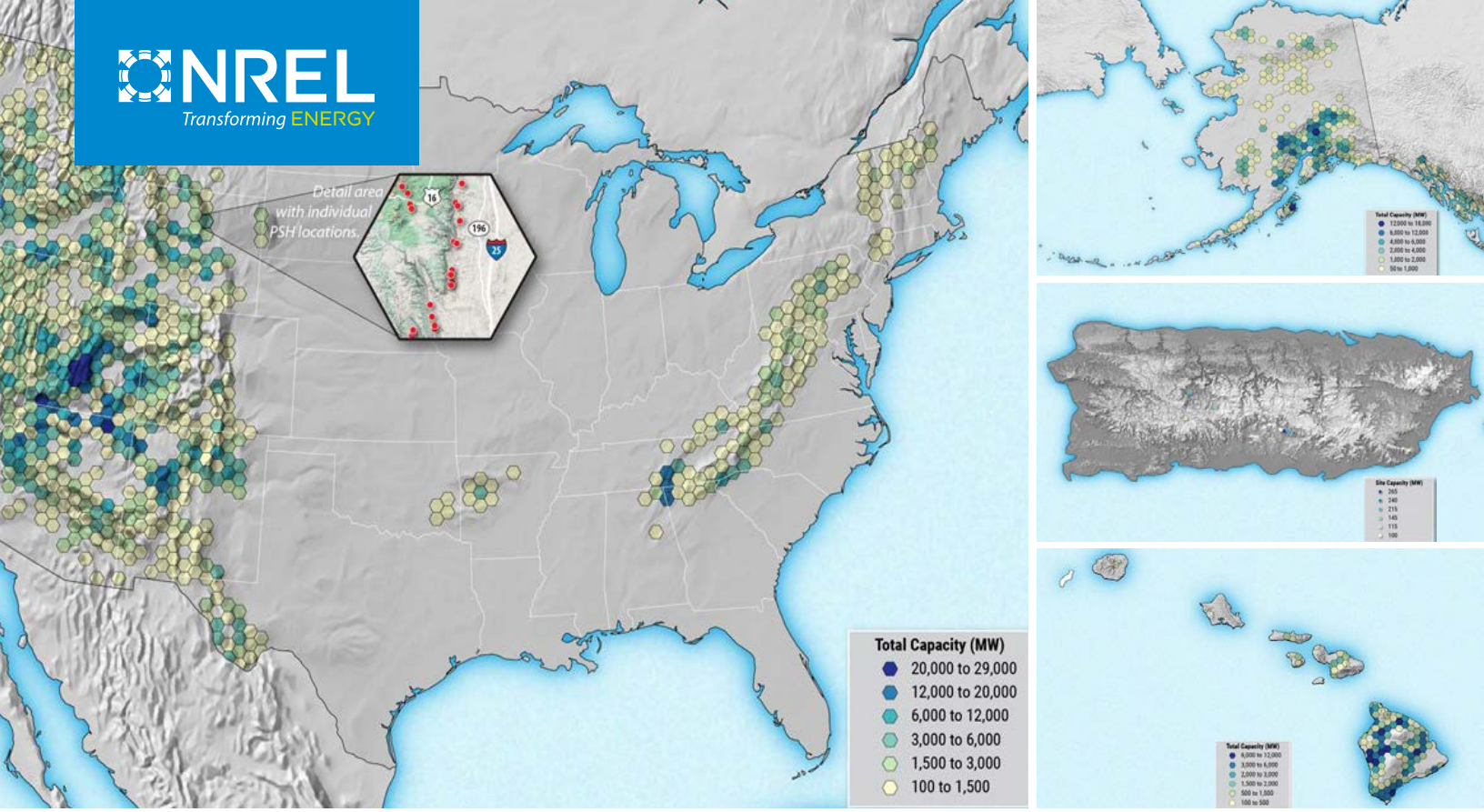


A new, one-of-a-kind data set identifies sites for closed-loop pumped storage hydropower across the United States, including Alaska, Hawaii, and Puerto Rico. Here, the colored hexagons identify mountainous areas that hold the greatest future potential for these clean energy storage facilities.
Screenshots by Stuart Cohen, NREL

Charting Hydropower's Role in the Next-Generation Grid

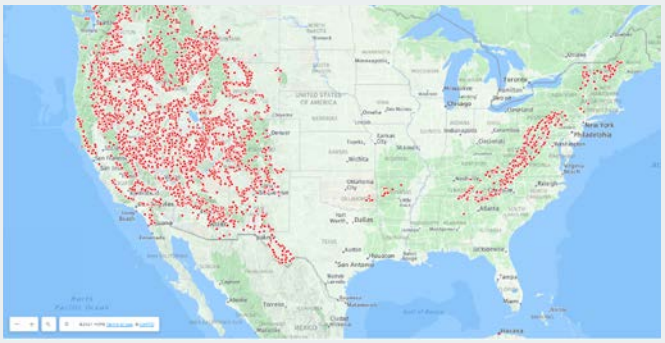
To build a 100% clean energy power sector, the United States is adding more energy storage and variable renewable energy sources, like solar power and wind energy, to the grid. Hydropower and pumped storage hydropower (PSH) can help with both. These technologies already play a key role in providing flexible, low-carbon electricity to the U.S. power grid, and this role will become even more valuable as that grid evolves.

That's why researchers at the National Renewable Energy Laboratory (NREL) are analyzing how the U.S. electricity sector could invest in hydropower and PSH using new data and modeling capabilities.

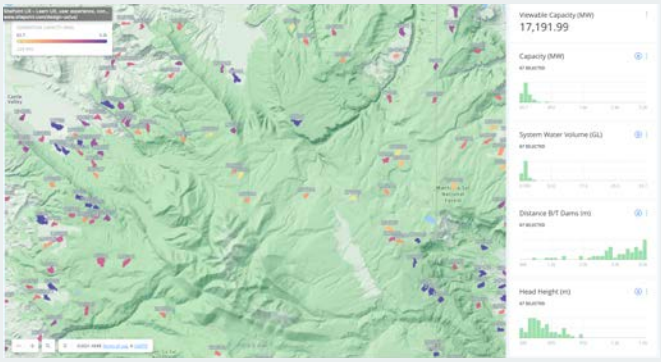
Closed-Loop PSH Resource Assessment for the United States

PSH is by far the most dominant source of energy storage on the grid today. Capable of generating power quickly when needed, this flexible and reliable energy source is well suited to build a resilient, low-carbon energy grid, sustaining power through periods of low energy generation or even blackouts caused by extreme weather or cyberattacks.

To store energy, PSH systems rely on two reservoirs of water, one at a higher elevation than the other. If low-cost power systems, like wind turbines, solar panels, or nuclear power plants, generate excess energy, PSH facilities can use that power to push water up into the top reservoir. During periods of high demand, the water is released back down, spinning a turbine to create electricity. But locating appropriate sites to build new PSH plants is not easy. So, to locate suitable sites, NREL researchers have used geospatial mapping to develop an interactive map and data set that identifies the quantity, quality, and cost of closed-loop PSH resources across the United States, including Alaska, Hawaii, and Puerto Rico.



When the sun sets and winds slow, how does a clean energy grid get power? Simple: energy storage. That's why NREL researchers are pinpointing potential sites to install more pumped storage hydropower facilities, which use just water and gravity to store clean energy for future use. *Data visualization by NREL*



These colorful spots represent potential sites for closed-loop pumped storage hydropower, which transfer water from one reservoir to another to store clean energy. NREL's new, interactive map and geospatial data set show the quantity, quality, and cost of resources to help guide future closed-loop pumped storage hydropower development. *Data visualization by NREL*

To build this data set, the team had to make technical assumptions based on stakeholder input and analysis, like a 10-hour storage duration, 40-meter dam heights, and 300-meter minimum head heights (the height difference between where the water enters the PSH system and where it exits). They also eliminated sites with environmental or other barriers, like those in national parks and urban areas. Each site is also assigned a cost based on its unique characteristics. In the future, the researchers will explore even more options such as alternative storage durations and a range of dam heights.

Ultimately, anyone interested in PSH—including policymakers, utilities owners and operators, or environmental groups—could use this tool to understand its potential as well as how facilities could be built with lower costs, shorter timelines, and reduced environmental footprints. The research team published their data set in a report, titled *Closed-Loop Pumped Storage Hydropower Resource Assessment for the United States*.[1] It reports that in total there are 35 terawatt-hours of potential PSH energy storage across nearly 15,000 sites, with the lowest-cost sites in the Western United States where elevation differences are higher. Stakeholders can use the report's results to help identify areas to consider or new PSH investments.

Advanced Hydropower and PSH Capacity Expansion Modeling

As the United States adds more variable renewable energy to the grid, the demand for flexible, dispatchable energy will increase. Hydropower and PSH can help meet that demand. Given their established and potential future role supporting the U.S. electricity system, it is critical to understand how these technologies contribute to a future carbon-free grid.

To do that, NREL researchers improved the state of the art for hydropower and PSH modeling by adding new capabilities to their flagship capacity expansion model, the Regional Energy Deployment System, or ReEDS, which models the future of the electricity system serving the continental United States. These additions include new data on existing and potential PSH resources and new ways to explore hydropower's long-duration energy storage potential. Researchers also evaluated how upgrades to existing hydropower plants could increase the plants' flexibility.

These new capabilities allow for an expansive exploration of hydropower and PSH to inform investment options and operational characteristics. A new technical report, *Advanced Hydropower and PSH Capacity Expansion Modeling*, demonstrates these capabilities and provides initial insights for analysts, electricity system planners, and hydropower decision makers to assess the future role of hydropower and PSH.[2] Researchers found that improving hydropower flexibility can reduce carbon emissions and improve electricity system economics and that low-cost PSH has potential for new investment.

This report lays the groundwork for researchers to explore the range of roles hydropower and PSH can play in the grid of the future. It can help both analysts and decision makers better identify key opportunities for hydropower and PSH investment when deciding how to achieve economic decarbonization of the U.S. electricity system and the rest of the economy.

Contact

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1. Rosenlieb, Evan, Donna Heimiller, and Stuart Cohen. 2022. Closed-Loop Pumped Storage Hydropower Resource Assessment for the United States. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-81277. https://www.nrel.gov/docs/fy22osti/81277.pdf.

2. Cohen, Stuart, and Matthew Mowers. 2022. Advanced Hydropower and PSH Capacity Expansion Modeling. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-80714. https://www.nrel.gov/docs/fy22osti/80714.pdf.

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