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The need for long-duration energy storage, which helps to fill the longest gaps when wind and solar are not producing enough electricity to meet demand, is as clear as ever. Several technologies could help to meet this need.

Toronto-based Hydrostor Inc. is one of the businesses developing long-duration energy storage that has moved beyond lab scale and is now focusing on building big things. The company makes systems that store energy underground in the form of compressed air, which can be released to produce electricity for eight hours or longer.

I spoke with Curtis VanWalleghem, Hydrostor"s CEO and co-founder, to get an update on how close he is to breaking ground on large plants in Australia and California and to learn how he makes the case for his company.

"It"s a very simple system that just uses a hole in rock [plus] air and water," he said. "And then the equipment is all from the oil and gas industry, so you don"t need new manufacturing or anything."

Some background on why long-duration storage matters: The grid of the near future will require a mix of energy storage resources to fill gaps when there are lulls in generation from wind and solar. Most lithium-ion battery systems run for a maximum of four hours. Energy system planners have said the grid will also need storage options that can run six, eight, and 12 hours, and some that last as long as a day or more.

The Department of Energy has identified the need for long-duration storage as an essential part of fully decarbonizing the electricity system and, in 2021, set a goal that research, development, and investment would help to reduce the costs of the technologies by 90 percent in a decade.

A variety of companies and technologies are competing for a share of the market. This includes several types of long-duration batteries, and some resources that have been around for a while, such as pumped hydro storage at hydroelectric dams.

Hydrostor"s first large project to go online is likely going to be Silver City Energy Storage Centre in Australia, which will have the ability to discharge at 200 megawatts for up to eight hours. Construction should begin around the end of 2024, and the plant should be running by mid-2027, VanWalleghem said.

The next project would be Willow Rock Energy Storage Center, located near Rosamond in Kern County, California, with a capacity of 500 megawatts and the ability to run at that level for eight hours. Hydrostor is aiming to begin construction by late next year and have it running before 2030. But before that, the company needs to get a permit from the California Energy Commission, a process that has restarted after a brief pause.

Unlike some other long-duration storage companies, Hydrostor has proven its technology. The company has operated a small, 1.75-megawatt plant in Goderich, Ontario, since 2019, which can run for about six hours at a time. Compressed-air storage existed before Hydrostor--plants in Germany and Alabama have been around for decades and use variations on this approach.

Hydrostor"s system uses a supersize air compressor that ideally would run on renewable electricity. The system draws air from the environment, compressing it and moving it through a pipe into a cavern more than 1,000 feet underground. The process of compressing the air produces heat, and the system extracts heat from the air and stores it above ground for reuse. As the air goes underground, it displaces water from the cavern up a shaft into a reservoir.

When it"s time to discharge energy, the system releases water into the cavern, forcing the air to the surface. The air then mixes with heat that the plant stored when the air was compressing, and this hot, dense air passes through a turbine to make electricity.