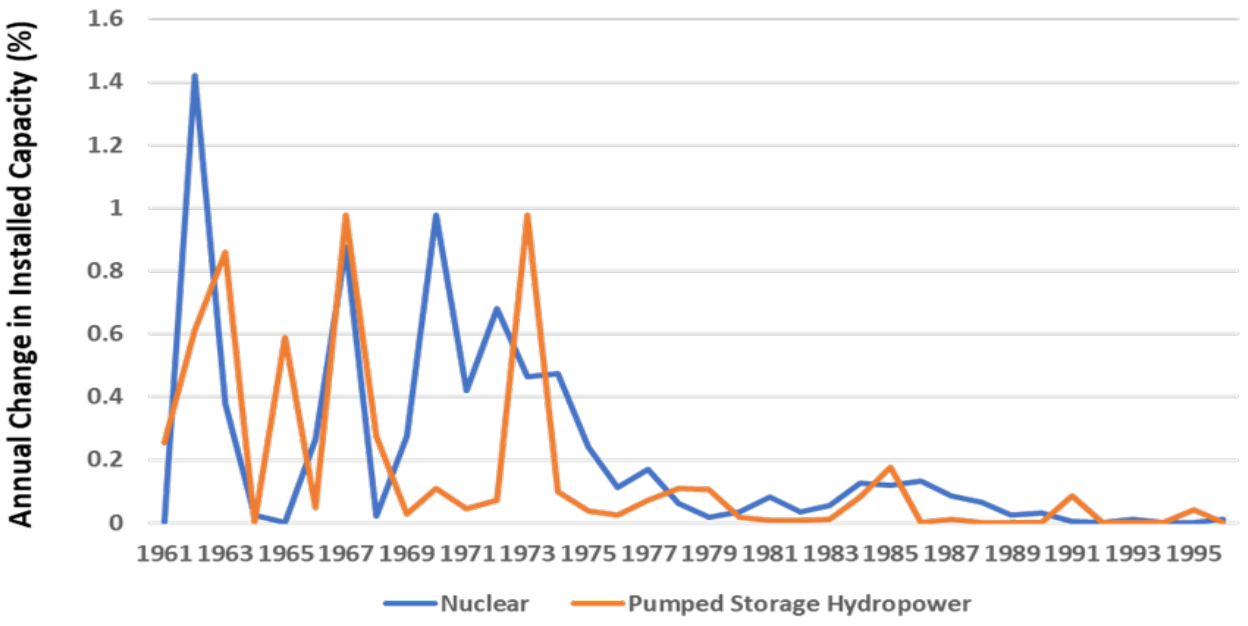
Approach: Describe and quantify how LDES can help optimize the operations and economics of natural gas, advanced nuclear, and advanced geothermal generation

PSH and Nuclear: The Start of a Beautiful Friendship

- Pumped storage hydropower (PSH) played a critical role in buffering nuclear power from daily load swings
- New construction of both technologies paused after 1996



U.S. Electric Fuel Mix, 1996 and 2023



Annual growth rates for nuclear and PSH in the U.S., 1961-1996

- The generation resource mix has changed significantly since 1996
- The growth of new types of thermal generation, coupled with the rise of new LDES technologies, offers the potential for new pairings

Storage with Combined Cycle Natural Gas

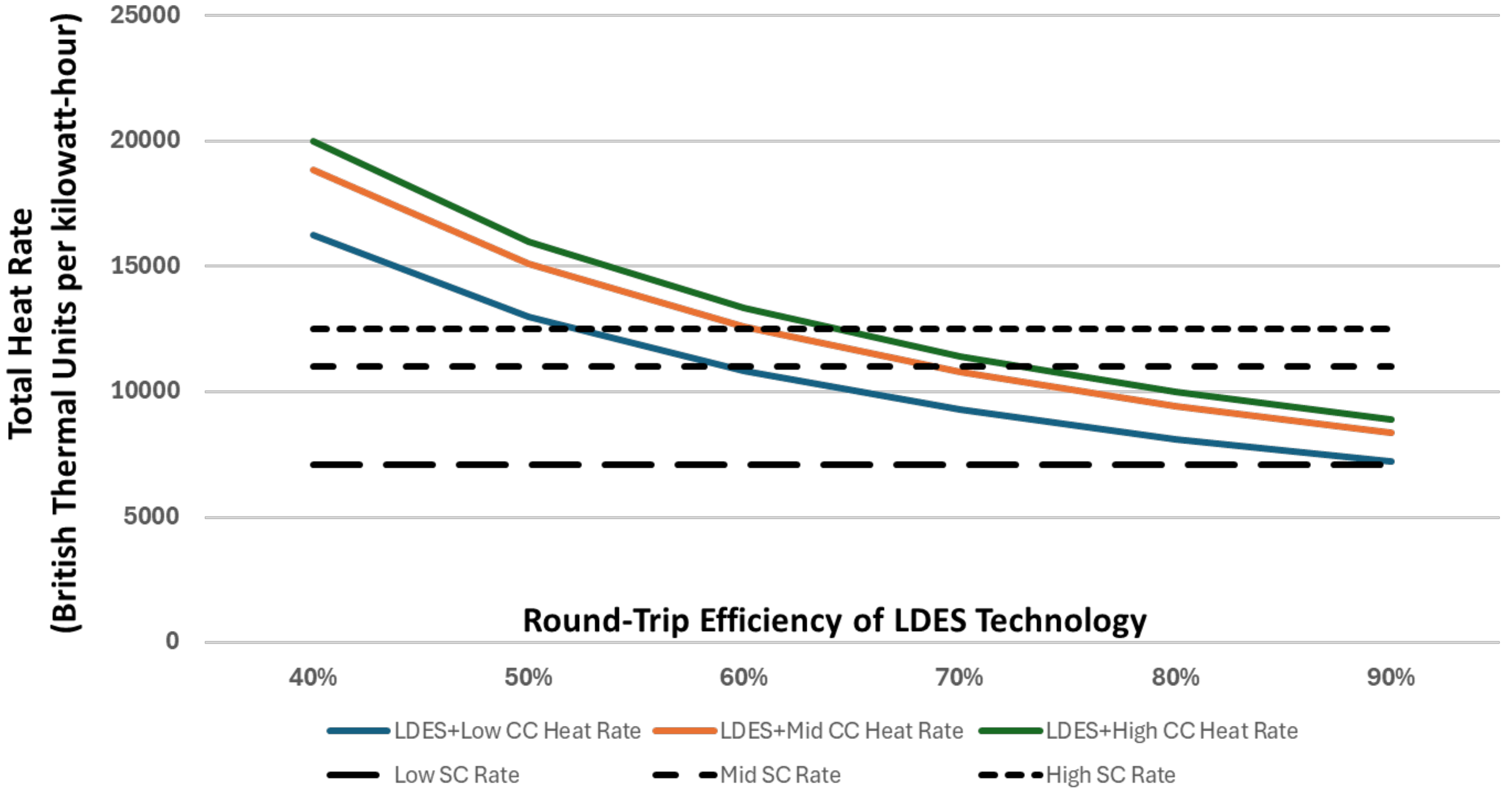
Literature review: when combined with lithium-ion, combined cycle natural gas achieves:

- Fewer starts and stops
- Less ramping
- Increased run time at optimal level

All of which translates into less money spent on fuel and maintenance

LDES technologies can provide all these benefits for combined cycle natural gas while also using the stored energy to displace the need for higher-cost generation from single-cycle natural gas peakers.

The figure at right shows that under many conditions, combined cycle generation paired with LDES has a lower (more efficient) overall heat rate than a simple cycle peaker



Heat rate efficiency frontier for combined cycle (CC) + LDES technologies versus simple cycle (SC) peakers

Storage with Advanced Nuclear and Geothermal

- We also tested the value of adding storage (short- and long-duration) to small modular reactor (SMR) and enhanced geothermal system (EGS) technologies
- These technologies do not incur ramping costs, but by shifting more of their output to higher-value periods, can storage increase their value?
- The answer right now is no, because market prices are not volatile enough for the increased revenues to offset the cost of the storage
- Increased market volatility, decreasing storage system costs, and increasing round-trip efficiency for LDES technologies could all improve the potential for coupling storage with these technologies

Reclassifying Energy Storage as a Grid Function

Problem: Energy storage is forced to play by rules developed for other grid functions, which constrains its growth

Approach: Describe how these rules limit energy storage, introduce the concept of reclassifying energy storage as a grid function, and identify potential strategies for doing so

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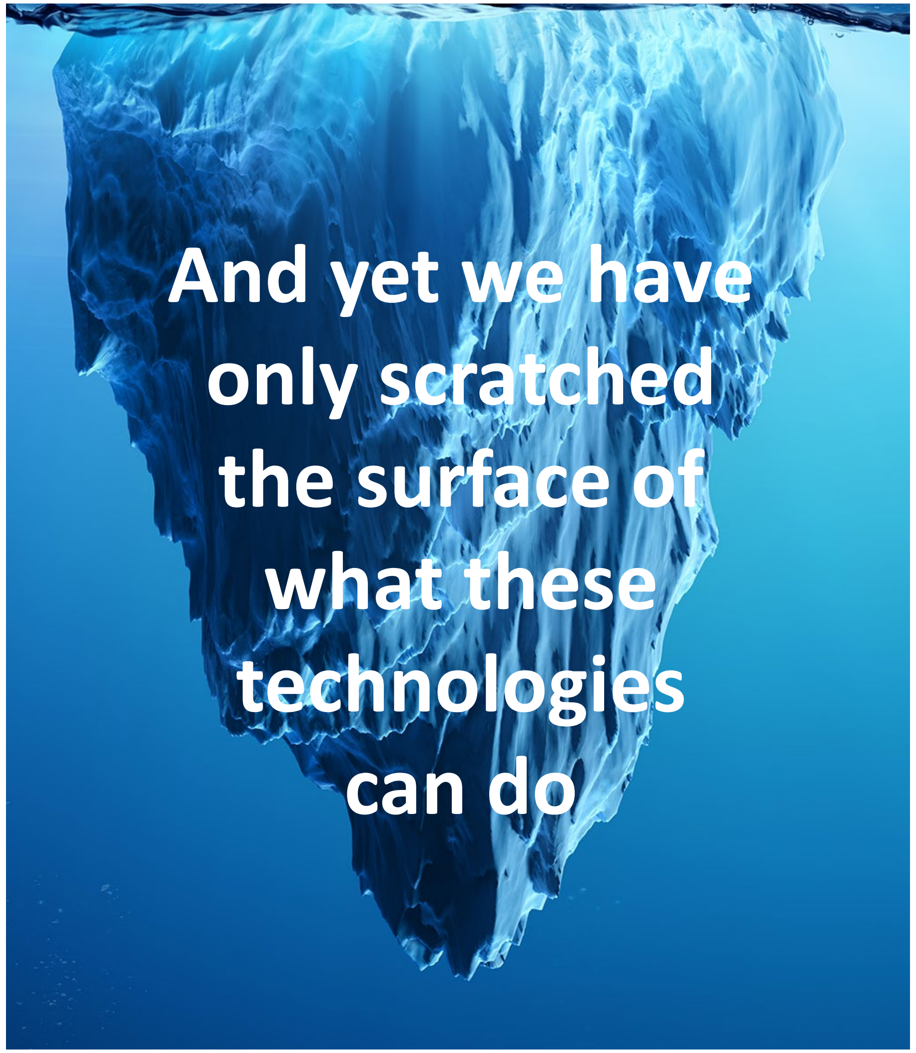
Energy Storage Is Booming…

The U.S. electric grid is divided into three functions, each with its own rules, planning processes, compensation mechanisms, and jurisdictional oversight:

- **Generation**: the production of electricity
- **Transmission**: high-voltage, long-distance movement of electricity
- **Distribution**: low-voltage delivery of electricity to customers

Energy storage is forced to play by rules crafted for these functions—rules that artificially constrain its growth.

Only by redefining energy storage as a grid function can we unleash the full potential of these transformative technologies.



Storage Doesn't Fit Well In Other Functions

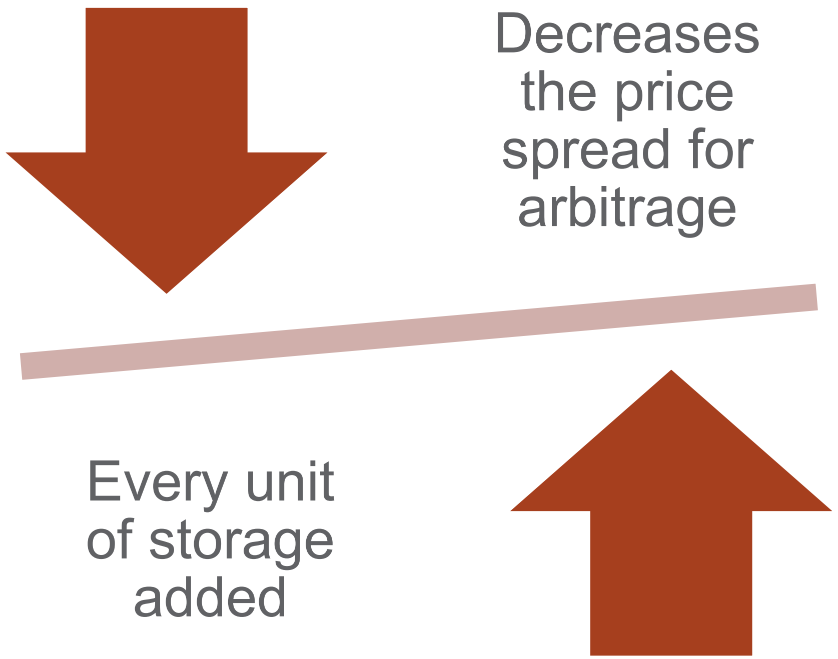
Federal and state regulators have enacted numerous reforms to fit storage into the three grid functions, but success has been limited for three reasons:

- **Transmission and distribution** reforms have been largely unsuccessful
- **Cross-functional** potential has not been realized
- **Market-based reforms** force storage to behave like a generator, failing to compensate its unique capabilities

Generation Revenues are Diminishing

When treated like a generator, the primary revenue stream for storage is arbitrage (charging during low prices and discharging during high prices)

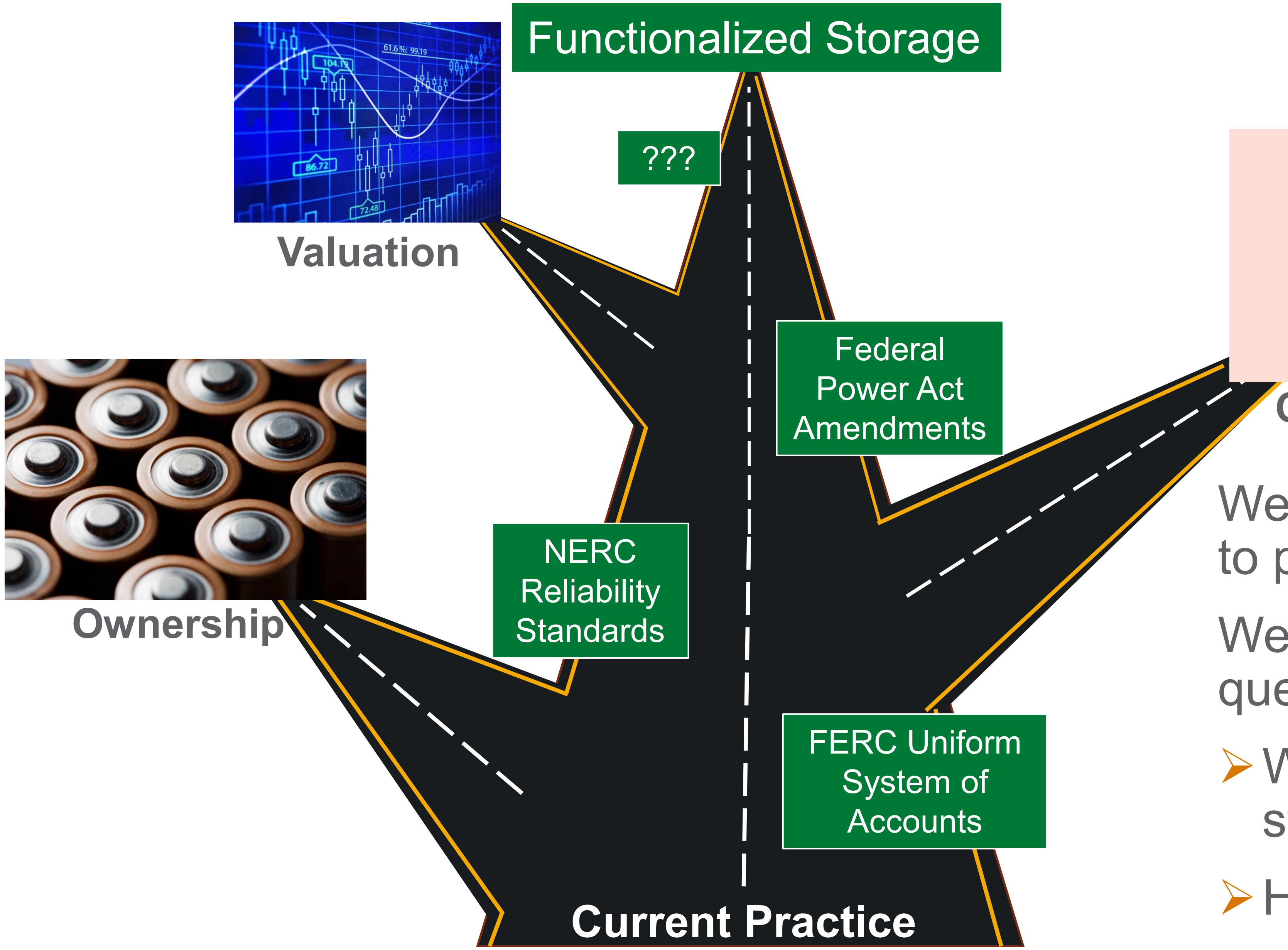
But this approach has diminishing returns that place an artificial constraint on storage development:

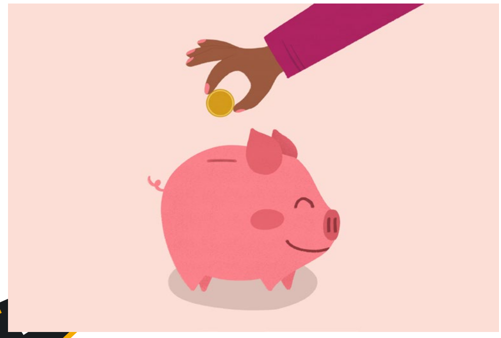


These diminishing returns are already having an impact:

- "(Battery growth in Texas) has placed downward pressure on prices" and made forecasting more complicated – *Energy Storage News*
- "Storage in PJM also tends to cannibalize its own potential revenue stream from arbitrage" – *ESS News*
- Ancillary service revenues for batteries have fallen 90% since 2023 in Texas and up to 60% in 2025 in CAISO – *PV Magazine*

We're Working on a Functionalization Road Map





We're working on identifying the levers to pull that would achieve the goal

We're also investigating related questions:

- Who would own functionalized storage assets?
- How would they be compensated?
- What grid values could be achieved?

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Outreach Efforts

Problem: State and local agencies that conduct energy oversight occasionally need additional capacity to deal with time-sensitive, complex issues

Approach: Provide objective, tailored assistance to states that helps them develop solutions that will work in their jurisdictions

FY26 State Engagements

- **Maryland Public Service Commission:** Assisted commission staff in reviewing energy storage procurement plans filed by utilities, conducting background research, drafting data requests and developing a scoring rubric
- **Utah Office of Energy Development:** Provided a presentation and consultation on transmission planning processes and energy storage as a non-wires alternative
- **Iowa:** Assisted the Iowa Cohort of the Reliable Energy Siting through Technical Engagement and Planning (R-STEP) program in providing training on energy storage permitting and safety codes to local planners from around the state
- **North Carolina, South Carolina:** Assisted the Carolinas Cohort of R-STEP in training local planners and first responders on energy storage safety codes and permitting processes and reviewed draft model ordinance language
- **Indiana**: Reviewed a guidebook on energy storage permitting

Score	Benefit Cost Analysis (BCA)	Bill Impact Assessment	Budget Caps	Non-Price Selection Criteria	Demonstration of Grid Benefits	Cost Recovery Proposal	Project Risks
3	BCA is consistent with the NSPM, supported by reliable sources, and accurately considers the potential benefits of storage (including locational benefits)	Assessment is clearly presented with supporting analytical details	Cost caps are reasonably established in terms of $/MW or $/MWh and are supported by reliable sources	Criteria are robust, reasonable, not unduly preferential, and informed by the record	Grid benefits of proposed projects are clearly summarized, including discussion of non-wire/reliability benefits and the projects' inclusion in the utility's distribution plan	Proposal contemplates the considerations identified by the commission (prudence, cost-effective operation, and appropriate cost sharing) and reasonably addresses them	The proposal presents a full accounting of project risks, appropriate strategies for managing those risks, and a plan for reporting changes in risk profile
2	BCA is consistent with the NSPM and generally supported by reliable sources, but does not accurately consider all the potential benefits of storage	Assessment is lacking in analytical support or is otherwise unclear	Cost caps are established in terms of $/MW or $/MWh, but lack support by reliable sources or otherwise appear overly restrictive	Criteria are generally reasonable, but key topics are missing or lack support	Grid benefits are discussed, but one or more key details (non-wire/reliability benefit, inclusion in distribution plan) are absent	The proposal omits one or more of the considerations, but remaining considerations are present and reasonably addressed	The proposal generally presents a reasonable strategy for managing identified risks, but may fail to account for some factors or appropriately address them
1	BCA is consistent with the NSPM, but is lacking support from reliable sources and/or key benefits	Assessment lacks one of the substantive elements	Cost caps provided, but not in terms of $/MW or $/MWH	Criteria are limited, incomplete, or unduly preferential	Grid benefits are presented with some degree of specificity, but discussion is underdeveloped or incomplete	The proposal omits multiple considerations and/or fails to address them in a reasonable manner	Risk analysis lacks several key factors or fails to appropriately address them
0	BCA was not provided or is not consistent with the National Standard Practice Manual (NSPM).	Assessment was not provided	Cost caps not provided	Criteria not provided	Discussion of grid benefits is absent or too vague to reasonably assess	The proposal is inconsistent with the Commission's considerations	Risk analysis is severely deficient in identifying and addressing risks or was not provided

Scoring rubric developed for the Maryland PSC

FY26 Outreach Efforts

<u>**Conferences, webinars, and other:**</u>

- IEEE Energy and Policy Forum
- EEI/LDES Council Long-Duration Energy Storage Summit
- Energy Storage Finance Summit
- NAATBatt Annual Meeting
- Wisconsin Public Utilities Institute – RTO Advanced Conference
- Office of Electricity Energy Storage Safety and Reliability Forum
- Legislative Energy Horizons Institute
- CESA Regulatory Energy Storage Working Group
- Ad hoc consultation with various utilities, technology developers, and others

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Thank you

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