Sandia National Laboratories

THE LDES NATIONAL CONSORTIUM



LDES Discussion with the Massachusetts Office of Energy Transformation

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What I Will Cover Today

- Storage deployment in the US (2024 stats)
- ES use case trends
- Examples from the handful of states that have recently developed ES and LDES-specific policies.
- Description of LDES technology categories
- Current work of the LDES National Consortium and the commercialization challenges we are addressing with action-based industry recommendations.
- Alignment with the “guiding principles” articulated by DOE Secretary Wright.
- Q&A

Where is energy storage being developed?

Which states added the most battery capacity in 2024?

Utility-scale battery storage capacity additions by state

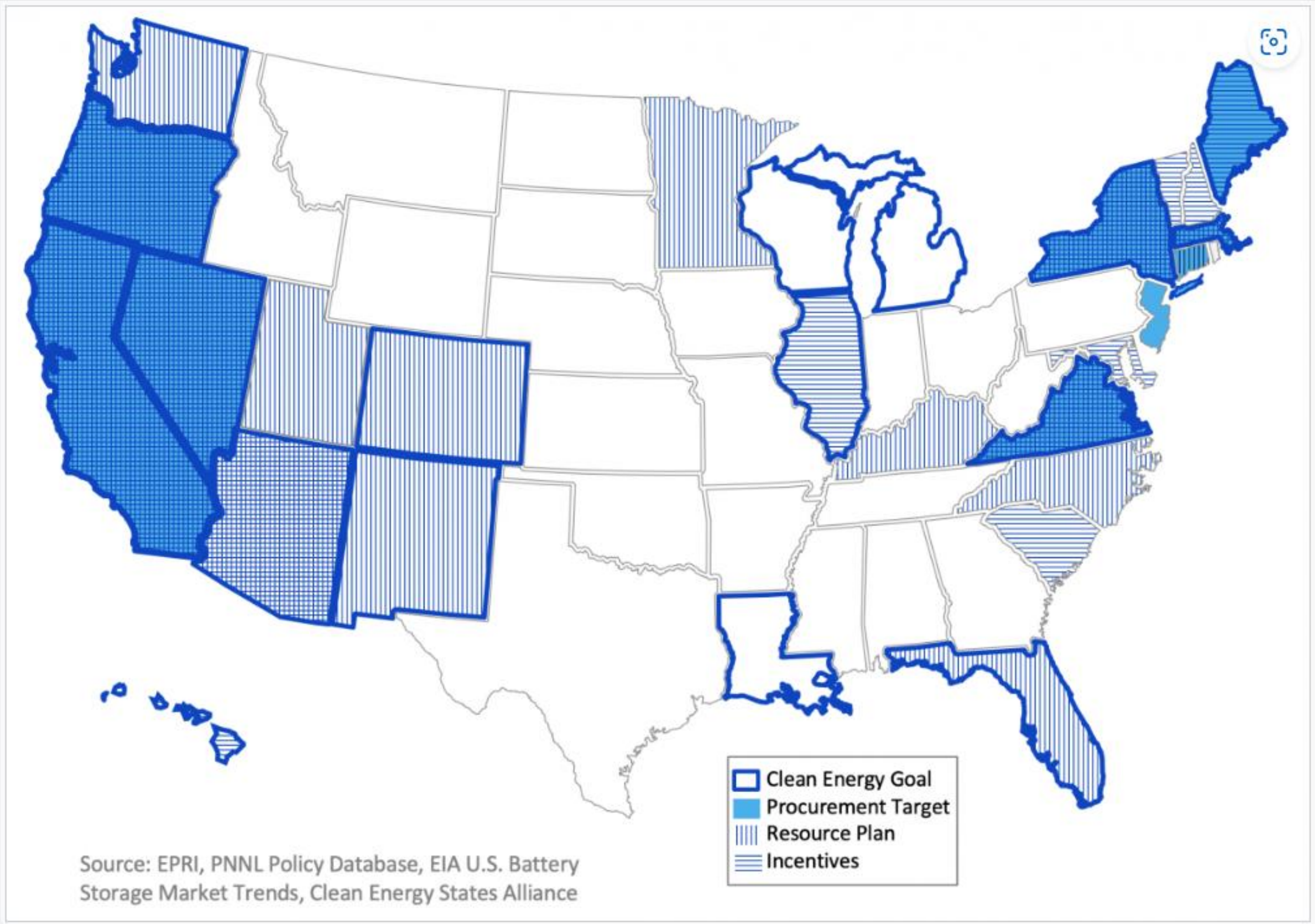
	State	Capacity additions (MW) ▼	Energy capacity additions (MWh)
1	CA	3,152	11,237
2	TX	2,832	4,536
3	AZ	976	3,837
4	NV	565	742
5	ID	280	320
6	NM	150	761
7	CO	78	313
8	HI	73	290
9	GA	65	260
10	MS	50	200

Of these 10 states, six have at least one energy storage (or related) policy in place*:

- ➢ Procurement policy
- ➢ Energy storage incentives
- ➢ Inclusion of energy storage in utility IRPs
- ➢ Clean energy / renewable energy goal

Source: CleanView

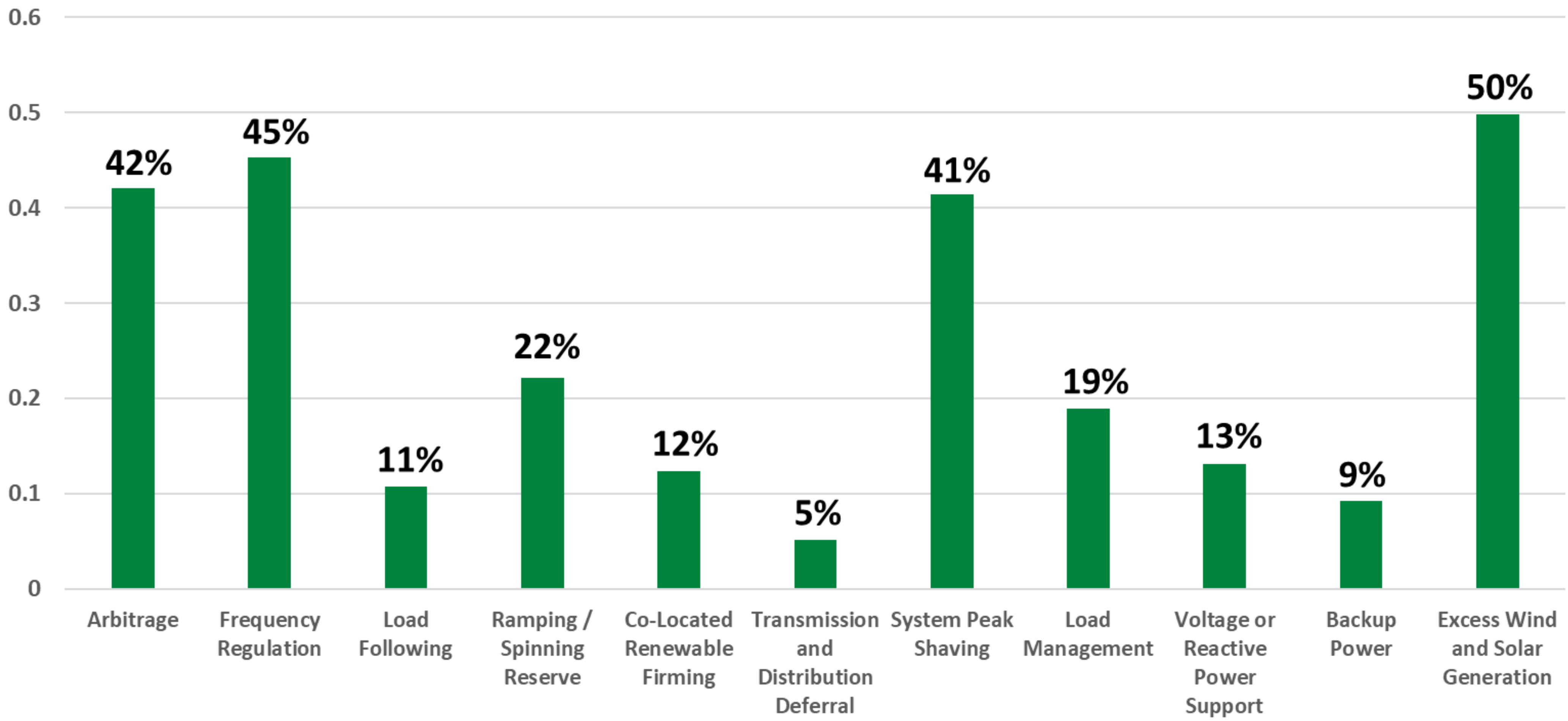
** Not necessarily specific to LDES.*



In total, about 15 states have what I could characterize as "substantive energy storage policy frameworks," meaning that they have more than one energy storage policy in place.

In addition, 19 states have 100% clean energy or 100% renewable energy goals with aggressive deadlines. The latter (100% renewable goal) will require energy storage in order to be achieved.

How is energy storage is being used?



Percentage of battery energy storage projects reporting each use case (EIA)
(Projects may select multiple use cases, which can be referred to as "value stacking")

What are the indicators of a strong energy storage marketplace?

- **Robust policy frameworks:** States with more than one policy lever: e.g., states with procurement targets, financial incentives, and other enabling regulations.
- **Large-scale projects:** States like California and Texas have seen the development of massive battery storage projects, which significantly contribute to their overall capacity.
- **Decreasing costs:** The falling costs of batteries and other energy storage technologies are making deployment more economically viable.
- **Renewable energy growth**: The increasing deployment of variable renewable energy sources like solar and wind necessitates energy storage to ensure grid reliability and balance supply with demand.
- **Grid reliability:** Energy storage helps maintain grid stability, especially during periods of high demand or when renewable energy generation is low. Examples could be utility VPP programs.

Is there a correlation between ES policymaking and ES deployment?

- I would say that the data clearly shows that the answer is "yes." There are also exceptions (namely, Texas) which I will discuss but for the most part there is a "build it and they will come" sensibility that continues to play out with regard to policies driving ES development.
- Example: #1 example is **California**
  - **Procurement policies:** 1,825 MW procured by 2020 and installed by 2024. Carve-out of 500 MW for BTM. Additional 2 GW (1 GW of 12-hr storage and 1 GW multi-day) of LDES to be deployed between 2031 and 2037.
  - Subsidies and incentives offered.
  - State-sanctioned procurements through the CEC.
  - **Results:** 10,383 MW total (about 4,999 MW pending) + 1,193 MW BTM. This represents a surplus of the mandate achieved in the range of 569%.
  - California continues to represent the leading example of a state that has driven energy storage development through policy (not only the procurement mandate but incentives).

Other state examples:

- **Arizona (#3 in capacity):** Emerging as a strong market, especially through pairing solar with batteries; established policy support for energy storage via the state's Energy Storage Policy; utility investments in energy storage that have been approved by the Arizona Corporation Commission.
- **Nevada (#4):** Has set procurement targets and expanded renewable energy tax credits to include battery storage.
- **New Mexico (#6):** Established energy storage as a resource type in legislation; goal for 100% zero-carbon resources by 2045; interconnection queue reform; mandate for utilities to consider storage in their IRPs.
- **Colorado (#7):** Consumer right to energy storage; streamlined rules governing the installation, interconnection, and use of customer-sited energy storage systems; require utilities to consider storage in IRPs.
- **Hawaii (#8):** 100% renewable goal by 2045; financial incentives (e.g., the Battery Bonus program provides financial support to customers who install BTM batteries).

Exceptions:

- **Texas (#2 in capacity):** With virtually no energy storage policies in place, is Texas an anomaly? Very unique for multiple reasons:
  - *Unique Market Conditions*: Deregulated wholesale market not under the jurisdiction of FERC
  - *Arbitrage Potential:* The increasing penetration of intermittent resources like wind and solar power in Texas has created price volatility, allowing BESSs to profit by charging during low-price periods (e.g., during peak solar generation) and discharging during high-demand, high-price periods (e.g., during evening hours).
  - *Ancillary Services:* BESS can also generate revenue by providing ancillary services, such as frequency regulation and grid stability support.
  - *High Price Caps and Scarcity Pricing:* ERCOT's high energy price cap and scarcity pricing mechanisms incentivize new resource additions, including energy storage, by allowing them to capitalize on price spikes.
  - *Extreme Weather Events*
  - *Rapid Load Growth*
  - *Streamlined Permitting:* Texas' streamlined permitting process and ample land availability make it easier for developers to deploy BES projects.

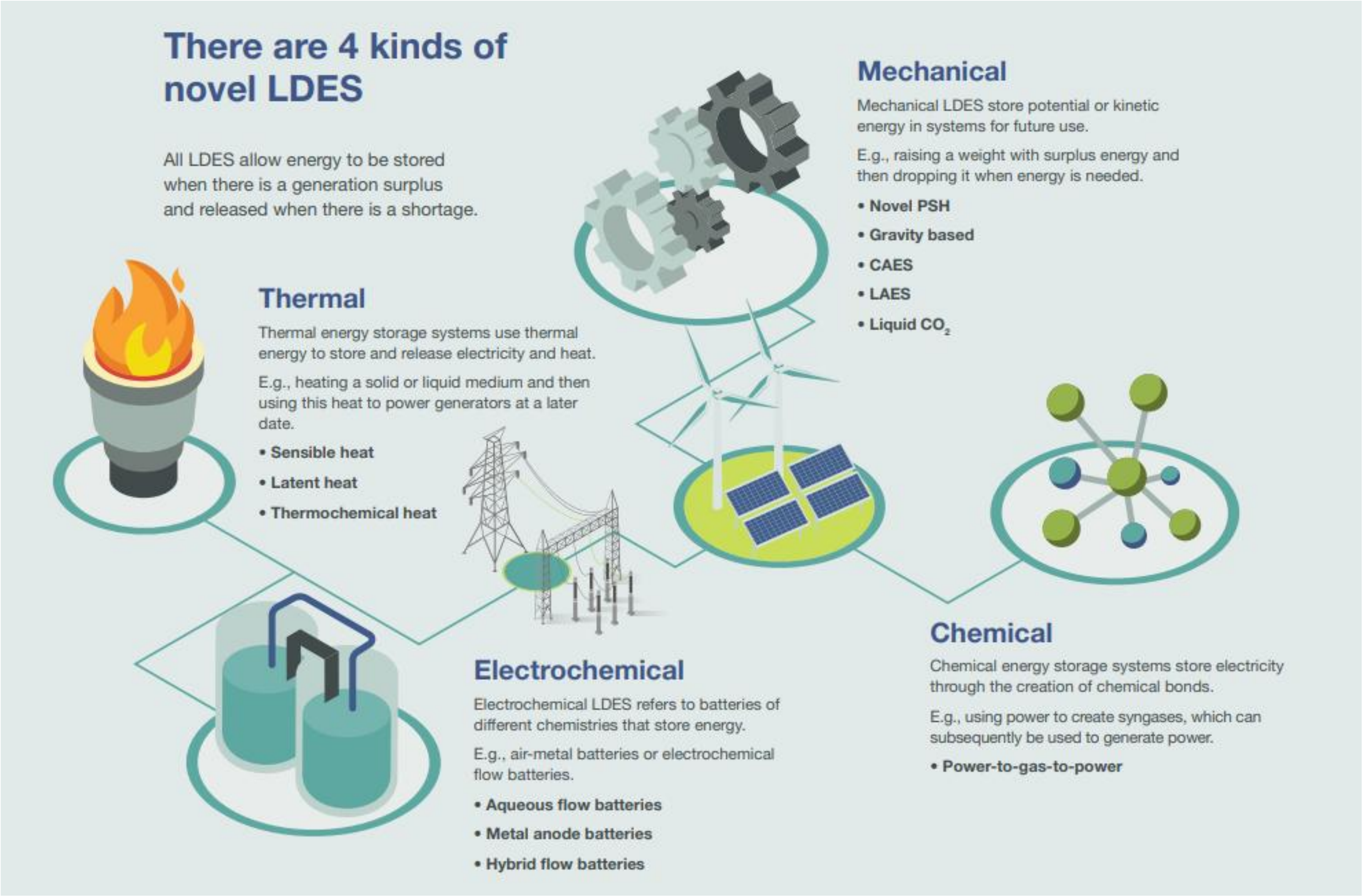
Other exceptions:

- **Georgia and Mississippi (#9 and #10 in capacity):** Georgia does not have a dedicated energy storage policy; Mississippi has net metering and a battery incentive program that runs through 2027. Neither has an RPS. So how do we explain their positions in the top 10?

  - The Southeast remains vertically integrated and thus the role of Southern Company is prominent.

  - Southern Company is taking an "all of the above" approach toward resources, which includes energy storage. This is reflected in Georgia Power's IRP with BESS inclusion.

  - Renewables + storage projects are going forward in the Southeast / bilateral without RPS because it is the cheapest solution for the modeled load. (This is not yet true for LDES).



Source: Pathways to Commercial Liftoff: Long Duration Energy Storage, DOE

Key LDES storage types and parameters

Energy storage form	Technology	Market readiness	Max deployment size, MW	Max nominal duration, Hours	Average RTE[1] %
Mechanical	Novel pumped hydro (PSH)	Commercial	10–100	0–15	50–80
	Gravity-based	Pilot	20–1,000	0–15	70–90
	Compressed air (CAES)	Commercial	200–500	6–24	40–70
	Liquid air (LAES)	Pilot (commercial announced)	50–100	10–25	40–70
	Liquid CO_2	Pilot	10–500	4–24	70–80
Thermal	Sensible heat (eg, molten salts, rock material, concrete)	R&D/pilot	10–500	200	55–90
	Latent heat (eg, aluminum alloy)	Commercial	10–100	25–100	20–50
	Thermochemical heat (eg, zeolites, silica gel)	R&D	na	na	na
Chemical	Power-to-gas-(incl. hydrogen, syngas)-to-power	Pilot (commercial announced)	10–100	500–1,000	40–70
Electrochemical	Aqueous electrolyte flow batteries	Pilot/commercial	10–100	25–100	50–80
	Metal anode batteries	R&D/pilot	10–100	50–200	40–70
	Hybrid flow battery, with liquid electrolyte and metal anode	Commercial	>100	25–50	55–75

1. Power-to-power only. RTEs of systems discharging other forms of energies such as heat can be significantly higher.

Source: Pathways to Commercial Liftoff: Long Duration Energy Storage, DOE

THE NATIONAL CONSORTIUM FOR THE ADVANCEMENT OF LDES TECHNOLOGIES

The LDES National Consortium provides a forum through which stakeholders across the LDES ecosystem can convene to **identify barriers, determine potential synergies, and collaboratively develop and implement strategies necessary to achieve LDES technology commercialization** within the next decade.

MAJOR DELIVERABLES OVER NEXT THREE YEARS:

- LDES Demonstrations & Deployments Tracking System
- LDES Technology Maturity Evaluation Framework
- Assessment of Utility Needs for LDES
- Geographical Readiness Assessments
- Evaluation of US Wholesale Markets
- Evaluation of US Retail Markets
- Full Set of Commercial Pathways Recommendations
- Networking and Community Outreach

National Launch: January 2024

Lab Leadership

Lead by Sandia Labs partnering with ANL, INL, NREL, ORNL, & PNNL

~200 Teaming Partners

LDES National Consortium will be comprised of U.S. industry and community stakeholders, known as "Teaming Partners."

Website

Community of Knowledge and Best Practices ensuring findings are easily accessible

3 Years
$7M Federal Funds + Cost Share

15 Tiger Teams

Topical working groups to evaluate challenges.

Goals & Scope

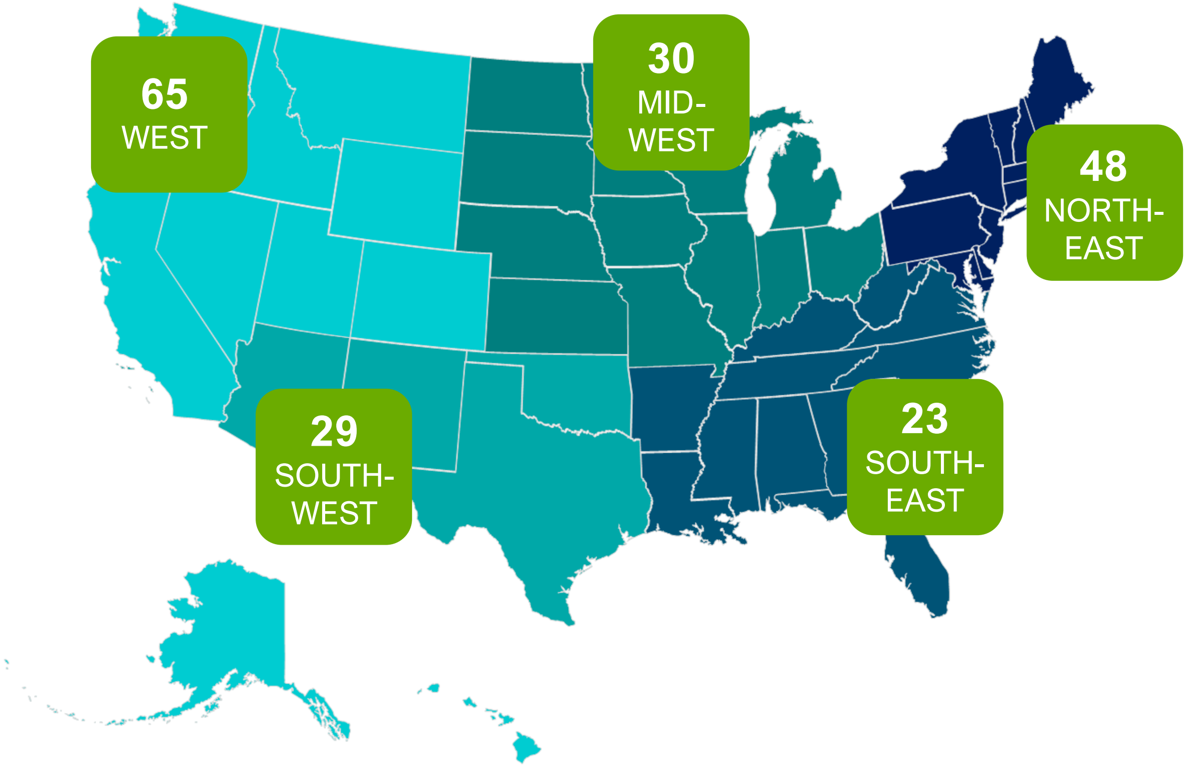
A Leadership Team powered by the knowledge, expertise, and relationships possessed by six National Labs guides a broad network of industry and community stakeholders **(i.e., "Teaming Partners")** to collaboratively develop these actionable recommendations.

- ✓ Focus on addressing the adoption challenges facing the full range of LDES technologies.
- ✓ Emphasis placed on bringing stakeholders together, including off-takers, regulators, adopters, investors, communities, etc., to develop actionable recommendations in a consensus-based process.
- ✓ Focus on defining a full set of recommendations to accelerate demonstration and deployment of LDES technologies in this decade.
- ✓ The overarching goal is to identify and solve adoption challenges to enable technology commercial liftoff and deployment.

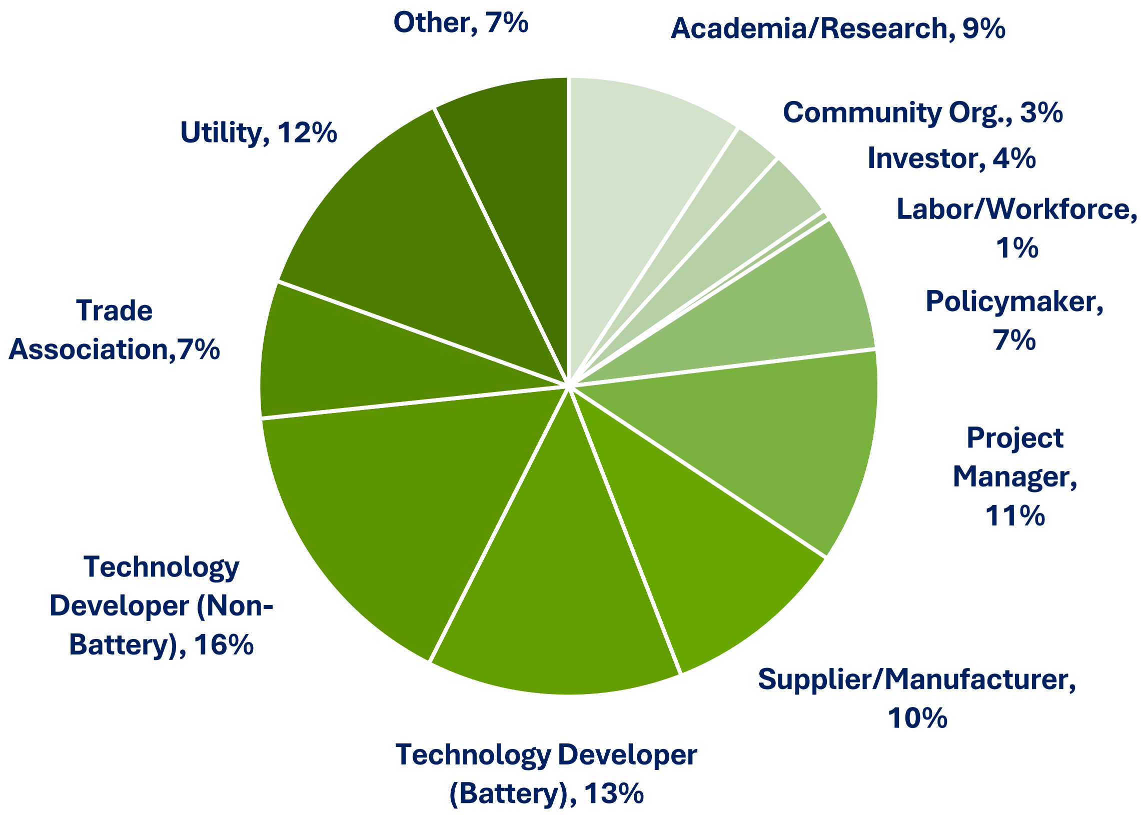
Current Teaming Partner Demographics

200+ U.S. TEAMING PARTNERS

Partners by U.S. Region



Partners by Organization Type



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Initial set of challenges pulled directly from the DOE's LDES Lift-off Report.

- Cost of an LDES system needs to come down by 2030
- LDES technologies must achieve 7-15% improvement in roundtrip efficiency to compete with Li-ion storage and hydrogen.
- The specific needs related to LDES workforce training (i.e., skills and training) are presently not well defined.
- A uniform approach toward developing resource adequacy compensation for LDES technologies does not exist, in either regulated markets (PUC evaluation) or competitive markets (ISO/RTO).
- A comprehensive assessment of necessary supply chain improvements specific to LDES technologies does not presently exist.
- There is presently a lack of resources regarding how to evaluate grid upgrades or expansions that will be necessary to accommodate both new variable renewable generation sites and LDES systems
- Presently, there is no publicly available evaluation of LDES technologies against primary competitive factors.
- LDES is not included in most utility grid firming plans
- LDES use cases require market changes.
- ISO and RTO markets will need to develop support mechanisms.
- State-level policymaking specific to LDES has been very limited.

Source: Pathways to Commercial Liftoff: Long Duration Energy Storage, DOE

LDES Policies are slowly emerging.

- Targeted & centralized procurement: The CPUC is targeting 2 GW of LDES, with 1 GW specifically for multi-day storage and another 1 GW for storage with at least a 12-hour discharge period. The California Department of Water Resources (DWR) will act as the central procurement body for LDES, geothermal, and offshore wind resources.

- Their roadmap includes a target of 20% of 8+ hour resources in bulk storage procurements, aiming for 1200 MW of LDES by 2030.

- Within the state's broader ES procurement target (legislative mandate that utilities solicit proposals to secure up to 5 GW by 7/1/30), the target includes specific capacities for mid-duration (4-10 hours), long-duration (10-24 hours), and multi-day (24+ hours) storage.

LDES Policies are slowly emerging.

- Currently exploring the potential for LDES and how to expand upon existing ES target of 300 MW of installed capacity by end of 2030. renewable energy sources.

The Michigan Public Service Commission (MPSC) is required to study LDES and multi-day storage (completed report in February) and establish processes to guide integration into utility planning.

We are preparing ongoing sets of Industry Recommendations

- The recommendations address the commercialization challenges referenced by the DOE's 2023 Lift-off Report.
- The 11 challenges were assigned to the Tiger Teams; most of the challenges now have 5-10 recommendations associated with them.
- Along with making the recommendations, we will be developing an implementation tracking system to track results. (Findings will be included in forthcoming assessment reports).

2025 Calibrations

- The LDES National Consortium adheres to the DOE's Secretarial Order and other federal executive orders seeking to "Unleash Golden Era of American Energy Dominance."
- America must lead the world in innovation and technology breakthroughs, which includes accelerating the work of the DOE's National Laboratories.
- LDES technologies can play an increasingly critical role in maintaining the security of the nation's electric grid and supporting resilience efforts across diverse markets.

1. **Advance Energy Addition, Not Subtraction**
2. **Unleash American Energy Innovation**
3. Return to Regular Order on LNG Exports
4. Promote Affordability and Consumer Choice in Home Appliances
5. Refill the Strategic Petroleum Reserve (SPR)
6. **Modernize America's nuclear stockpile**
7. **Unleash Commercial Nuclear Power in the United States**
8. **Strengthen Grid Reliability and Security**
9. **Streamline Permitting and Identify Undue Burdens on American Energy**

The work of the LDES Consortium directly supports the nine principles articulated by DOE Secretary Chris Wright that will guide the DOE's agenda going forward.

Website Information

The Community of Knowledge & Best Practices Website is the official name for the LDES National Consortium's public facing Website.

- **The Website will be the primary repository for the output of the LDES National Consortium, along with knowledge-sharing information that seeks to enhance the public's understanding of LDES and the role it will play in the energy future of the US.**
- **It is anticipated that the Website will include, but is not limited to:**
  - Continually updated list of Industry Recommendations
  - A list of participating Teaming Partners that includes organization name, URL, primary point of contact name and title, and contact information (after approval from the Teaming Partner organization).
  - A glossary of "LDES common terminology" with suggestions on how key terms should be defined.
  - A library of previously published LDES materials developed by our national Lab Partners and DOE offices.
  - LDES Technology Evaluation Matrix
  - LDES Demonstrations & Deployment Project Tracking System

ldesconsortium.sandia.gov

Acknowledgements

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THANK YOU!

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