Long Duration Energy Storage Viability Survey

Using first principles to determine the cost floor for potential technologies

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Long Duration Energy Storage



Long Duration Energy Storage (LDES)



Electric Grid Energy Storage Use Case

- Grid Energy Storage
 - Short Duration
 - ~ms to hour
 - Mid Duration (MDES)
 - ~hourly to daily
 - Multi-Day Long Duration
 - multi-day ~10 times per year
 - Seasonal Long Duration
 - Once per year for ~3 months



- U.S. grid has ~200 GWh storage capacity (2023)
- Energy storage need increases with additions of renewables
 - lack of current LDES market demand
 - greatest LDES need comes if renewables > ~80% of grid
 - potentially ~150x more grid energy storage capacity in future than today
 - LDES demand could be decades away



LDES Techno-Economic Analysis

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Levelized Cost of Storage (LCOS)

- LCOS based on price arbitrage
 - Neglect capacity payments (possible future market)
- Note: 'decoupled' LDES systems desired
- Energy capital costs drive LCOS for large systems with long duration discharges and low CF. (LDES)
- Use storage material costs to determine if storage system could be viable.





Discharge Duration [h]

Energy Storage Material Cost Data Approach



For best case for energy storage

Determine energy storage materials cost as:



- Use first principles to determine maximum case energy density, ρ_E , for a given material and form of energy storage
- Accumulate bulk material prices, C_{mat}, from markets and price databases



Determine target cost of the energy storage materials to yield a LCOS of 0.05 USD/kWh

Median Specific Price (USD/kg)



Energy Storage Material Cost Results







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Thank You

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Supporting Codes & Data:

<u>energy-storage-analysis/LDES-Survey: v1.0</u> (zenodo.org) LDES-Survey/cap_cost/data_consolidated at main · energy-storage-analysis/LDES-Survey (github.com)