Americans for a
Clean Energy Grid

Smart Solar Inverters

A solar inverter converts direct current (DC) produced by solar panels into alternating current (AC), which is utilized by the electric grid. Solar inverters are, therefore, necessary for connecting photovoltaic solar power installations—both central and distributed—to the electric grid. Grid operators have long been concerned that the integration of solar power into the grid would negatively impact the resiliency and reliability of the electricity system. This is because it is both non-dispatchable (the sun cannot be called upon) and intermittent (due to changing atmospheric conditions such as cloud cover). When, for example, a cloud passes over a solar photovoltaic panel, the intensity of the light falling on the panel decreases, causing a drop in the output voltage. Such issues are ubiquitous across all solar installations, but because distributed solar generation feeds directly into the distribution grid—as opposed to central generation feeding into the transmission system—it presents particularly troublesome system control issues for grid operators. Yet, technology has provided means for addressing these challenges. In this case, the answer is "smart" solar inverters.

A smart solar inverter improves the reliability of the electric grid by allowing distributed solar sources to stay connected to the grid in case of minor disturbances in voltage and frequency. Traditional solar inverters, by comparison, are not capable of handling voltage and frequency fluctuations, and are required by the Institute of Electrical and Electronics Engineers (IEEE) 1547 standard to trip and disconnect from the grid in such situations [2]. Sudden and widespread disconnects resulting from the IEEE 1547 standard can worsen grid stability rather than improving it. Smart solar inverters can distinguish between a serious disturbance and a minor disturbance in voltage or frequency. In case of minor voltage or frequency fluctuations, a smart solar inverter's built-in mechanism allows it to maintain acceptable voltage and frequency levels;

therefore, it does not have to disconnect from the grid. Smart solar inverters disconnect from the grid when severe voltage and frequency fluctuations occur. Although smart solar inverters are capable of handling minor momentary voltage and frequency fluctuations, the IEEE 1547 standard still requires smart solar inverters to trip and disconnect during such situations. This is a major barrier to their deployment. Before significant installation of smart solar inverters can take hold for new and existing projects, the IEEE 1547 standard must be revised to allow smart solar inverters to stay connected to the grid in case of minor voltage and frequency fluctuations.

Besides handling voltage and frequency disturbances, smart solar inverters improve the reliability of the grid by producing and absorbing reactive power along with real power, which helps with voltage fluctuations associated with distributed solar power [2]. Voltage fluctuations arising from distributed sources can cause damage to distribution infrastructure, which can then damage transmission assets. Smart solar inverters can increase resiliency of transmission network by counteracting voltage fluctuations at the distribution level. Additionally, smart solar inverters provide real-time communication between grid operators and distributed solar sources, which improves the resiliency of the grid by allowing grid operators to remotely enable and disable functions and change set points of controlled parameters (voltage, frequency, etc.) as needed by the grid [2]. These benefits of smart solar inverters convinced the Western Electric Industry Leaders (WEIL), a group of electric utility executives across the Western Interconnect, to write a paper addressed to governors, commissioners, and legislators urging them to revise the IEEE standards for inverters.

The WEIL paper, issued on August 7, 2013, urges this step so that the installation of smart solar inverters could be mandated for new distributed solar power projects. The paper argues that mandating smart solar inverters for new solar power projects now is cheaper than retrofitting traditional inverters with smart solar inverters at a later time, and uses Germany as a case study. Germany did not mandate smart solar inverters before it experienced exponential growth in distributed solar sources. This massive penetration of distributed solar power into the German electric grid increased voltage fluctuations and threatened to destabilize the grid at large [3]. Consequentially, the German authorities had to order a mass retrofit of smart solar inverters at a cost of hundreds of millions of dollars [3]. The United States can avoid the high price of retrofitting smart solar inverters by revising IEEE inverter standards and mandating smart solar inverters for all new distributed solar projects. A smart converter only costs $150 more than a traditional inverter, a bargain compared to expensive retrofits [3]. The WEIL paper justifies the slightly higher cost of smart solar inverters by stating that utility companies have experienced considerable improvement in power quality from the installation of smart solar inverters.

Smart solar inverter demonstration projects are being led by the Electric Power Research Institute (EPRI) and the University of Hawaii’s Natural Energy Institute (HNEI) [1]. The EPRI project is funded by a $4.4 million DOE SunShot High Solar Penetration initiative grant and a $2.7 million contribution by inverter maker Solectria Renewables [1]. The EPRI project involves the installation of a 350 kW inverter at a DTE Energy site, a 500 kW inverter and a 380 kW inverter at two National Grid sites, and eighteen 100 kW inverters in the Pepco Holdings service territory [1]. The HNEI project is focused on residential feeders and is funded by a $6.1 million DOE SunShot High Solar Penetration initiative grant and a $6.1 million contribution from smart communication pioneer Silver Spring Networks (SSN) [1]. The HNEI project involves the installation of 30 smart solar inverters in Maui and 10 in Pepco territory [1]. So far, the early results from the EPRI led project have shown the smart solar inverters do not significantly increase the installation cost of a new distributed solar project [1]. The detailed results from both demonstration projects are pending.

The Solar Electric Power Association (SEPA) sees smart solar inverters as being a key part of solar expansion in the future [2]. Smart solar inverters would not only increase the penetration of distributed solar sources, but would also make the electric grid more resilient and reliable. In order for distributed solar to see continued success, it is imperative that the IEEE inverter standards be revised and that installation of smart solar inverters be mandated for all new distributed solar projects.

References

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