U.S. Takes Steps Toward a Clean Hydrogen Economy

Sun, wind and water combine to store renewable energy for when the power grid needs it most

MHI Group's White Deer Wind Farm in Texas is participating in a study on wind-powered electrolysis for hydrogen production.

The age of hydrogen may be dawning. With plentiful supply on Earth, the lightest atom holds promise as a limitless, nonpolluting source of power. And while hydrogen isn't new, with varying technologies surrounding its production, only recently has it been seen as a versatile answer for a different conundrum: how to store excess renewable energy, especially in the United States.

Making renewable energy more reliable

Increasingly, renewable resources make up more of the U.S. energy mix. In 2018, they totaled more than 11% of energy, up from just 6% in 2005. However, there are still challenges, including intermittent supply both throughout the day and season by season. This spring, for example, just as California was setting records for its solar power generation, it was forced to curtail that output due to limitations on what the grid could handle. Yet by August, California was instituting rolling blackouts as extreme heat caused electricity demand to soar. In order to rely on renewables, excess power needs to be stored for when the sun doesn't shine, the wind doesn't blow. More and more, that challenge is extending beyond day-to-day concerns to balance renewables.

"If we could shift that wasted energy from April into August, it could've prevented the blackouts," says Michael Ducker, vice president, renewable fuels and Western region at Mitsubishi Power Americas. "As we keep adding more renewables to the grid, we're going to need more storage technologies capable of storing energy for both short and long durations."

Current storage options cover a range of prices, sizes, technical and environmental challenges, and capacities. Technologies include charging batteries, compressing air or natural gas, and pumping water uphill. While batteries are good for short duration, they're less ideal for longer periods, such as holding a charge for weeks or even seasons. And pumping water has certain geographical requirements—a steep hill and room for a reservoir. The advantage of hydrogen is that it can be produced anywhere, including near solar and wind farms, and it also can be used there later to generate electricity, avoiding transportation costs.

No emissions

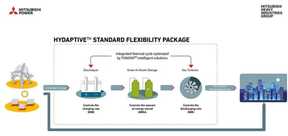
Hydrogen has to be "produced" because it isn't usually found by itself. Rather, it tends to form compounds with other elements. For example, when hydrogen forms with carbon, it's a hydrocarbon—like that found in petroleum, natural gas or coal. When hydrocarbons burn, the carbon is emitted into the atmosphere.

But hydrogen also really likes oxygen. Two hydrogen atoms plus one oxygen atom form water, which covers about 70% of the Earth's surface. When hydrogen alone reacts with oxygen, the process produces heat and water vapor with no carbon emissions. That carbon-free reaction can then be used to power vehicles, in manufacturing processes, and in gas turbine power plants.

Two such projects currently under development by Mitsubishi Heavy Industries (MHI) Group aim to make green hydrogen a viable storage solution for renewable energy, and its $1 billion Advanced Clean Energy Storage project in Utah may be the largest renewable energy storage in the world. When complete, it will store 150 gigawatt hours of carbon-free dispatchable energy, making it 150 times bigger than the sum of all the lithium-ion batteries currently installed in the U.S., Mr. Ducker says.

The project will use excess renewable energy to produce green hydrogen, which will be stored in nearby salt caverns. The green hydrogen can then be used as needed to power gas turbines, such as the co-located Intermountain Power Agency hydrogen-capable gas turbines that will be manufactured by Mitsubishi Power. The plant will replace a coal-fired plant in 2025, at first using a combination of natural gas and hydrogen, and evolving to 100% hydrogen no later than 2045 for a zero-emissions source of power.

MHI Group is also partnering with a major Gulf Coast utility, Entergy, to help decarbonize its utilities in four states with hydrogen, along with building three similar electricity-generating plants in New York, Virginia and Ohio, totaling $3 billion, that will use Mitsubishi Power's Hydaptive and Hystore packages to shift from natural gas to 100% hydrogen fuel.



Key next steps toward a hydrogen society

Further south, in the Texas panhandle, MHI Group's White Deer Wind Farm is doing its part to push the envelope on hydrogen production. The project is collecting data from 70 wind turbines for the University of Texas. "Part of the study is to analyze how wind energy could be used to power electrolysis, with the hydrogen that's produced going into a fuel cell," says Mark Tallman, president and chief executive of Diamond WTG Engineering & Services, a part of MHI Group.

When excess renewable energy reaches critical mass, hydrogen storage can be used to support deeper efforts to decarbonize power grids. One method uses an electrolyzer to separate the hydrogen and oxygen atoms in water molecules. If an electrolyzer is powered by excess renewable energy, then the hydrogen can be stored and used later to produce emission-free power when the grid needs it most. Unlike many industrial processes, which need to run continuously for optimal results, an electrolyzer can serve as a dispatchable load by being dynamically turned on and off, Mr. Tallman notes.

While batteries and other forms of storage play important roles in making renewables work, hydrogen has certain advantages: It can store energy over short and long time periods, can work at utility scale, can be used for industrial processes that require heat—and can even be exported to help other countries to fuel their clean-energy goals, Mr. Ducker says.

"A meaningful technology shift is in sight and will provide long-term benefits for the grid," Mr. Tallman says. "The U.S. has the innovation, the capital, the capability and the demand for power to drive investment in the most efficient emission-free technologies for our energy future."

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