Cheapest energy storage per kwh

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National Renewable Energy Laboratory researchers have studied which tech offers the lowest levelized cost of energy to provide the US Western Interconnection grid with electricity when wind and solar are not available. They assumed 85% renewables penetration and determined that geologic hydrogen storage and natural gas combined-cycle plants with carbon capture storage are the cheapest options for 120-hour discharge applications. ?

The US Western Interconnection is the area marked in yellow.

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Researchers at the US Department of Energy"s National Renewable Energy Laboratory (NREL) have assessed the cost and performance of most long-duration energy storage (LDES) technologies. They have also looked at flexible power plants to help electricity systems to deal with extremely high levels of renewable energy penetration and have found that, given current and future capital cost scenarios, that geologic hydrogen storage and natural gas combined-cycle (NGCC) plants with carbon capture storage (CCS) technologies offer the lowest levelized cost of energy (LCOE) for 120-hour discharge applications and that pumped hydro, compressed air, and batteries are the cheapest solutions for 12-hour discharge.

“Since energy storage technologies will compete with low-carbon power generation technologies such as NG-CC with CCS to provide the grid with electricity during times when wind and solar are not producing electricity, we compare them all together within this paper,” researcher Chad Hunter told pv magazine. “This allows for a quick comparison of technologies that have not all been looked at in the same analysis before our paper.”

The techno-economic analysis considered the LDES and flexible power generation technologies in the US Western Interconnection, which is a wide-area synchronous grid stretching from Western Canada to Baja California in Mexico, with an 85% share of renewable energy in the area"s electricity mix.

“LDES requires large energy capacities so that a typical rate of charging or discharging can be sustained for days, weeks, or even longer,” the scientists explained. “In this study, flexible power plants and LDES system power generation equipment are sized at 100 MW, in the range of peaking and

load-following plant sizes today.”

Through their analysis, the academics found that, for the maximum duration of seven days, NG-CC plants with CCS are the cheapest solution. For the minimum 12-hour threshold, the options with the lowest costs are compressed air storage (CAES), lithium-ion batteries, vanadium redox flow batteries, pumped hydropower storage (PHS), and pumped thermal energy storage (P-TES), which they said is mainly due to their moderate power-related capital costs and high round-trip efficiency.

“Batteries will likely play a large role in grid energy storage moving forward, especially if battery prices continue their strong decline as we have seen over the past decade,” Hunter explained. “Shorter-duration battery storage will be complemented by low-cost, longer-duration storage technologies, such as geologic hydrogen storage.”

For more than four days of storage, the least-cost solutions are diabatic compressed air energy storage (D-CAES), NG-CC, NG-CC with CCS, natural gas combustion turbine (NG-CT), and hydrogen storage in salt caverns with re-electrification in heavy-duty vehicle proton exchange membrane (HDV-PEM) fuel cells. They also determined that pumped hydro storage and the HDV-PEM fuel cells with salt cavern storage offer the lowest LCOE for the 12-hour and 120-hour durations, respectively.

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