Research Briefing: Small capacity energy storage for grid stabilization and reliability

Small energy storage systems packages are required to support diesel generators in islanded microgrids with medium and high renewable energy penetration. These systems can also be utilized to reduce diesel fuel consumption through operation of smaller diesel generators by providing sufficient peaking capacity.

Problem Description

There are two distinctly different issues in small, islanded (hybrid-) diesel microgrids that can potentially be solved by small, well-packaged energy storage systems.

*Power quality support:* when integrating variable renewable power sources, e.g., wind and solar PV, into islanded microgrids, the firm generation sources, e.g., diesel generators, have to balance supply and demand very quickly. As renewable power contributions increase, this can push ramp-up and ramp-down capabilities of diesel generators to its limit. When diesels cannot balance supply and demand very quickly (<1 s) power quality is diminished. That is, frequency and voltage can severely deviate from nominal values. This has detrimental effects on sensitive equipment, and in the worst case causes power outages.

*Spinning reserve capacity:* In small, islanded microgrids, spare capacity to meet sudden increases in demand, or sudden drops in renewable power, needs to be provided locally. This generally is achieved by keeping enough diesel generation capacity online such that this can pick up typical swings in demand and renewable power. The problem is that this spinning reserve capacity, which only has to be called upon in contingencies, requires diesel generators to be operated away from their optimal load points, which renders their operation less efficient, and in severe cases, pushes generator loading down to levels that can be detrimental to the engine and exhaust system if sustained.

Research Needs

The research required to tackle the above problem ranges from development of applicable sizing algorithms based on thorough system analysis, all the way to packaging small, high-power, fairly low energy capacity energy storage systems for successful deployment in harsh conditions and at potentially very high duty cycle.

The following topics have been identified for study:

- Assessment of typical power and energy storage capacity required based on typical system sizes and demand dynamics.
- Assessment of available energy storage and power electronics technologies to meet demands based on the previous assessment, including life-cycle and cost analysis.
- Development of a dedicated package of energy storage devices, power electronics and controls that are tailored for the determined needs, and can flexibly be sized for a specific islanded microgrid.
- Sustained study of initial implementations to allow for data-driven refinement and optimization.