20 kWh renewable energy

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The Biden administration"s infrastructure plan, released last Wednesday, has accelerated an already lively discussion about the changes that will be necessary to decarbonize the U.S. power grid.

In the week leading up to the release of the American Jobs Plan, three studies were published analyzing how various regions in the U.S. can meet their electricity needs with low or zero carbon sources.

The most geographically focused of these, the LA100 study, conducted by the National Renewable Energy Laboratory explored several pathways for the Los Angeles Department of Water and Power (LADWP) to meet its electricity needs with reliable, up to 100% renewable power by 2045 or earlier. A second study (Long et al.), from leaders in academia, consulting, and nonprofits, focuses on California, while a third study (Sepulveda et al.), from MIT and Princeton academics, explores regions like Texas and the Northeast.

The three studies echo a common conclusion in the growing literature on net zero carbon power grids: while solar, wind, and lithium-ion batteries will meet the majority of future electricity demand, clean, firm resources provide significant cost savings and reliability benefits over a renewables and lithium-ion only approach.

At Form Energy, we live and breathe energy storage, so we"re naturally interested in what these new studies mean for batteries and beyond. What follows is our summary of the implications of these studies for the energy storage industry, complemented by our original analysis.

While the various studies take different approaches to modeling storage, they all conclude that ultra-low cost storage can decrease the costs of zero carbon grids substantially and that the capability to generate over multiple days of adverse weather is critical for reliable, low carbon power.

Sepulveda et al. conclude that storage technologies with energy capacity capex costs less than $20 per kilowatt-hour can save billions in electricity costs relative to systems with only renewables, lithium-ion, and carbon capture, nuclear, or hydrogen. Furthermore, and relatedly, they also conclude in an analysis of Texas and the Northeast that storage technologies "exceeding 100 hours" in duration play the biggest role in reducing power system costs.

While Long et al. don"t explicitly model long duration storage in their core cases, they do model "zero carbon fuels" that include hydrogen, at costs ranging from $15 per MMBtu to $50 per MMBtu (or roughly 5 to 17 times today"s natural gas prices, implying LCOEs ranging from roughly $0.12 per kilowatt-hour to $0.40 per kilowatt-hour). The models all implicitly assume that the infrastructure required to store and deliver this fuel is embodied in the fuel prices. In turn, they similarly find that these fuels are cost effective to maintain reliability "when the sun doesn"t shine for many days."

It is also important to note that while all of these exercises point to the value of storage that can power grids for multiple days, all studies also point to the fact that a technology inclusive, portfolio approach delivers the least cost decarbonized electric system, a finding we have confirmed many times over in our own modeling.

While these studies and others point to the value of firm zero carbon technologies, few provide a clear definition of "firm." The inclusion of hydrogen as a "firm" option in these studies adds further confusion, as any hydrogen strategy (whether blue or green) would require storage and other supporting infrastructure and would be subject to weather vagaries. Aligning on this definition can help provide clarity to policy makers, regulators, utilities, and entrepreneurs.

In practice, all resources are subject to availability conditions. As we learned from the February 2021 storms in Texas that brought down roughly one-third of the state"s "firm" thermal generation, no technology class is perfect. Ultimately, firmness is defined by the relevant regional weather and demand conditions, and firm resources must be able to consistently meet a given demand under a wide variety of weather conditions.

To understand what those conditions could look like in one of the focus regions of these recent studies, we analyzed 35 years of intermittent generator profiles from the solar and wind generation datasets used in the California Public Utilities Commission"s (CPUC) Integrated Resource Plan to determine what types of resources might be necessary to provide clean firm power in California.

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