Large scale power storage

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Recent developments to do with pumped hydro, liquid air and kinetic energy storage technology hold out the promise of inexpensive, widely available energy storage. If realized, deployments could be the catalyst that fuels growth of solar, wind and other emissions-free, renewable energy capacity to new, significantly higher, heights, proponents say.

Pumping and storing water from lower to higher elevations and then releasing it to drive turbine generators is one of the oldest, most efficient and widely used means of generating baseload electricity known. An Australian National University (ANU) research team found no less than 530,000 potential short-term, off-river pumped-hydro energy storage sites worldwide that could be used to support low-cost, renewable energy zones and power grids. "Pumped hydro accounts for 97 percent of energy storage worldwide, has a typical lifetime of 50 years and is the lowest cost large-scale energy-storage technology available," pointed out Bin Lu, a project team member and PhD candidate at the ANU Research School of Electrical, Energy and Materials Engineering (RSEEME).

Another promising large-scale energy storage technology recently emerged in news reports, one that, akin to pumped hydro, is based on fundamental principles of Newtonian physics taught to undergraduate college students. About an hour"s drive south of Milan, Italy, Energy Vault intends to use cranes to lift 35-metric ton bricks from ground level to build a tower, then release the stored potential energy by lowering them again to drive turbine generators.

In a third instance, Highview Power is out to prove that its liquid air energy storage systems (LAES) can provide gigawatt-hours (GWh) worth of cheap, highly efficient energy storage for five-10 hours per day. "At giga-scale, energy storage resources paired with renewables are equivalent in performance to--and could replace--thermal and nuclear baseload in addition to supporting the electricity transmission and distribution systems while providing additional security of supply," according to the company.

An untold wealth of cheap, efficient pumped hydro energy storage sites exist worldwide, sites that could be linked with solar or wind power systems to create emissions-free electricity grids, according to the ANU"s latest, most ambitious, audit. The findings run contrary to conventional wisdom.

"The perception has been there are limited sites for pumped hydro around the world, but we have found hundreds of thousands," said lead researcher Matthew Stocks, PhD and Research Fellow at the ANU College of Engineering and Computer Science. "Only a small fraction of the 530,000 potential sites we"ve identified would be needed to support a global, 100 per cent renewable electricity system. We identified so many potential sites that much less than the best one per cent will be required," Stocks highlighted.

Significantly, the pumped-hydro energy storage sites the ANU team identified don"t necessarily need to be

located near rivers or other waterways. According to the researchers"analysis, their terrain is suitable for the construction of lower and upper water reservoirs, which would then be connected to tunnels or conduits to pump water up-slope and then down to drive hydroelectric generators to provide baseload grid electricity, or released on-demand when grid conditions warrant.

Solar or wind power generation could be used to pump the water from the lower to the upper reservoirs, thereby storing energy cheaply and efficiently. High-voltage transmission lines could be built to deliver electricity, thereby creating zero-emission grids, according to the research team.

There are many opportunities for renewable energy zones (REZ) to be created around the world where there wind, sun and pumped hydro opportunities are good, Andrew Blakers, research team member and director of the ANU Centre for Sustainable Energy Systems, said in an interview. They include areas of U.S. states, such as Arizona, Colorado and Texas, as well as some 3,000 others across Australia.

"The cost of transmission can then be shared across wind, solar and pumped hydro. The pumped-hydro storage ensures that the power line runs at full load even in the middle of the night, which reduces transmission costs and also allows existing transmission to be much better utilized...We provide a geographical survey of potential sites, and the constraints we apply [set aside] national parks or urban areas," Blakers explained.

"As we state in the disclaimer, geological, environmental and other factors will rule out many sites. However, there are so many sites that we can afford to be choosy--fewer than 1 percent of sites will need to be developed to support 100 percent renewables. Costs for transmission, water supply and road-access are significant, but [they] are not the dominant costs for most sites. The larger the site, 50 or 150 GWh for example, the less important are these costs."

Typically, the off-river, pumped-hydro energy storage sites identified in the study could dispatch maximum power anywhere from five to 25 hours depending on the size of the reservoirs, Blakers continued. Construction methods are well known and proven and pumped hydro provides fast energy response of just a few minutes. Furthermore, the water required for pumped hydro energy storage paired with solar PV or wind power generation would require much less water than a fossil fuel power plant as they don"t require water for cooling, Blakers noted.