Form Energy: Transforming the Grid with Novel Multi-Day Energy Storage

There is widespread agreement that full decarbonization of the electricity system will require terawatt-scale electricity storage at prices far below the costs of lithium-ion batteries.

To fully decarbonize the electric grid, we must have breakthrough technology that can cost-effectively store electricity and discharge it over multiple days during renewable energy lulls, power plant or transmission outages, fuel shortages, and extreme weather events.

Form Energy was founded in 2017 to address this need. Since then, Form has made rapid progress, growing to over 250 employees across the U.S. and raising $367M in venture capital from leading investors including EIP, Breakthrough Energy Ventures, MIT's The Engine, and many others.

The company's multi-day storage (MDS) technology is uniquely suited to help fill the baseload generation gap that many power systems are facing as coal and gas power plants are retired. The Form battery uses a unique iron-air process that they describe as "reversible rust" – "breathing in" oxygen from the air to discharge, converting iron metal to rust, then "breathing out" oxygen in order to charge, converting the rust back to iron.

The active components of Form's battery system are the safest, cheapest, and most abundant materials on the planet — iron, water, and air. These inputs are available at terawatt scale globally without many of the economic and geopolitical supply chain risks other clean energy technologies are now starting to face. From the start, Form focused on building a supply chain that can scale with global storage demand. In 2021 they signed a joint development agreement with ArcelorMittal, the world's second largest steelmaker, to explore iron inputs tailored to its proprietary iron-air chemistry.

Form Energy co-founder Mateo Jaramillo (left) and EIP Partner Shayle Kann in front of a Form energy battery module

"The problem that we were going after is a very large problem, and it's a very large market. So any option we were considering had to be able to scale to meet the size of the challenge — thousands of terawatt hours capability. And it also had to be safe. It had to be fundamentally cheap, fundamentally scalable, and fundamentally safe."

MATEO JARAMILLO,
Co-Founder and CEO, Form Energy

Form energy

A GAME-CHANGER FOR GRID DECARBONIZATION

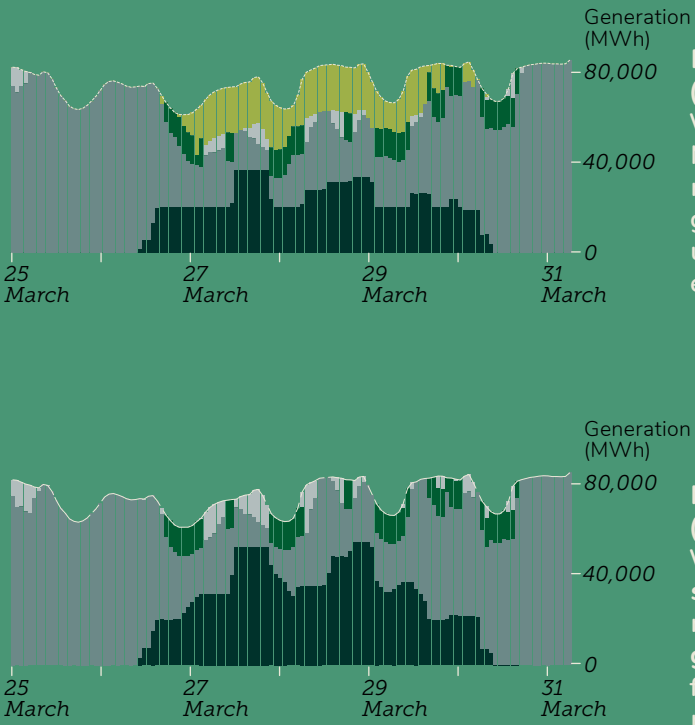
The availability of economical, reliable MDS will be a game-changer for grid decarbonization. The figure below visualizes the displacement of thermal generation in the midcontinental U.S. power market (known as MISO) with and without MDS installed on the system. The figure shows the hour-by-hour operation of all types of power plants expected to be on the MISO system in 2030 during one week of that year, from March 25-31. It also shows the hourly energy provided by the discharge of Form's storage systems in the second panel. The figures at right were produced with Form's own proprietary grid simulation software (Formware™) and illustrate electricity provided by fossil generation as hourly beige lines, renewable generation of all types that is not stored as slate blue, imported electricity as forest green and electricity provided by lithium ion batteries as pale gray blue. Form's stored renewable energy discharge is shown in lime green.

Comparing the two panels in the figure, it is easy to see that the simulation that includes Form's MDS batteries greatly reduces the need for fossil generation during this week. Because everything else in these two simulations are identical – the same power plants are in place, the same daily weather is assumed, and so on – the difference in fossil generation is clearly attributable to Form's ability to store and later provide renewable energy that would otherwise go unused. The reduction of carbon-based generation in this single balancing authority in just one simulated week is over 330 thousand metric tons.[34]

As this simulation shows, Form's breakthrough technology will enable the economic retirement of fossil assets by providing a zero-carbon firm capacity replacement. Using its simulation software, Form projects that its deployments will reduce projected CO_2 emissions by approximately 28 million metric tons between 2023 and 2032.

SIMULATIONS OF THE MISO POWER SYSTEM WITH & WITHOUT FORM STORAGE

One Typical Spring Week, 2030



MISO 2030 System (With MDS)
With **multi-day storage,** MISO is able to reduce reliance on fossil generation and improve utilization of excess wind energy

MISO 2030 System (No MDS)
Without **multi-day storage,** MISO relies more heavily on **fossil generation** to provide flexible capacity during renewable energy (wind and solar) lulls

COMMERCIAL PROGRESS & AMERICAN JOBS

Form has received significant commercial interest from a wide range of customers with aggressive decarbonization targets. This includes regulated utilities, developers in merchant markets, and commercial and industrial (C&I) buyers across a wide range of electrical grid balancing authorities. Earlier this year, Form announced a collaboration with Georgia Power, the largest electric subsidiary of Southern Company, an EIP partner, on a project application of up to 15 MW/1,500 MWh of energy storage systems to be located in the utility's service area. This project builds on Form's previously announced pilot with Great River Energy, to deploy 1.5 MW/150 MWh in Cambridge, MN in 2023.

Form plans to perform the production and assembly work for most key components in-house, creating thousands of American jobs and millions of square feet of U.S. manufacturing footprint. In 2023, Form will bring a production facility online at their western PA facility to support the Great River Energy project deployment as well as other early commercial projects. By the end of the decade, Form seeks to have gigawatts of production capacity online to meet the anticipated demand.

"At Georgia Power, we know that we must make smart investments and embrace new technologies now to continue to prepare for our state's future energy landscape. We're excited to have Form Energy as a partner to help us build on Georgia's solid energy foundation."

CHRIS WOMACK,
Chairman, President and CEO, Georgia Power