Strategies to Help Maintain Reliability and Improve Grid Efficiency

Presentation to

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Representing

BATTERY COUNCIL INTERNATIONAL

100 YEARS

October 21, 2024

BCI – Serving America's rechargeable battery industry

Member operations

Technologies and applications

BCI member companies manufacture a variety of battery chemistries

Pb Lead

Flow

Na Sodium

Ni Nickel

Li Lithium

Transportation & Power Sports

Telecom, Data Centers & Critical Systems

Industrial Logistics

Power Grid & Energy Storage

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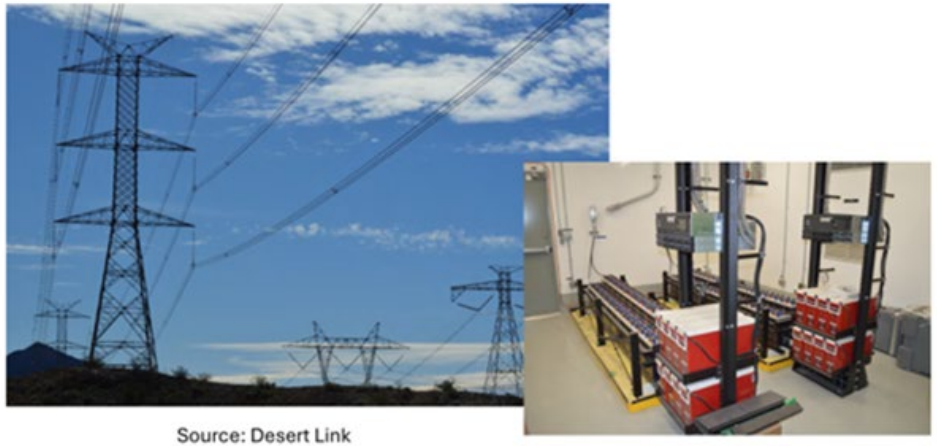
For more than 100 years, BCI member companies have been – and continue to be – suppliers to America's electric power industry.

Batteries in generation

Source: EMR

Batteries in long distance transmission



Source: Desert Link

Batteries in distribution

Source: AEP

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Energy storage system (ESS) profiles are evolving.

System components

Batteries provide capacity and voltage.

Control system determines when the batteries should be charged and provide power to serve loads.

Inverter converts DC to AC voltage suitable for consumers.

Battery management system (BMS) controls battery temperature, important for all types of batteries, including lithium-ion.

Unmanaged temperature can cause thermal runaway, leading to fire and explosion.

System functions

Frequency regulation
Arbitrage
Ramping
Spinning reserves
Voltage support
Congestion relief

Why these functions are critical:

Estimated cost of electricity interruptions in the US: ~$150B/year.

For every $1.00 spent on electricity, $0.50 is spent to cover the cost of power failures.

Source: B Chalamala, Sandia National Laboratory, 2024

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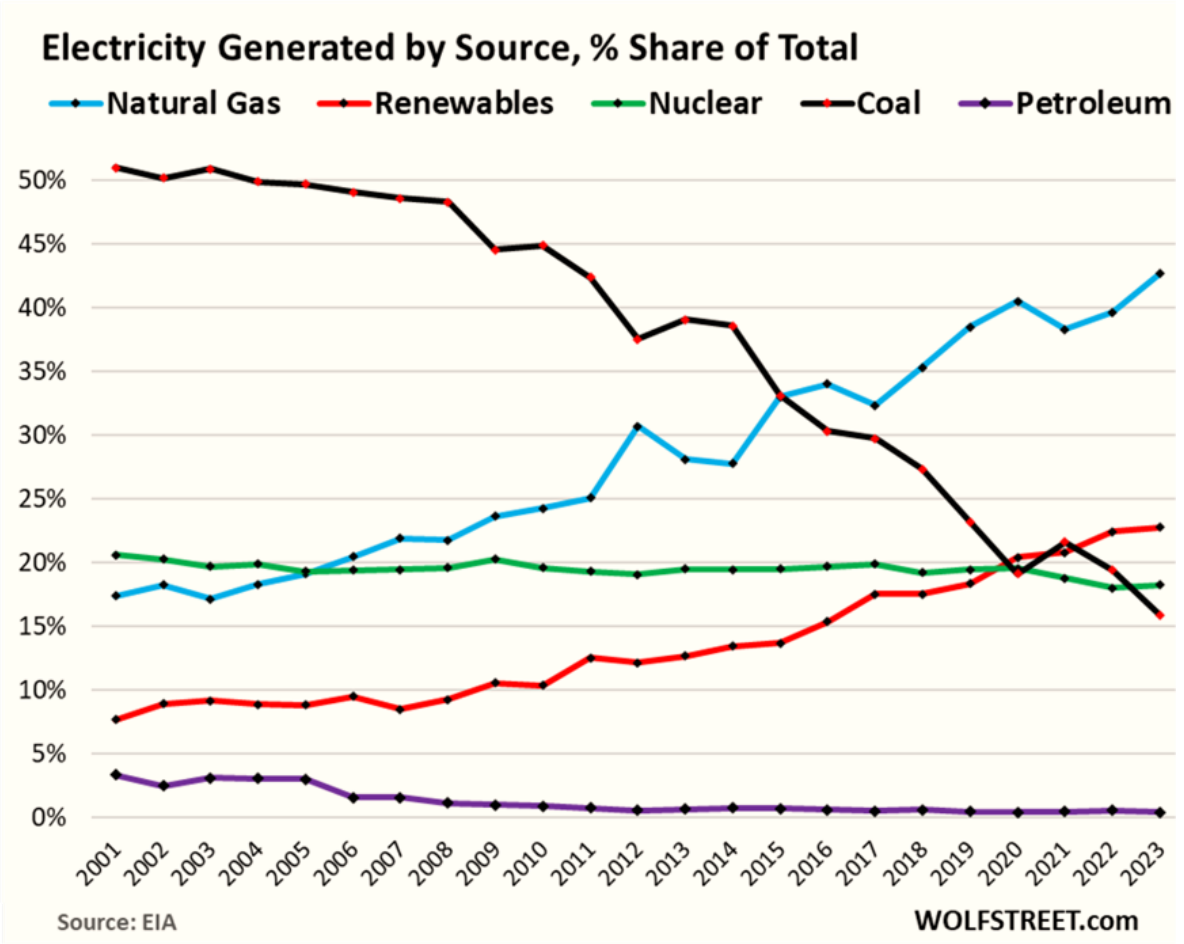
Climate change is a big challenge, but not the only one. The total electric power paradigm requires efficient source utilization.



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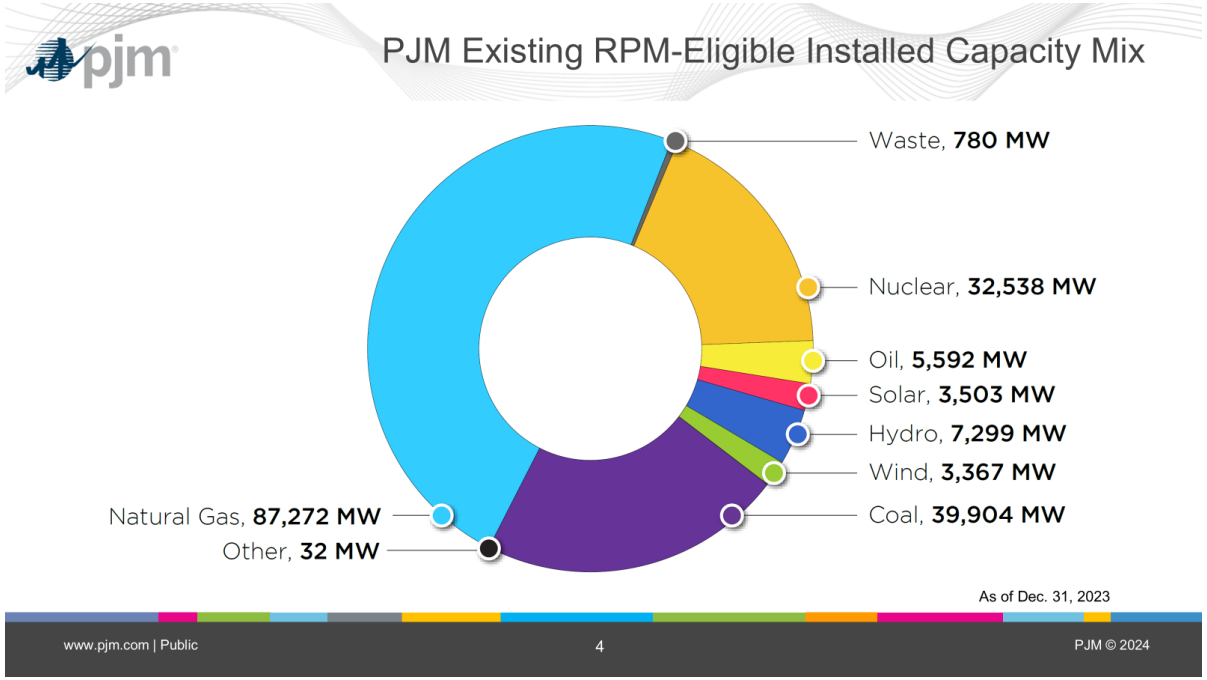
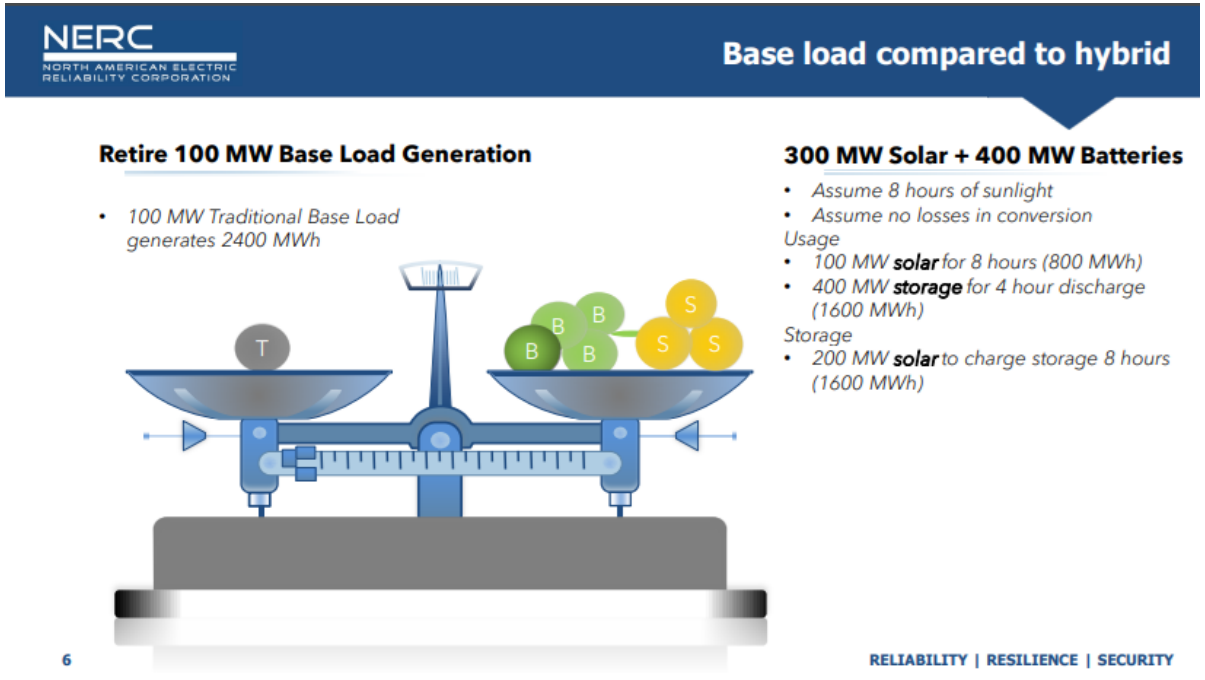
What PJM and NERC say about capacity mix:





"Growing levels of intermittent and limited duration resources, such as wind, solar and battery storage, do not replace conventional large-scale generation installations megawatt-for-megawatt, but rather require multiple megawatts to replace one megawatt of dispatchable generation due to their limited availability in certain hours of the day and seasons of the year."

PJM RTEP – March 7, 2024, p. 19

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Why a lack of nationwide consensus on grid storage? Economics. Some areas of the U.S. are more willing than others to embrace it.

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

"IBRs and DERs increase variability and uncertainty in demand, so they require careful attention in planning for resource adequacy and energy availability.

"Until storage technology is fully developed and deployed at scale, natural-gas-fired will remain a necessary balancing resource to provide increasing flexibility needs."

2023 State of Reliability,
North American Electric Reliability Corporation

U.S. DEPARTMENT OF ENERGY

"Energy storage is essential to enabling utilities and grid operators to effectively adopt and utilize the nation's growing portfolio of clean energy resources, like solar and wind, on demand. However, today's energy storage technologies are not sufficiently scaled or affordable to support the broad use of renewable energy on the grid."

DOE announcement
"Biden-Harris Administration Announces $325 Million For Long-Duration Energy Storage Projects"
September 22, 2023

The U.S. Energy Information Administration (EIA) lays out the economics. Storage costs must come down.

Estimated levelized costs of new assets in 2027 expressed in 2021 $/MWh

Plant type	Capacity factor (percent)	Levelized capital cost	Levelized fixed O&M[b]	Levelized variable cost	Levelized transmis-sion cost	Total system LCOE or LCOS	Levelized tax credit[c]	Total LCOE or LCOS including tax credit
Dispatchable technologies								
Ultra-supercritical coal	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*
Combined cycle (natural gas)	87%	$8.56	$1.68	$25.80	$1.01	$37.05	*NA*	$37.05
Advanced nuclear	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*
Geothermal	90%	$21.80	$15.20	$1.21	$1.40	$39.61	-$2.18	$37.43
Biomass	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*
Resource-constrained technologies								
Wind, onshore	43%	$27.45	$7.44	$0.00	$2.91	$37.80	*NA*	$37.80
Wind, offshore	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*
Solar, standalone	29%	$26.35	$6.34	$0.00	$3.41	$36.09	-$2.64	$33.46
Solar, hybrid (with 4-hr Li-ion storage)	26%	$39.12	$15.00	$0.00	$4.51	$58.62	-$3.91	$54.71
Hydroelectric	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*	*NB*
Capacity resource technologies								
Combustion turbine	10%	$55.55	$8.37	$49.93	$10.00	$123.84	*NA*	$123.84
Battery storage	10%	$64.74	$29.64	$18.92	$11.54	$124.84	$0.00	$124.84

Source: U.S. Energy Information Administration, *Annual Energy Outlook 2022*

Current state of the ESS market

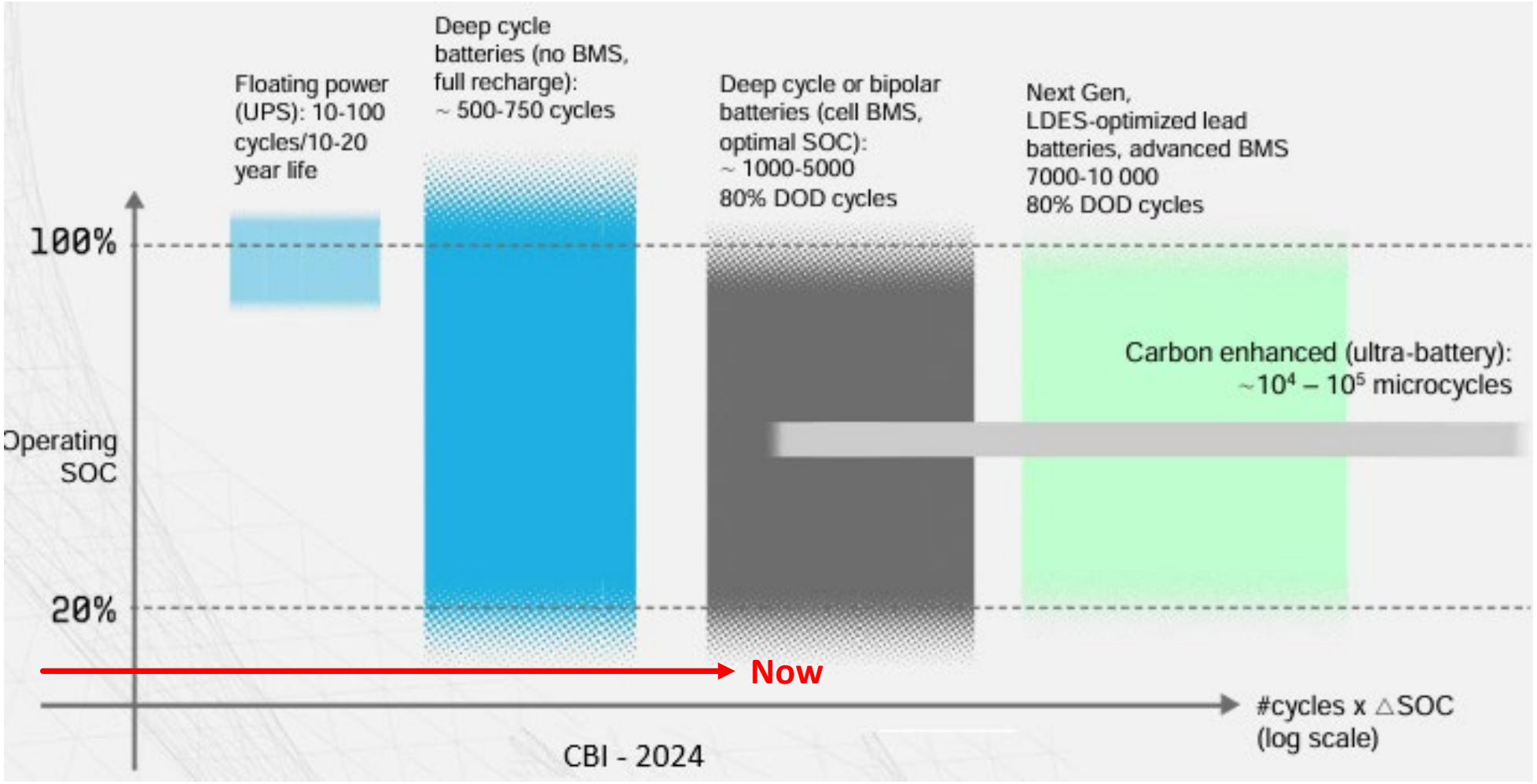
The key market for all energy storage moving forward

Battery Type	ESS Serv. Life (AV)	Energy Density (Wh/kg)	Working State of Charge (SOC)	Approximate capital cost ($kWh) -10 MW 10 hr	Cycle life (based on 80% DOD)
Pb Bi-polar	7 years	70	0-100%	100*	1200
Thin Plate Pure Lead (12V)	7 years	45	30-90%	345	1500
Advanced AGM (2V)	10 years	35	20-90%	412	4000
LFP	10 years	120-150	20-100%	378	3600-4800
NMC	10 years	150-180	20-100%	428	3000-3600
VRFB	25 years	20	35-100%	408	Unlimited

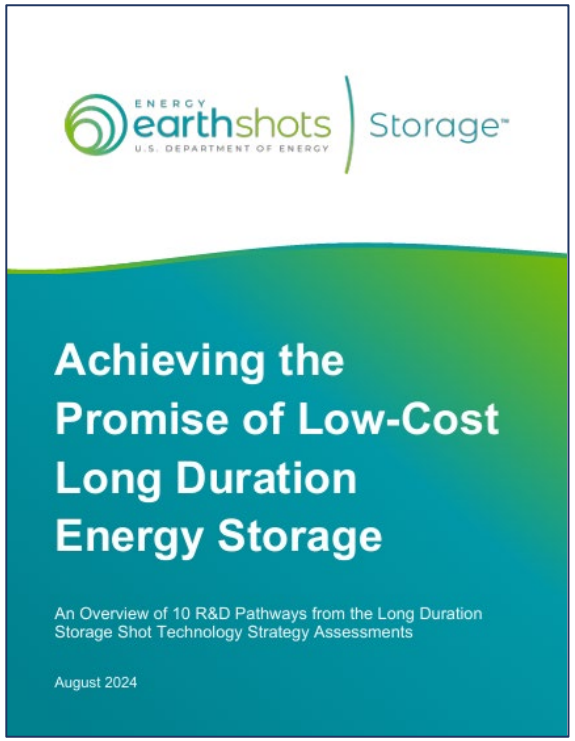
- The worldwide ESS market is predicted to need 585 GW of installed energy storage by 2030.
- Massive opportunity across every level of the market, from residential to utility, especially for long duration.
- No current technology fits long duration requirement.
- Lead is a viable solution, if cycle life is increased.
- Other technologies like flow need to lower cost, already allow for +25 years use (with some O&M of course).

Source: 2022 Grid Energy Storage Technology Cost and Performance Assessment
*Source: 2023 Advanced Battery Concepts Cost indication for bipolar ESS modules

Pb battery example – Cycle life (energy throughput) is key in ESS!



DOE Long Duration Storage Shot: Estimated R&D investment required for technologies to approach DOE's ambitious $0.05/kWh cost goal.



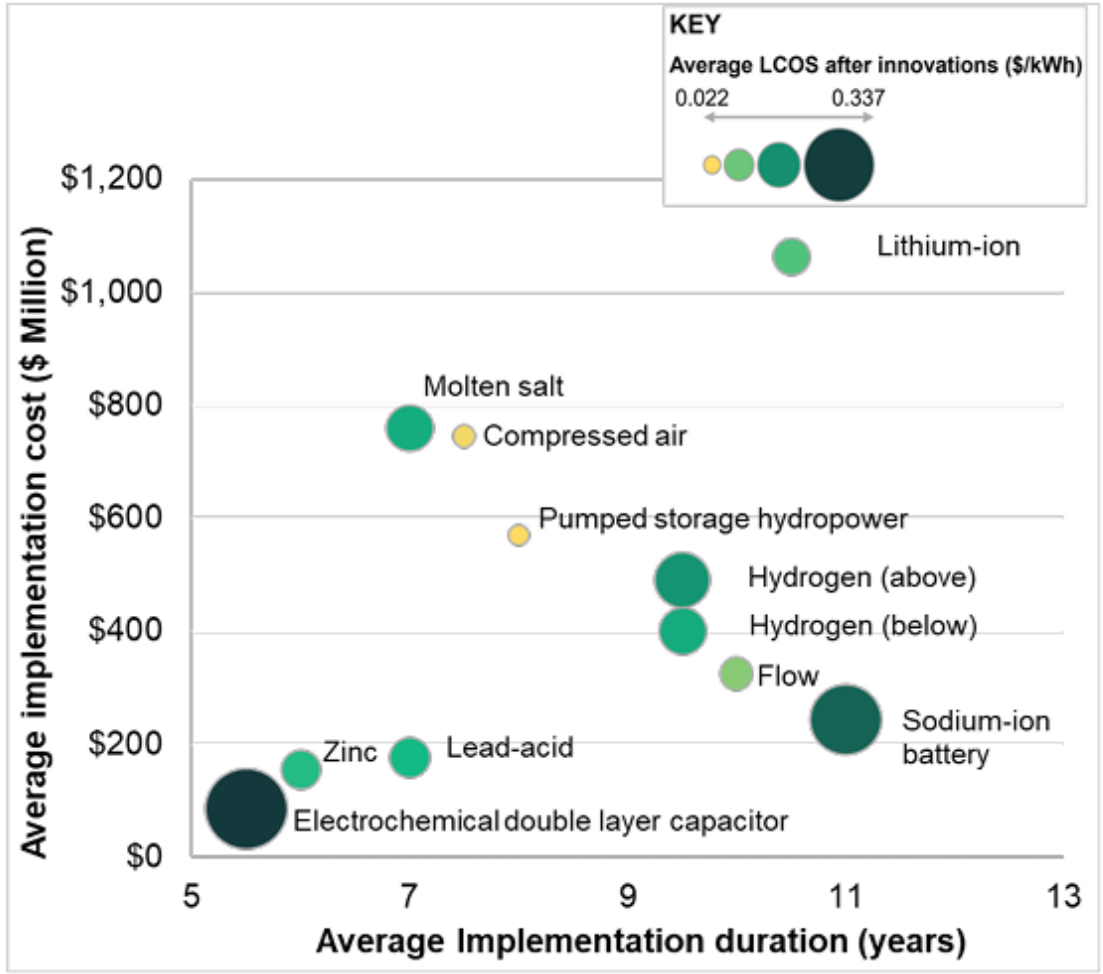


Figure ES2. The average duration and cost of implementing the top 10% of innovation portfolios that drive down the LCOS of long duration energy storage. The circle area and color correspond to the average projected LCOS after implementing the top 10% innovation portfolios for each technology. Above and below ground hydrogen storage are shown separately. LCOS: levelized cost of storage.

DOE's Office of Electricity (OE) held workshops with U.S. storage experts in 2022-23.

OE on July 25, 2023, issued competitive FOA 3020.

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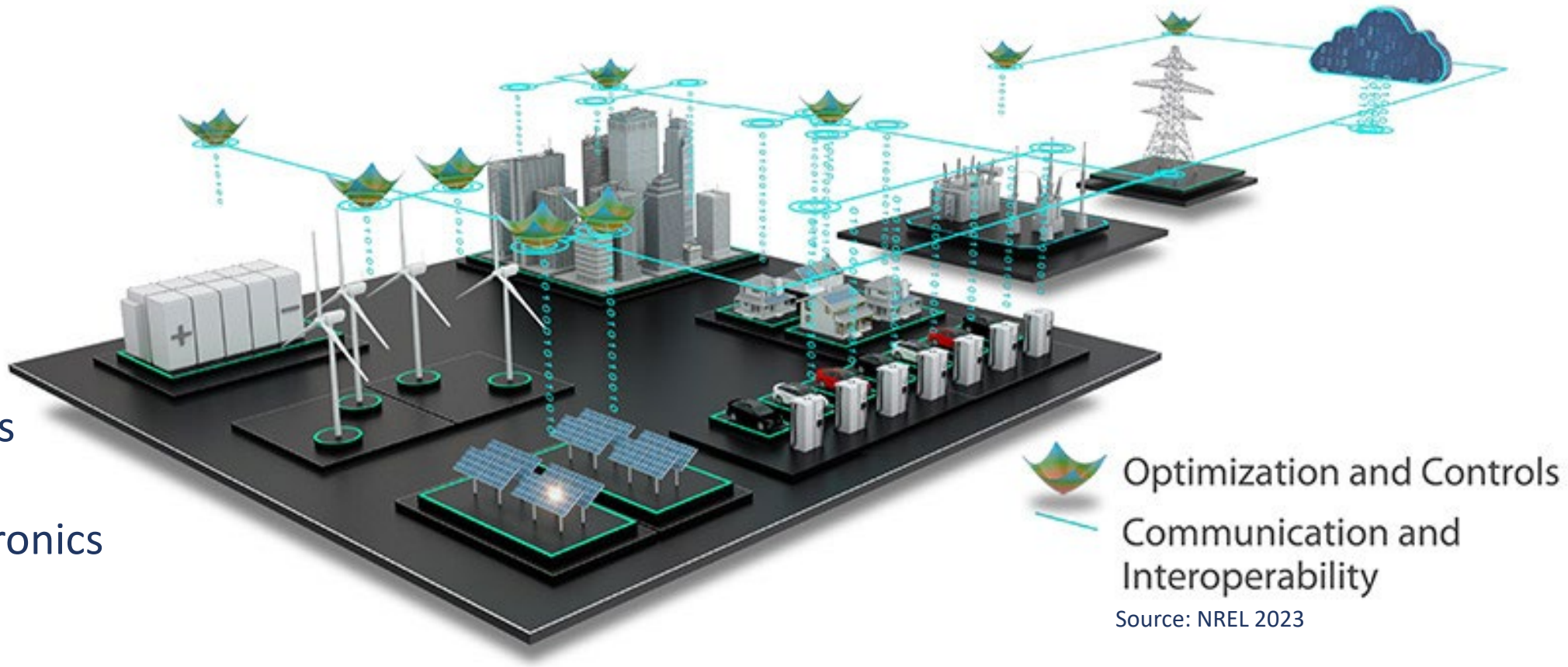
DOE Office of Electricity announced awards for FOA 3020 on April 8, 2024, focused on alternatives to lithium-ion.

- **New Lab, LLC**
  - Project Title: *Enabling high-capacity zinc utilization through electrode and electrolyte fundamentals*
  - Federal share: $4,992,570
- **Battery Council International**
  - Project Title: *Consortium for Lead Battery Leadership in LDES*
  - Federal share: $4,972,746
- **Clean Tech Strategies LLC**
  - Project title: *Pre-Competitive Research & Development to Accelerate the Maturation of Flow Battery Technologies into Cost-Effective Long Duration Energy Storage*
  - Federal share: $5,000,000

Other storage technologies being researched and potentially reflected in future FOAs include electrochemical (iron, sodium, etc.) and mechanical (compressed air, pumped hydro, etc.).

Batteries and other storage technologies are increasingly essential components of a changing power system.

Storage
Generation
Inverters
Transformers
Conductors
Power electronics



Source: NREL 2023

Suggestion for transmission owners/operators/regulators: Audiences

Message development is of paramount importance, but so is audience awareness.

Don’t forget your suppliers.

Important DOE initiative to raise and address emerging long duration energy storage issues.

THE NATIONAL CONSORTIUM FOR THE ADVANCEMENT OF LONG DURATION ENERGY STORAGE TECHNOLOGIES

BATTERY COUNCIL INTERNATIONAL
ESSENTIAL ENERGY EVERYDAY

Teaming partner

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BATTERY COUNCIL INTERNATIONAL | 100 YEARS

BCI's member companies have supplied batteries and systems to the nation's electric power industry for more than 100 years.

The safe, efficient and reliable performance of today's storage systems is vastly superior to yesterday's.

BCI will continue to support member companies in making tomorrow's energy storage systems even better than today's.