

# LARGE-CAPACITY AND LONG-DURATION ENERGY STORAGE TECHNOLOGY



What is long-term energy storage? Long-term, large-capacity energy storage may ease reliability and affordability challenges of systems based on these naturally variable generation resources. Long-duration storage technologies (10 h or greater) have very different cost structures compared with Li-ion battery storage.



What are long-duration energy storage technologies? In this paper, we loosely define long-duration energy storage technologies as ones that at minimum can provide inter-day applications. Long-duration energy storage projects usually have large energy ratings, targeting different markets compared with many short duration energy storage projects.



Can energy storage technology help a grid with more renewable power? Energy storage technologies with longer durations of 10 to 100 h could enable a grid with more renewable power, if the appropriate cost structure and performance???capital costs for power and energy, round-trip efficiency, self-discharge, etc.???can be realized.



How does the technology landscape affect long-duration energy storage? The technology landscape may allow for a diverse range of storage applications based on land availability and duration need, which may be location dependent. These insights are valuable to guide the development of long-duration energy storage projects and inspire potential use cases for different long-duration energy storage technologies.



How do you compare long-duration energy storage technologies (LDEs)? Review commercially emerging long-duration energy storage technologies (LDES). Compare equivalent efficiency including idle losses for long duration storage. Compare land footprint that is critical to market entry and project deployment. Compare capital cost-duration curve.

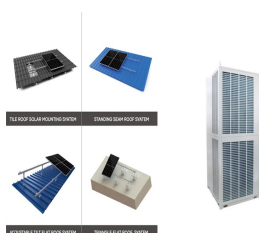
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What technologies can be used for long-duration applications? Some technologies for long-duration applications, such as power-to-gas-to-power (PGP), pumped hydro storage (PHS), and compressed air energy storage (CAES), have additional flexibility in that the power and energy capacities for a given project can be sized independently (Table S4 provides energy and power specific capital costs).



At the annual Conference of Parties (COP) last year, a historic decision called for all member states to contribute to tripling renewable energy capacity and doubling energy efficiency by 2030.. A year later at COP29 in ???



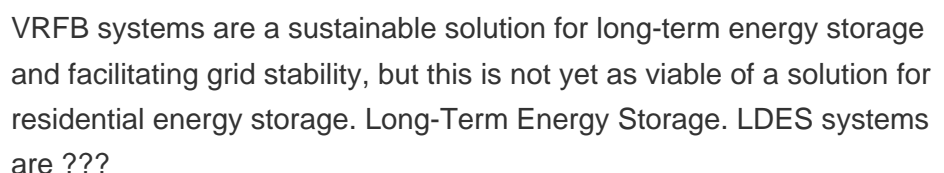
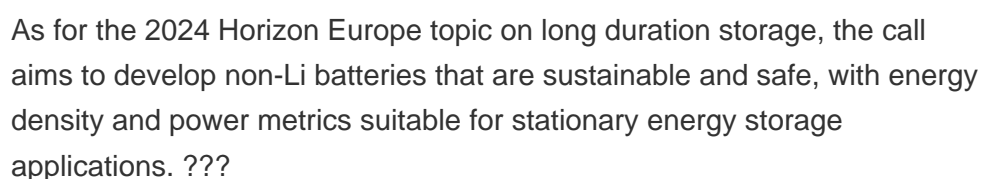
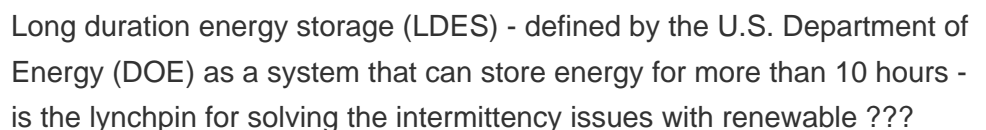
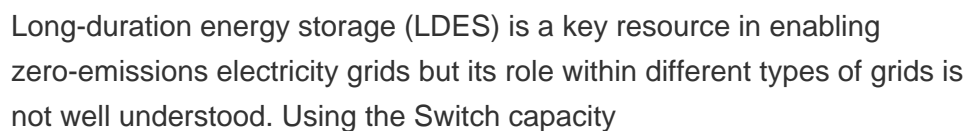
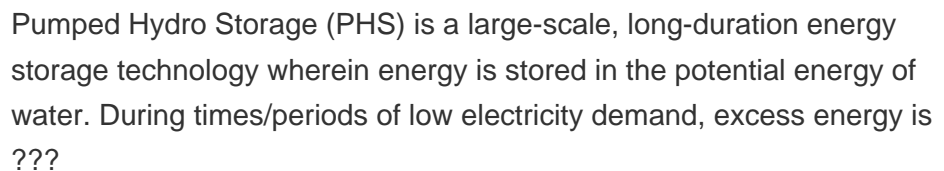
Long-duration electricity storage systems (10 to ?? 1/4 100 h at rated power) may significantly advance the use of variable renewables (wind and solar) and provide resiliency to electricity supply interruptions, if storage assets that can be ???



Based on cost and energy density considerations, lithium iron phosphate batteries, a subset of lithium-ion batteries, are still the preferred choice for grid-scale storage. More energy-dense chemistries for lithium-ion batteries, ???



Renewable energy generation can depend on factors like weather conditions and daylight hours. Long-duration energy storage technologies store excess power for long periods to even out the supply. In March 2024, the ???



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The value of long-duration storage is also recognized by regulators, utilities, and industry experts for its flexibility in addressing multiple use cases with a single storage asset. ???