Utility DIVE

FEATURE

California solar pilot shows how renewables can provide grid services

A utility-scale solar project demonstrated how solar can compete with natural gas over grid services and cost

By **Herman K. Trabish** • Oct. 16, 2017

Increasing amounts of renewable energy have sparked worries in the federal government over grid reliability and resilience. But some grid operators are successfully demonstrating how large amounts of intermittent resources can be integrated and sustain system reliability as successfully as a natural gas plant.

The California ISO is a leading example. The state now gets much of its essential grid services, the “ancillary services, from natural gas plants. But the methane leaks from the Aliso Canyon storage facility pushed stakeholders to advocate for more diverse and reliable resources, arguing renewable energy fits the bill.

A grid operator is going to be “somewhat risk averse” because it is responsible for keeping the lights on and faces financial penalties for violating reliability standards, said Laura Wisland, senior advisor for the Union for Concerned Scientists. "It is not going to use renewables for essential reliability services just because advocates and technology providers argue for them.”

But a recent pilot successfully showcased how renewable energy can be used for reliability services to balance the wind and solar penetration on CAISO.

CAISO collaborated with developer First Solar and the National Renewable Energy Laboratory (NREL) on a 300 MW solar power

plant project that showed renewable energy can sustain system reliability as effectively and more efficiently than a natural gas plant. The group released a study, documenting the pilot project's progress.

The pilot's success threw stakeholders off guard at first.

"I did not know that inverter-based resources could respond so accurately," said Clyde Loutan, CAISO's senior renewable energy integration advisor. Project data showed "those plants can reliably provide frequency control, voltage control, ramping capability, which are the three essential reliability services."

The pilot comes as CAISO is seeing a rising need for reliability services to balance the penetration of variable renewables on its system, the study on the pilot reported. The system operator saw its first ancillary service scarcity event in 2015, when it could not procure the necessary services, "signaling a mismatch between the demand and supply of ancillary services."

In short, the solar farm project's response "was much better, 24 points to 30 points better, than the fastest they now have in their ancillary services fleet," said Mahesh Morjaria, First Solar's vice president of PV systems development.

CAISO's two-year report on ancillary services listed 10 events, and UCS's Wisland said,CAISO is now working to identify "the economic and contractual incentives that will encourage large-scale solar plants to provide more grid services."

CAISO's project study argued that compensation should be based on "allowing all resources capable of providing ancillary services to compete on an equal footing with conventional resources is a pre-requisite for a competitive market."

Despite its success, integrating renewable energy remains a challenge for most grid operators. Lessons learned from the pilot project could pave the way for grid operators to integrate more renewables, even as the Energy Department pushes for cost recovery for baseload plants in wholesale power markets

It's not so simple

CAISO's Loutan said his team took the pilot's outcome to the Board of Governors and suggested that renewables participate in the ancillary services market. In response, the Board followed the study's recommendation to assess and quantify.

"They asked us to inventory the existing solar fleet and quantify the MW available to provide ERS," he said. His initial survey showed about 40% of existing utility-scale solar MW need "minor modifications" in hardware to take part in the market. A follow-up survey is now being conducted.

First Solar's Marjoria said the fundamental barrier is compensation and it begins with the power purchase agreement (PPA). The plant owner, likely to be an independent power producer (IPP) like NextEra or NRG, then contracts with an off-taker, to be one of the investor-owned utilities (IOUs), Pacific Gas and Electric, Southern California Edison, or San Diego Gas and Electric.

To support the use of renewables for grid-services, a PPA would need to resolve a list of issues, according to Brattle Group Principals Hannes Pfeifenberger and Judy Chang. That list begins with identifying the full range of grid services that could produce costs and benefits.

The PPA should allocate, between the IPP or the IOU, the costs and benefits of providing those services, they said. It should address costs of lost opportunities, costs resulting from operational risks, costs of being the bid and scheduling entity, and costs from any changes in policy and market design.

"The PPA is typically an energy only arrangement," Marjoria said. The IPP is compensated for kWh production and the IOU is credited toward its renewable portfolio standard (RPS) obligation.

"But to provide ERS, the system operator has to keep a certain amount of capacity available and unused," he said. "If I have a 300 MW plant and 30 MW go unused, I am basically losing compensation for that output all the time."

Whether the compensation for the reliability services would be sufficient to forego other compensation depends on market conditions, Marjoria said, particularly in how the PPA is structured. Solar plants have an economic advantage over natural gas plants that would make it advantageous to ratepayers to bring them into the market, he added.

Natural gas plants face the one-two punch of the same loss of generation revenue, while turbines also incur operations and maintenance costs to service reliability. However, Marjoria said they can attenuate solar plants “without any impact. It’s all power electronics. There’s no mechanical device.” Conversely, solar’s marginal costs is zero. Investor-owned utilities also confront a barrier to providing grid services.

If CAISO curtails a portion of the plant’s production against the need for those services, less credit is applied against the IOU’s RPS obligation.

If solar does not provide the reliability, they will come from a natural gas plant. “We may not want to squeeze out every last credit from renewables if, in doing so, we are increasing the use of conventional generation and its CO2 emissions,” Marjoria said. “That is a policy question and policymakers need to think toward the end objective.”

Solar’s levelized cost is already competitive with natural gas in some places and prices are continuing to drop, Marjoria said. “The system operator needs the services. ERS from solar plants can save money for ratepayers and reduce emissions. It is technically feasible. And if IPPs and IOUs get their compensation and the RPS credit, why would they care how the plant is used?”

“There should be some provision that allows curtailment for a certain amount over a specific time and policymakers may have to allow that amount to go toward the off-taker’s RPS obligation.”

UCS’s Wisland said another barrier is that grid services have never been adequately quantified because they came free with natural gas generation. As part of its responsibility to protect system reliability, CAISO must begin to understand each

individual grid service and verify that it can be supplied by carbon-free resources, she said.

But tariffs, contracts, and RPS credits are the responsibilities of policymakers, Wisland said. “Now we have hard evidence that a large scale solar plant can provide ERS more accurately than a natural gas plant,” she said. “It is time to identify the policies and market changes needed to allow project owners to consider offering the services to system operators.

Turning the pilot into reality

CAISO isn’t the only one studying how to integrate renewables and their role in providing essential grid services. The Midcontinent Independent System Operator (MISO) is tackling the issue, even as wind provided grid services for MISO and major midwestern utility Xcel Energy. But providing flexibility is key to helping states meet renewables mandate. For instance, if California doesn’t invest in flexibility, its 50% renewables mandate will only lower greenhouse gas emissions 22%. But investing in grid integration tools, such as storage, demand response, and using renewables for reliability services, it can lower emissions by 27% and reduce curtailment by 44%.

Curtailment hurts states' abilities to reach higher penetrations of wind and solar, essentially wasting clean energy in exchange for more natural gas, according to another UCS study. The CAISO project underscores that research, Wisland noted. It showcased the ability of utility-scale solar to provide system stability and reliability at comparable levels to fossil fuel resources.

Extensive data verified the plant delivered the full range of essential services for reliability, the study reported. “Specifically, the tests conducted included various forms of active power controls such as automatic generation control.” They confirmed the newest generation of smart inverter technology, combined with advanced plant controls, allow solar plants to provide regulation, voltage support and frequency response.

The necessary hardware to provide these services is “already in existence in many utility-scale PV plants,” the study reported. Further “system-level modeling” is needed but “it is mainly a

matter of activating these controls and/or implementing communications upgrades to fully enable these," it added.

According to the study, the plant's operating characteristics allow it to provide reliability during periods of over-generation, voltage support when the plant's output is near zero, and fast frequency response and frequency response for low and high frequency events.

Because variable renewables will increase in penetration as the state moves to "decarbonize the grid," the study reported, "available peak power estimations" should be part of "future interconnection requirements and resource performance verification procedures."

Fine-tuning the hardware to get faster and more precise response might be necessary. Or new equipment may be the more efficient choice.

Many utility-scale PV power plants are already capable of receiving curtailment signals from grid operators, the study reported. That will make a wider transition to AGC operation mode "relatively simple."

The pilot team's study suggested several "next steps," which include identifying and addressing technical barriers. Overcoming them could improve the delivery of primary frequency response, upward and downward regulation, and more effectively use the control capabilities of smart inverters. Testing wind and solar plants could help tackle technical barriers, as well as pairing the two resources to understand the "aggregate response" in providing combinations of ancillary services. But identifying tariff proposals is key to addressing the technical barriers, sector experts agree.