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Advanced inverters: providing voltage regulation where it is needed most

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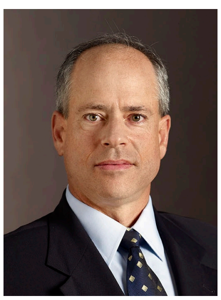
Pairing advanced inverters with distributed generation can make the power grid more reliable and efficient. Thus, it is not surprising that numerous utilities across the country are already pursuing the use of advanced features inherent in almost all inverters that are deployed throughout the world today.



For example, Georgia Power's latest interconnection agreement requires that even small solar generators use advanced inverters to provision reactive power. Importantly, Georgia Power is providing appropriate compensation for the reactive power provided.

Similarly, a group of Western utilities have endorsed advanced inverters as an effective tool to regulate voltage and is working to make them mandatory for all new solar facilities within their service territories.

As long as reactive power provisioning is properly compensated, these utilities are leading a critical transformation where reactive power will be dynamically provisioned where it is needed most: close to loads. Given that inverters are already being deployed as part of every distributed generation and energy storage project, the widespread adoption of advanced inverter functionality significantly optimizes power quality, system reliability, and ratepayer economics.

Dynamic and distributed reactive power control

Advanced inverters offer dynamic reactive power control, which can help maintain the integrity and reliability of the electric grid. As widely demonstrated in Germany, advanced inverters paired with distributed solar, wind, biopower, and energy storage facilities provision dynamic reactive power where it is needed. Importantly, advanced inverters are able to provision reactive power 24 hours a day, regardless of whether the sun is shining or the wind is blowing. When the sun and wind are not available, advanced inverters can draw real power from the grid, rather than from distributed resources, and convert it to reactive power -- in the exact same manner that capacitor banks and synchronous condensers provision 100 percent of their reactive power.

Compared to conventional solutions, installing advanced inverters on small-scale renewable and energy storage systems improves voltage regulation throughout a distribution system. A report by the Oak Ridge National Lab found that distributed voltage control significantly outperforms centralized voltage control. This is partly due to the fact that reactive power suffers far greater line losses than real power, and those losses increase as a line is more heavily loaded. Distributed reactive power improves electrical grid efficiency by minimizing these significant reactive power line losses. Moreover, excessive line congestion can be avoided if distributed generation, energy storage, and advanced inverters are installed throughout the grid. As a result, distributed voltage regulation provides substantial energy efficiency while delivering power quality and preventing blackouts, according to Oak Ridge National Laboratory.

The value of the services provided far outweighs the costs of advanced inverters, making this a winning solution for utilities, regulators, and ratepayers.

Voltage event ride-through

In addition to provisioning reactive power, advanced inverters can be programmed to ride-through minor voltage fluctuations on the grid, which eliminates unnecessary grid disconnects. This feature, for example, enables distributed solar to stay connected longer than rotating machines because solar does not have mechanical resonance issues and can ride-through grid disturbances caused by such issues. Unfortunately, outdated policy in the United States currently inhibits the use of the ride-through features built into advanced inverters. U.S. regulations today dictate that solar inverters must be programmed to automatically disconnect from the grid during any voltage event -- no matter how minor in duration or magnitude. This is like programming air bags to deploy every time a car drives over a speed bump. Unnecessary disconnections from the grid only exacerbate voltage problems, since voltage is most effectively controlled locally and such disconnections reduce the amount of real and reactive power that is available locally.

Fortunately, policy is advancing to match the full technical capabilities of inverters. A California Public Utilities Commission (CPUC) working group is currently focused on expediting revisions to technical standards to allow advanced inverters to ride-through voltage events. Given the importance of technical standards in guiding electrical grid operations, the Clean Coalition is supporting the CPUC working group and is an active participant in IEEE Standard 1547, which governs how distributed resources interconnect to the electrical grid. Through this involvement, the Clean Coalition is focused on innovating standards and other policies to embrace the full potential of advanced inverter capabilities, including fault ride-through and reactive power provisioning.

Spurring the adoption of advanced inverters

Given that advanced inverters are less expensive than conventional solutions for regulating voltage, utilities and their customers will be well served by their rapid adoption. To expedite this advantageous transition, distributed generators should be incentivized to install advanced inverters.

One method to spur the adoption of advanced inverters is to compensate generators for the value of the reactive power provisioned, as Georgia Power has done, according to UC Berkeley/Clean Coalition research.

Most inverters on the market have advanced capabilities built-in, so there are no significant costs to installing the advanced inverter, which is simply a standard inverter with the advanced features enabled. However, solar and wind generators with standard-sized inverters must divert a portion of real power production to provision reactive power when sun or wind resources are at their peak. Without compensation for the provisioning of reactive power, generators might lose revenue by converting real power to reactive power -- essentially a form of indirect curtailment.

An easy work-around to the curtailment issue is the use of inverters that are oversized to match a required minimum power factor setting such that real power would never be reduced through reactive power provisioning. If reactive power will be regularly needed during a generator's peak production hours, installing an oversized inverter (meaning an inverter with higher capacity than the capacity of the power generation facility) makes sense as long as any real power requirements for such reactive power are provided from the grid or appropriately compensated to the distributed resource owner, according to the UC Berkeley/Clean Coalition research.

For example, a 150 kW solar facility with a 10 percent oversized inverter set at a 0.9 power factor can draw 15 kW of real power from the grid to convert to reactive power even when the solar facility is producing a full 150 kW of real power. While the costs of oversizing inverters are less than installing and maintaining capacitor banks, they are can still be significant for smaller generators. Therefore, generators should either be compensated for the costs of oversizing inverters or for the value of real power converted to reactive power, which can be easily accomplished by compensating based on KVA instead of KWh.

Advanced inverters are an affordable technology to maintain grid integrity through stable and efficient voltage regulation. Spurring their widespread adoption requires that distributed generators are compensated either for installation costs or lost revenue due to reactive power provisioning. Yet, the value of the services provided far outweighs the costs, making this a winning solution for utilities, regulators, and ratepayers.

About the Author

Craig Lewis is the executive director of the Clean Coalition, a nonprofit organization whose mission is to accelerate the transition to local energy systems through innovative policies and programs that deliver cost-effective renewable energy, strengthen local economies, foster environmental sustainability, and provide energy resilience.

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