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A Smart Grid Approach To Regulation And Ramping

With the commercial availability of new technologies, the value of fast-response energy-storage regulation should be carefully considered by stakeholders and policy-makers.

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In terms of integrating and operating wind and solar resources on today's grid, several areas of common interest to developers, utilities and grid operators have been identified. These issues include the need for more regulation to help balance generation and load as wind and solar penetration rises; the projected shortfall in some grid areas of regional ramping capacity needed to cope with wind's and solar's variability; and the difficulty of developing variable generation in smaller balancing areas that lack sufficient regulation and ramping capacity.

Energy storage-based regulation technology can help alleviate concerns about new regulation and ramping capacity that will be needed as more wind and solar generation assets are deployed.

The California Independent System Operator, for example, estimates that by the time 20% of its electricity is supplied by renewable resources, regulation requirements will need to have been increased from 170 MW to 250 MW for so-called "up regulation" and from 100 MW to 500 MW for "down regulation," depending on the season and hour of the day. Without a new approach, regulation costs will rise as a result.

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While regulation costs are still generally socialized across balancing systems, pressure from stakeholders to allocate those costs directly to wind and solar developers will increase if the costs go up significantly. Technologies that can reduce these costs might minimize or eliminate the call for tariff changes that would hand the bill to developers of variable generation.

Just how much cost could energy storage-based regulation cut? Pacific Northwest National Laboratory tackled this question in a recent study titled "Assessing the Value of Regulation Resources Based on Their Time Response Characteristics."

The study defined an "ideal" regulation resource as one with infinite energy that can respond instantly with perfect accuracy to any system imbalance. The effectiveness of each type of regulation technology was then compared to this ideal resource.

The study found that 1 MW of fast-response regulation should deliver about twice the system regulation value of the average conventional regulation resource in California. Because California's average resources include a large percentage of relatively fast-response hydro, even this does not tell the whole story.

The study also found that fast-response regulation may be as much as 17 times more effective than some types of conventional ramp-limited regulation resources. Further, if California's regulation fleet included about one-third of such fast-response resources, California's system-wide regulation capacity requirement could be reduced by about 40%.

Watch the footprint

As impressive as a 40% capacity (and cost) reduction would be, if a carbon cap-and-trade program is adopted as federal policy, the benefits will be even greater. A high percentage of regulation in the U.S. is performed by coal-fired units. Any type of carbon tax will increase the cost of regulation from those units. Energy-storage systems do not burn fuel, so they emit zero direct carbon dioxide (CO2). Even including the carbon footprint of make-up energy that storage-based regulation providers must buy to account for inefficiency, storage-based regulation produces far less CO2 than fossil-fuel regulating generators.

A study by KEMA showed that coal- and natural gas-fired regulation increases fuel consumption for those plants by 0.5% to 1.5%. Assuming a midpoint value of 1%, energy storage-based regulation will cut (direct plus indirect) CO2 emissions by about 50% versus base-load gas-fired regulation generators. The reduction would be up to 85% compared to base-load coal-fired regulation resources.

Another reason to favor energy storage-based regulation is its fast response. Energy storage-based regulation can go to full up or down in a few seconds – even milliseconds – if required.

Reserve generation units that lumber to full output in 10 minutes will not be enough to meet the regulation and ramping requirements of the future. Either we will need considerably more of these ramp-limited reserves, or we must deploy resources with much faster-ramping capabilities.

Recent ramp-rate limitations imposed on wind resources by Hawaii Electric Co. (HECO) are an early indication of the increasing seriousness of this issue.

Under HECO's new rules, the ramp rate of some new wind assets may no longer exceed 2 MW per minute (up or down). Each wind developer must now solve its own ramp-rate requirement with whatever bolt-on solutions are available.

While this requirement may translate into new opportunities for energy-storage providers, askingeach wind developer to solve ramp-rate limits in this way will be costly – and counter to the smart grid principle of "highly integrated resources."

Storage-based regulation can be a far more practical and less costly solution.

Indeed, North American Electric Reliability Corp. asserted in its recent "Accommodating High Levels of Variable Generation" report (see page 16) that "the benefits of energy storage are most broadly realized and valuable when operated as a system resource for the benefit of the entire system, and not in a dedicated mode for any individual resource such as variable generation plants."

A more efficient and less costly approach would be to augment and/or replace some conventional slow-ramping regulation resources with fast-response energy storage-based regulation, and to share those fast-response smart grid resources across the entire grid network.

Another benefit of energy storage-based regulation is that it is a single-purpose solution: One can deploy just the amount of regulation needed. In contrast, conventional regulating generators must also produce base-load energy in order to provide regulation – and a customer (or customers) must be found to buy the base-load energy.

This can be problematic in smaller balancing areas with limited load growth. Sparsely populated areas may not need more base-load generation, and transmission limitations can further complicate the problem by limiting the ability to export new base-load energy to distant buyers.

A final challenge for conventional regulation technologies is the long lead time required for siting and constructing fossil-based regulating generators. Because it requires no fuel supply and has zero direct emissions, an energy storage-based regulation resource can be sited, permitted and built in about 18 months, versus two to five years for a fossil-based regulating generator. Given these circumstances, storage-based regulation can be a far more practical and less costly solution.

Regulatory environment

Energy storage-based regulation is new in the market, and its advantages are not yet widely known. But with the commercial availability of new technologies, the value of fast-response energy-storage regulation should be carefully considered by stakeholders and policy-makers. This includes greater regulation effectiveness, zero CO2 emissions, the ability to support regional ramping, and the ability to offer regulation a la carte and get it into operation in a time frame that works for developers.

Policy-makers and independent system operators have recognized the economic and environmental potential of energy-storage technology, and good progress has been made in changing market rules to allow this technology to compete.

An important step is that the Federal Energy Regulatory Commission (FERC) recently approved the country's first energy storage-based regulation tariff. Filed by the Midwest ISO, this tariff is scheduled to take effect this year. New York ISO (NYISO) is also actively developing new market rules to allow energy-storage resources to operate in its regulation market. NYISO's new rules are expected to be submitted to FERC during the first quarter of 2009.

California is in the middle of a stakeholder process that is expected to lead to a pilot program for fast-ramping energy-storage regulation this year, and ISO New England already has had an energy-storage pilot program under way since November 2008. However, there is more to do on the regulatory front.

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