



## 20 kWh energy storage efficiency

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Mateo Jaramillo, Form CEO and co-founder, said he doesn't consider the company's technology to be long-duration storage, instead preferring the term "multi-day storage." The capacity of the Form battery to dispatch energy for 100 hours, he said, "puts it in a different category" than the broad definition of long-duration storage, generally defined as systems with at least 10 hours of duration.

Jaramillo, who previously led Tesla's energy storage arm, said he considers the Form Energy technology as "complementary, not in competition" with shorter-duration lithium-ion batteries.

That balance, experts say, will be essential to transition the grid to renewable energy. While lithium-ion batteries can store energy for hours and distribute it throughout the day, a 100% renewable grid will need larger storage systems to tackle the day-to-day or seasonal variability in renewable production. While there are a variety of long-duration technologies on the market, the high cost and infrastructure difficulties have limited widespread penetration.

Mark Jacobson, director of the Atmosphere/Energy program at Stanford University, said a \$20/kWh cost -- if the commercial costs end up that low -- would be a "substantial breakthrough" that "would enable the rapid transition to 100% clean, renewable electricity on a worldwide scale, while avoiding blackouts, at lower cost than previously thought."

BloombergNEF found that lithium-ion battery pack prices fell to \$137/kWh in 2020, with projected costs close to \$100/kWh by 2023, and manufacturers like Tesla and CATL have dropped prices as low as \$80/kWh. A March study published in Nature Energy found that the energy capacity cost of long-duration storage technology must fall below \$20/kWh in order to reduce total carbon-free electricity system costs by at least 10%. Capacity costs would have to drop even lower to displace nuclear and natural gas plants, the study found.

The company will partner with Minnesota electric cooperative Great River Energy on a test project for the iron air exchange battery, with construction expected in 2023. Jaramillo said that other test projects are in the works but have not been announced.

"Early on, we had an indication that this type of technology had great potential," Jaramillo said. "Now we have to prove the bankability of the asset itself, proving that it is durable and meets the needs of the utilities. The only way to compare one type of storage to another is in real-world operating conditions."

Besides the investment from ArcelorMittal, Form Energy has been backed by Breakthrough Energy Ventures, the Bill Gates-led climate investment fund. A November 2020 Series C funding round raised \$76 million, including investments from Energy Impact Partners, Temasek and NGP Energy Technology Partners III.

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"The overall question for me is how to decarbonize society in the most affordable way," says Nestor Sepulveda SM '16, PhD '20. As a postdoc at MIT and a researcher with the MIT Energy Initiative (MITEI), he worked with a team over several years to investigate what mix of energy sources might best accomplish this goal. The group's initial studies suggested the "need to develop energy storage technologies that can be cost-effectively deployed for much longer durations than lithium-ion batteries," says Dharik Mallapragada, a research scientist with MITEI.

In a new paper published in *Nature Energy*, Sepulveda, Mallapragada, and colleagues from MIT and Princeton University offer a comprehensive cost and performance evaluation of the role of long-duration energy storage (LDES) technologies in transforming energy systems. LDES, a term that covers a class of diverse, emerging technologies, can respond to the variable output of renewables, discharging electrons for days and even weeks, providing resilience to an electric grid poised to deploy solar and wind power on a large scale.

"If we want to rely overwhelmingly on wind and solar power for electricity -- increasingly the most affordable way to decrease carbon emissions -- we have to deal with their intermittency," says Jesse Jenkins SM '14, PhD '18, an assistant professor of mechanical and aerospace engineering and the Andlinger Center for Energy and the Environment at Princeton University and former researcher at MITEI.

In their paper, the researchers analyzed whether LDES paired with renewable energy sources and short-duration energy storage options like lithium-ion batteries could indeed power a massive and cost-effective transition to a decarbonized grid. They also investigated whether LDES might even eliminate the need for available-on-demand, or firm, low-carbon energy sources such as nuclear power and natural gas with carbon capture and sequestration.

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