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Session : Long Duration Energy Storage (LDES)

Long-Duration Storage within the NREL Storage Futures Study

Presented By

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Introduction

Recent storage and renewable energy US cost declines are leading to significant changes.

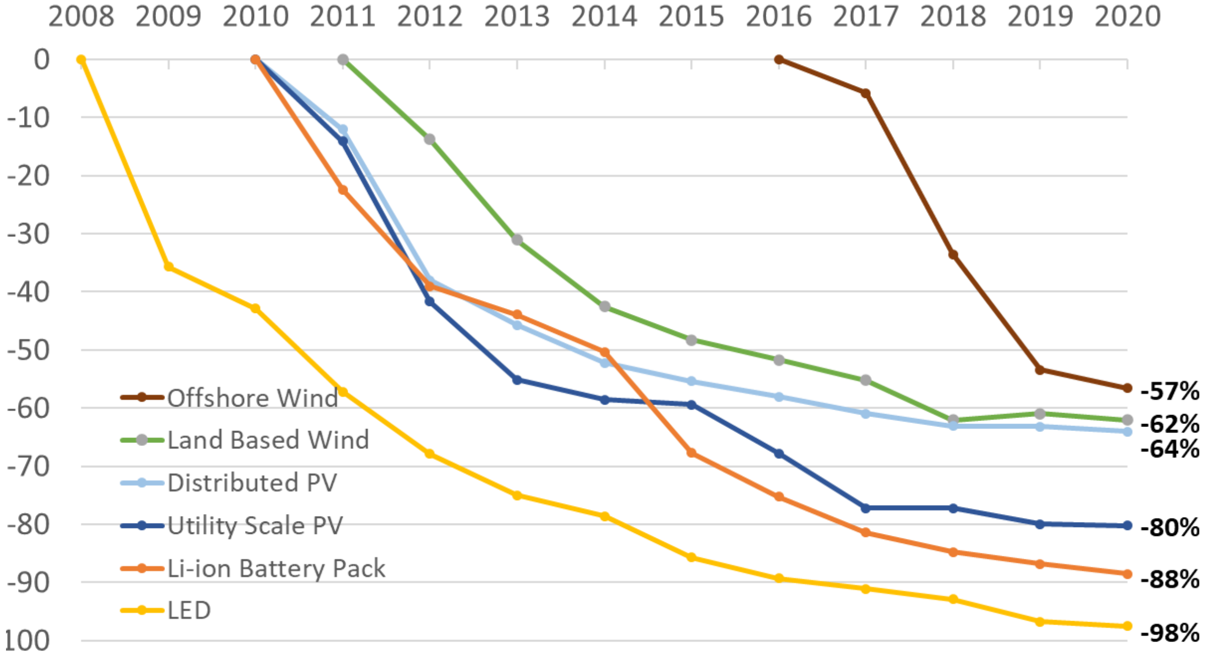
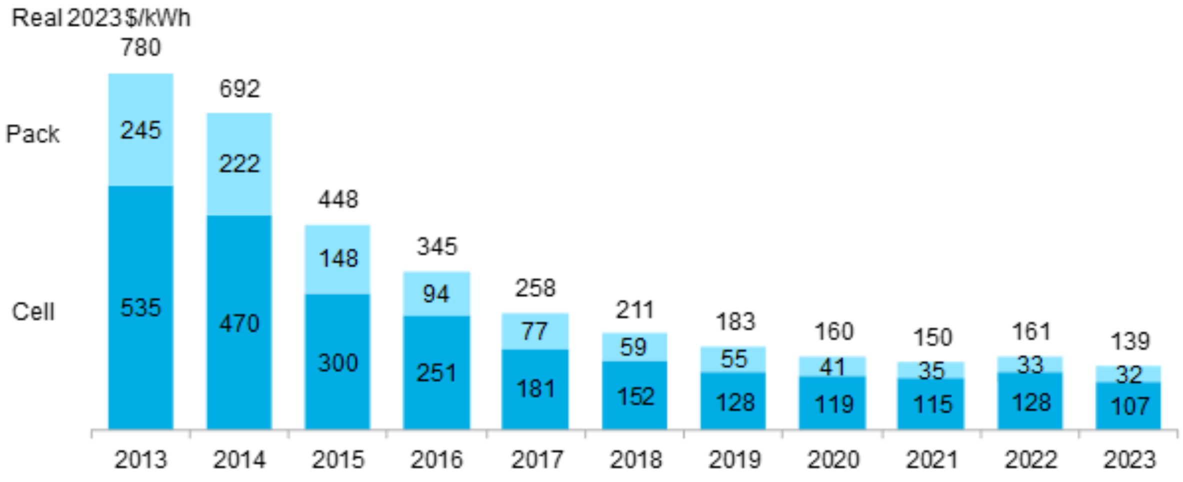


Figure 1: Volume-weighted average lithium-ion battery pack and cell price split, 2013-2023



Source: BloombergNEF. Historical prices have been updated to reflect real 2023 dollars. Weighted average survey value includes 303 data points from passenger cars, buses, commercial vehicles, and stationary storage.

The Four Phases of Storage Deployment

Phase	Primary Service	National Potential in Each Phase	Duration	Response Speed
Deployment prior to 2010	Peaking capacity, energy time shifting and operating reserves	23 GW of pumped hydro storage	Mostly 8–12 hr	Varies
1	Operating reserves	<30 GW	<1 hr	Milliseconds to seconds
2	Peaking capacity	30–100 GW, strongly linked to PV deployment	2–6 hr	Minutes
3	Diurnal capacity and energy time shifting	100+ GW. Depends on both on Phase 2 and deployment of variable generation resources	4–12 hr	Minutes
4	Multiday to seasonal capacity and energy time shifting	Zero to more than 250 GW	Days to months	Minutes

While the Phases are roughly sequential there is considerable overlap and uncertainty!

Phase 3: Ultimate Limits Due to Seasonal Mismatch

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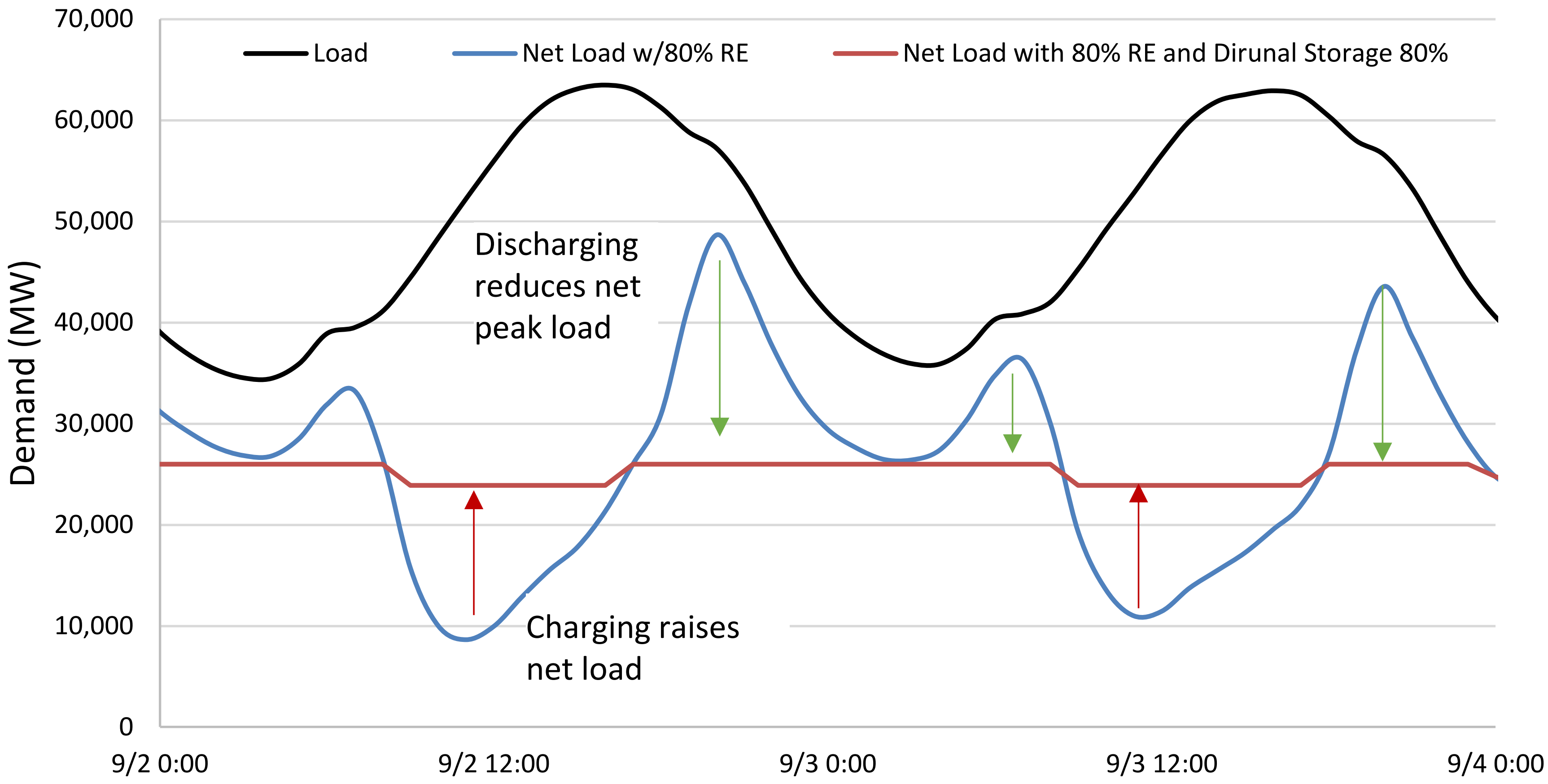
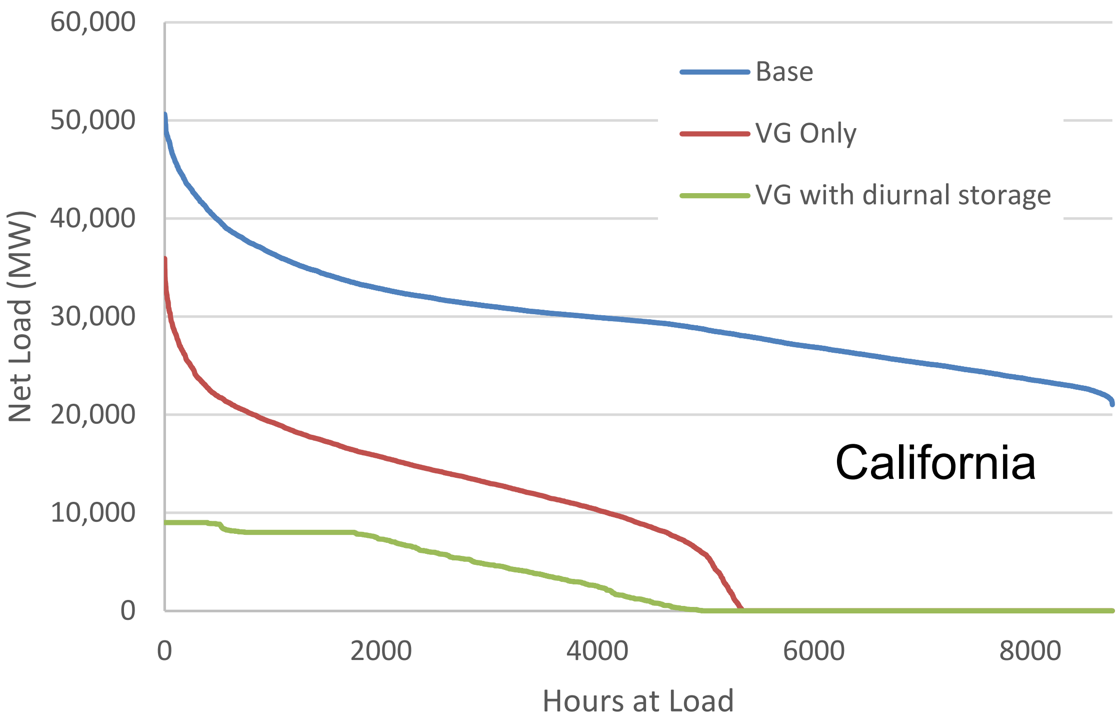
Simulated flattened loads in ERCOT at 80% RE



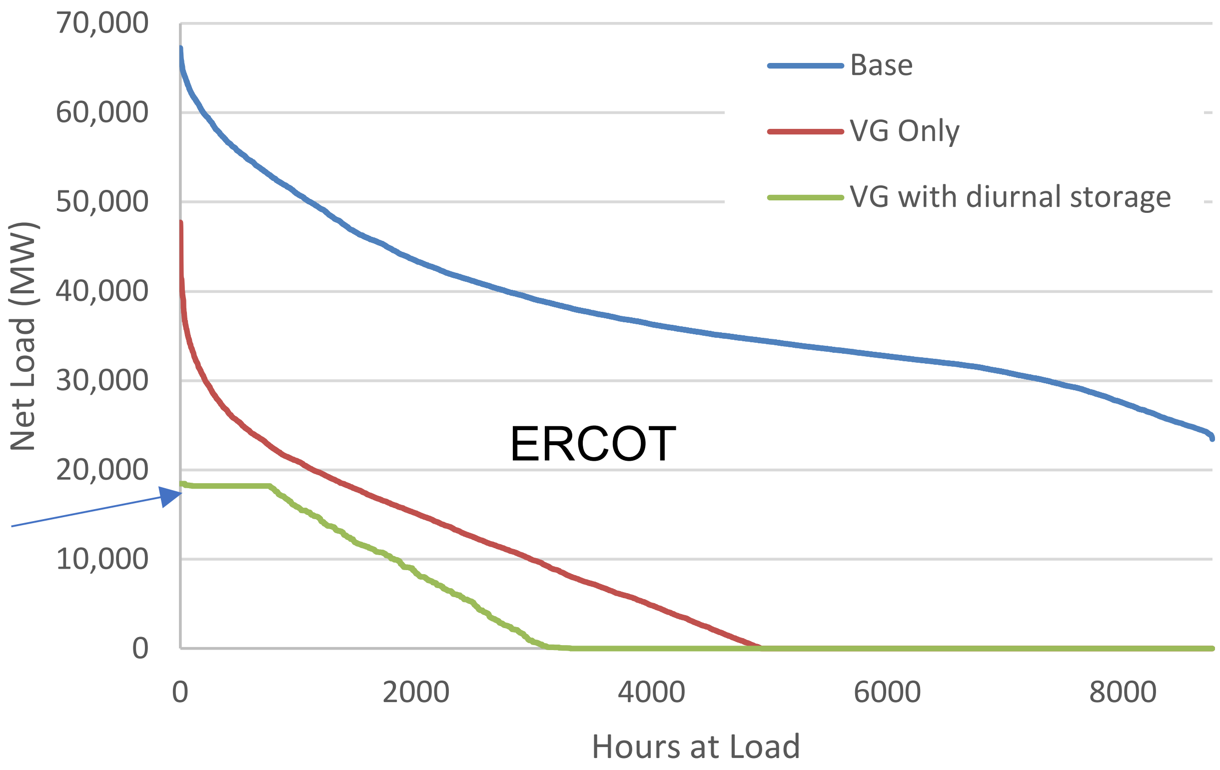
Decline in capacity value due to a flattened net load

Phase 4: The Need for Residual Capacity



Residual load duration curves at 90% RE showing the need for significant firm capacity

Firm capacity needed to meet net peak demand and serve remaining 10%



Capital Cost vs. Duration for Storage Technologies

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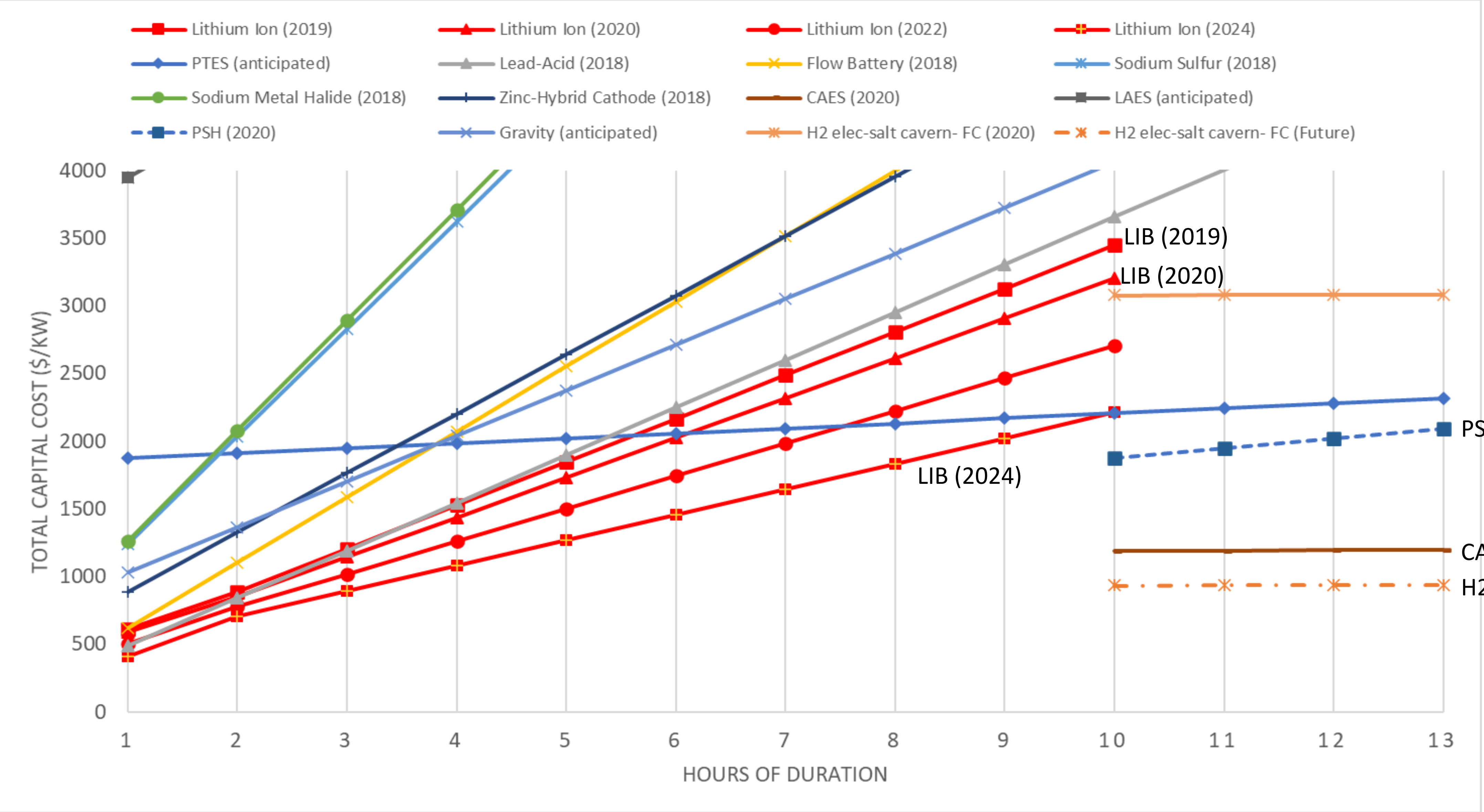
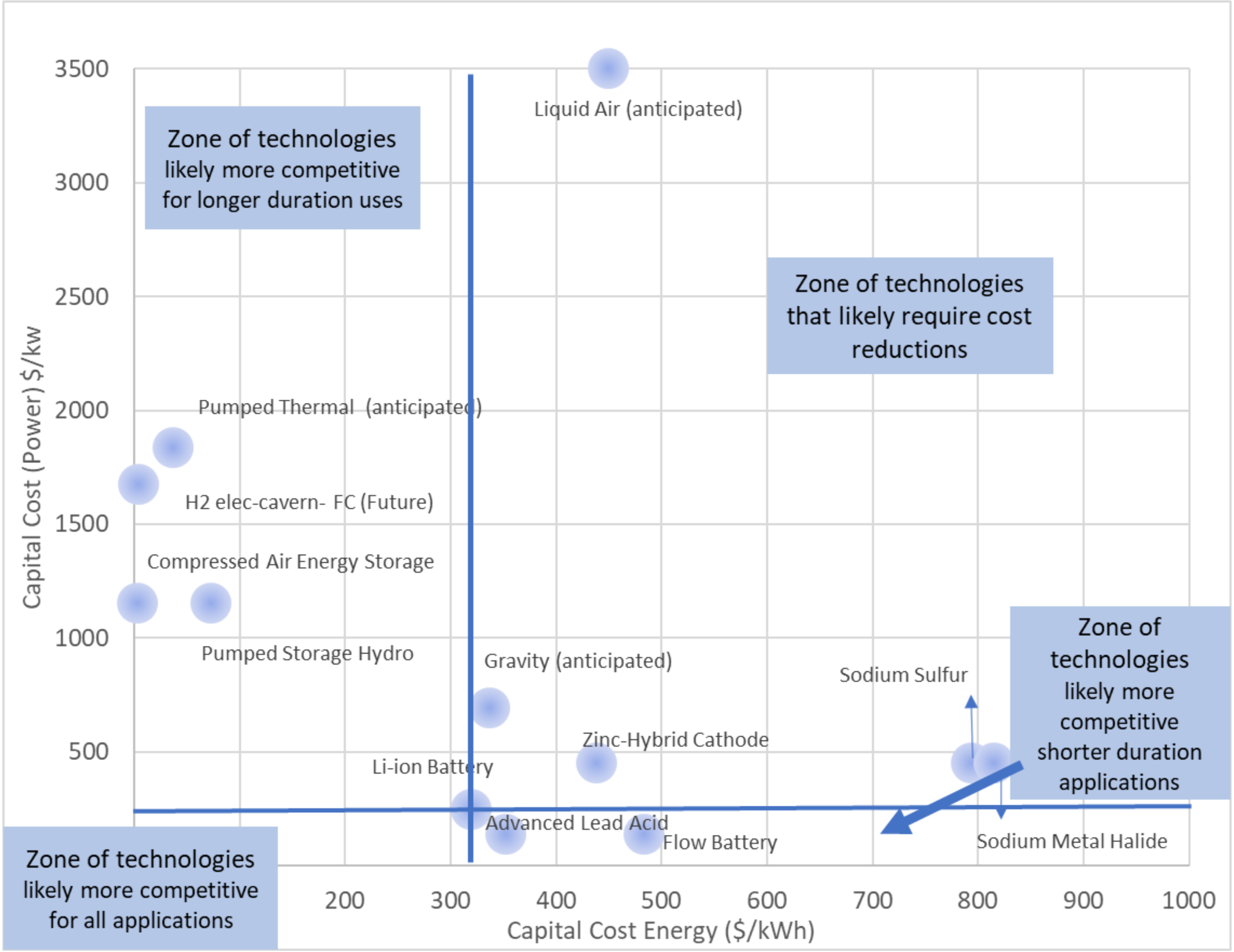


Technology Comparison

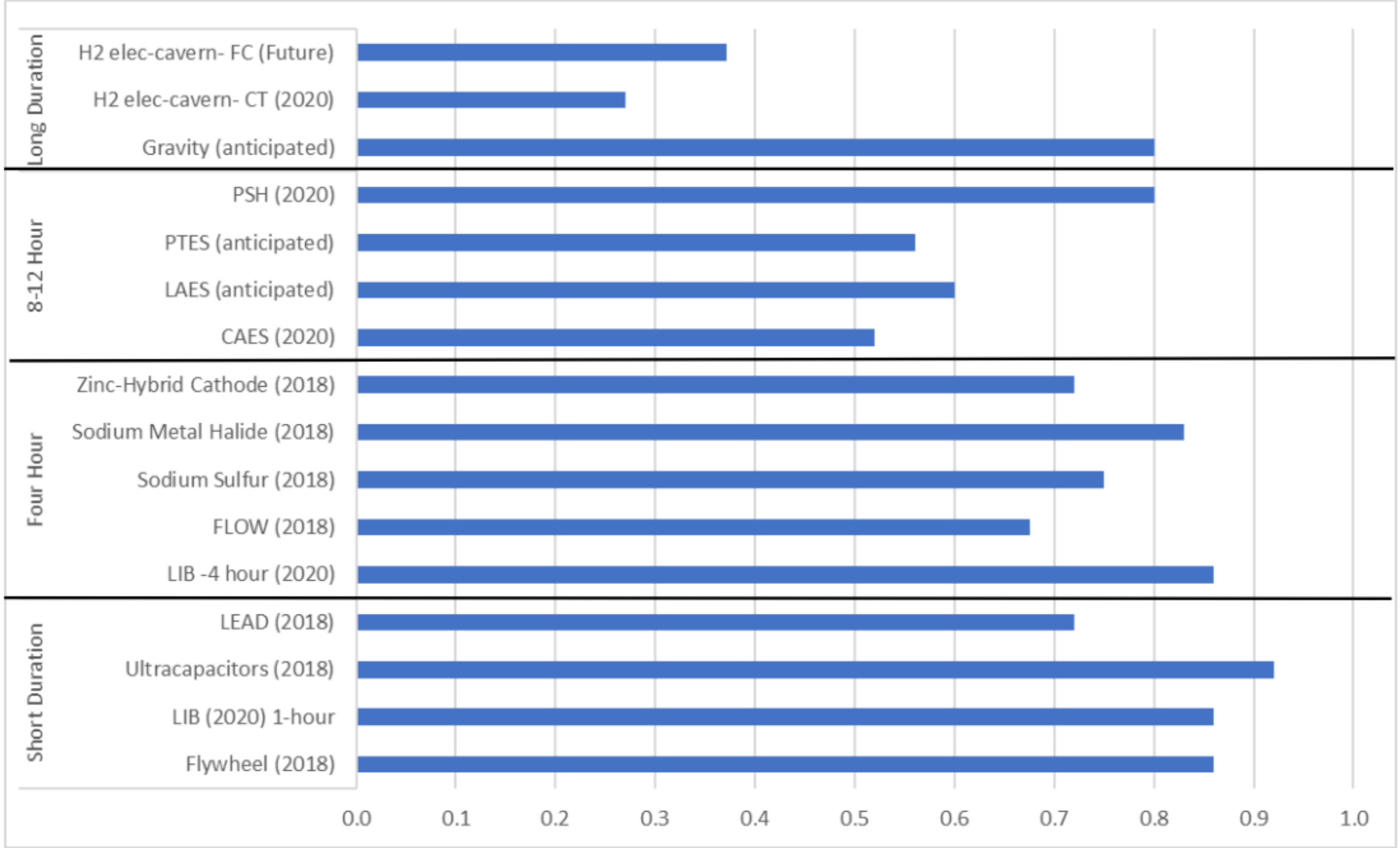
Capital cost for energy ($/kWh)

versus

Capital cost for capacity ($/kW)



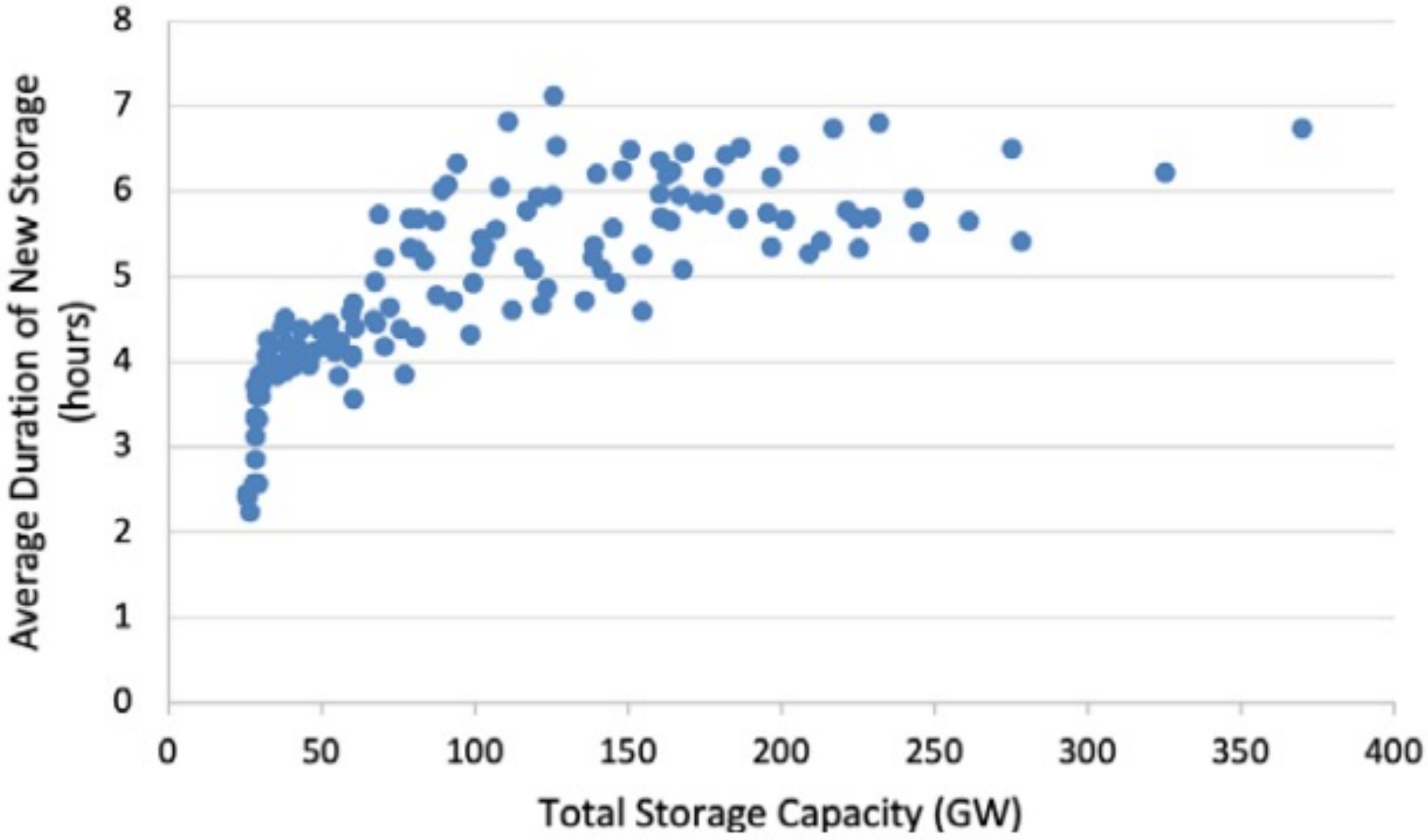
Round Trip Efficiency is critical to Cost-Effectiveness



Key Learnings:

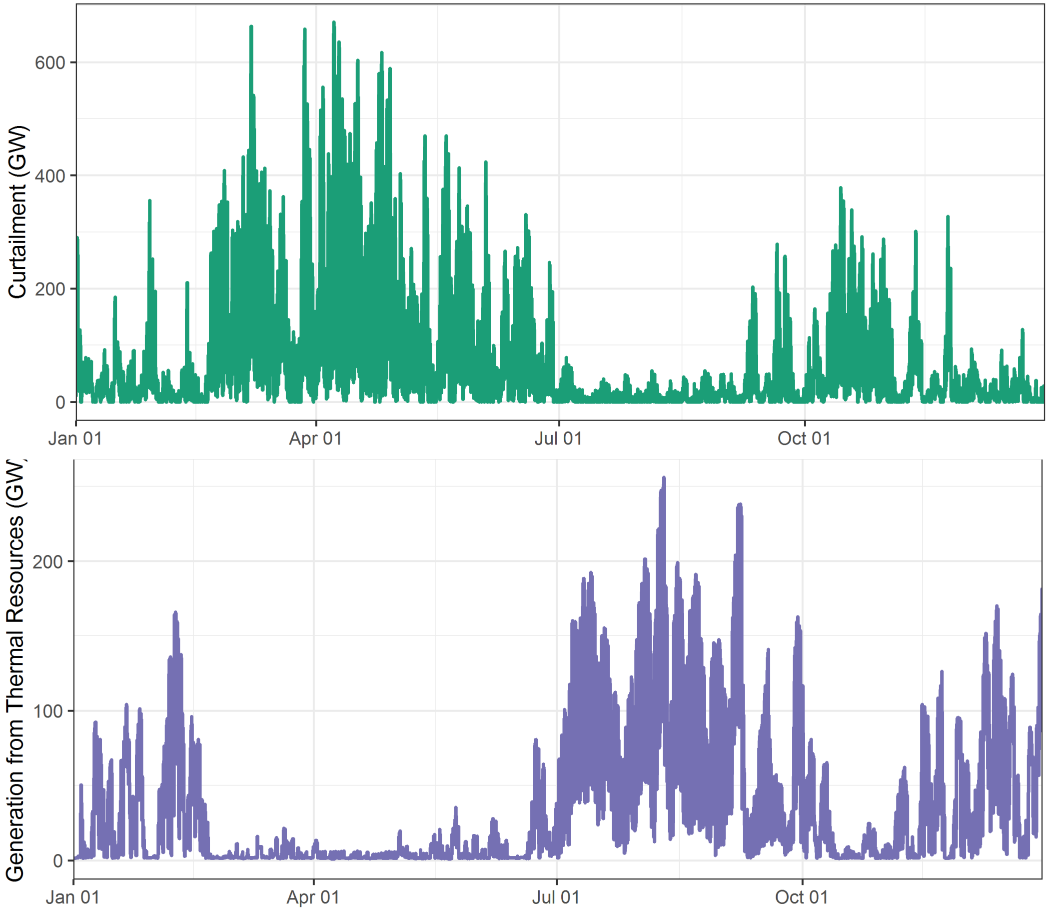
Storage durations will likely increase as deployments increase.

- Net peak load periods widen with more storage deployments requiring longer-duration storage to provide firm capacity.
- PV narrows the peaks but only to a point.



Key Learnings:

Seasonal storage technologies become especially important for 100% clean energy systems



- 100% decarbonization scenarios
- 94% of national demand is met by VRE plus hydropower and geothermal
- 6% of demand is met by renewably-fueled thermal resources such as combustion turbines burning hydrogen and biofuels.
- Thermal resources used during low wind and lower solar periods.

THANK YOU

For discussions/suggestions/queries email: ***isuw@isuw.in***

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- Learn more about the Storage Futures Study NREL/PR-7A40-82370 Contact: Nate.Blair@nrel.gov
  www.nrel.gov/analysis/storage-futures

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