Pumped hydro not a magic bullet for energy storage

By one estimate, we'd need 2,500 of these to provide storage for the nation's electricity needs.

Pumped-hydro energy storage is a century-old technology that's increasingly being seen as a tool that could help the nation meet its future energy storage needs.

But it's likely to play a limited role, according to a UC-San Diego physicist.

As we reported today, researchers at the University of Minnesota-Duluth have spent the past year studying whether abandoned mining pits on the state's Iron Range could be used for pumped-hydro energy storage. The systems work by using cheap or excess electricity to pump water uphill into a higher-elevation lake or reservoir. The energy can be recaptured later by reversing the flow and sending the water through hydro turbines on its way back down to a lower reservoir.

Tom Murphy, an associate professor of physics at the University of California, San Diego, wrote last week in a blog post that pumped-hydro works well in certain locations, but a closer look at the numbers reveals serious practical concerns about its scalability.

As we rely more on intermittent renewable energy sources such as wind and solar, we're going to need a similar increase in energy storage capacity to avoid blackouts and inefficiencies. Murphy thinks we need "a nation-sized battery" that can store seven days worth of renewables to withstand a worst-case scenario of persistent clouds in the Southwest and lack of wind in the Midwest.

Murphy's magic number (which he explains in more detail): 336 billion kWh.

Pumped-hydro energy storage is efficient in the sense that energy it stores doesn't degrade over time and the hydroturbines give back more than 85 percent of the power you spend pumping water uphill. What it lacks, though, is density. "For example," Murphy writes, "to get the amount of energy stored in a single AA battery, we would have to lift 100 kg (220 lb) 10 m (33 ft) to match it."

In short: it requires a lot of water.

The existing 22-gigawatts worth of U.S. pumped-hydro facilities only gets us 1 percent of the way toward Murphy's national battery. Achieving the other 99 percent through pumped-hydro alone would require hundreds if not thousands of projects on a scale never before seen, says Murphy.

One hypothetical option: build 170 large 12-gigawatt pumped-hydro systems, each one larger than the Grand Coulee dam. Another way to get there would be with more than 2,500 smaller, 600-megawatt systems. Even those would stand taller than the Hoover Dam and use 19 million cubic meters of concrete each.

The energy cost of the concrete alone would exceed three years of current U.S. energy consumption, Murphy estimates. And the amount of new surface water created by the projects would equal Lake Erie. Then there's the question of where that water comes from, he notes.

Murphy admits his calculations rely on some assumptions, and that some people believe his seven-day battery is overkill. But pumped hydro's limitations remain, he writes:

The fact that just one of the 'small' dams considered here has as much concrete as the Three Gorges and Grand Coulee dams combined is humbling. I would be impressed if we made one. I would be astounded if we made 25. And this just gets us to 1 percent of our need (or 7 percent if you still bristle at a 7-day battery).

Let's be clear that I am not making any claim that large scale storage at the level we need is impossible. But it's far more daunting than almost anyone realizes.

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