

CASE STUDY

PV Powered—Bend, Oregon

Smart Anti-Islanding Using Synchrophasor Measurements

With the increasing use of photovoltaic distributed generation comes the need for smarter anti-islanding schemes. PV Powered and Schweitzer Engineering Laboratories, Inc. (SEL) demonstrated a scheme that utilizes wide-area measurements. The scheme accurately detects when it should disconnect the distributed generation.

Photovoltaic (PV) systems are generating interest due to the desire to increase the use of renewable electrical energy sources. For broader adoption of PV generation, a reliable way to connect systems to the bulk power grid is needed. PV Powered, a manufacturer of grid-tied solar inverters, assembled a team (Sensus, Northern Plains Power Technologies, Portland General Electric [PGE], and SEL) to address the challenges associated with the integration of solar distributed generation (DG). The effort is funded by the U.S. Department of Energy under the Solar Energy Grid Integration Systems (SEGIS) program. A witness trial at the PGE solar highway demonstrated the effectiveness of using wide-area measurements for smart anti-islanding.



Figure 1—Solar Panels in PGE Solar Highway

When a DG source is islanded from the bulk transmission system, the source must also disconnect from the islanded portion of the electric network. Failure to trip the source could risk personnel safety, power quality, and out-of-phase reclosing. The IEEE 1547 Standard for Interconnecting Distributed Resources With Electric Power Systems defines the requirements for integrating distributed sources into the bulk power grid

with an aggregate capacity of 10 MVA or less. IEEE 1547 specifies that a source must disconnect from the islanded system within 2 seconds.

Traditional methods for islanding detection use local voltage and frequency information to check if the frequency or voltage magnitude is outside predetermined thresholds. However, local detection schemes cannot detect islanding in a timely manner if the power (real and reactive) mismatch between the source and the local load is small. Other traditional schemes rely on breaker status communication, open-phase detectors, and trip commands to detect islanding and isolate the source. Such schemes are simple in concept but must be adapted to topology changes in the power system. These adaptation requirements can result in a system with many communications links and poor reliability.

Another limitation to traditional approaches is the inability to scale with future requirements. For example, present standards require disconnection for sagging voltage under high demand. With a small amount of generation, such a requirement is reasonable, but disconnecting a high-density solar generation source would further aggravate the low voltage level. The wide-area measurements supplied by synchrophasors provide a platform for solutions that keep the generation online during transient conditions. A synchrophasor-based detection method overcomes the limitations of traditional approaches.

Figure 2 shows the anti-islanding scheme used for the witness evaluation test, which was based on SEL algorithms running in the SEL-3378 Synchrophasor Vector Processor (SVP). Both the bulk power system and DG locations supply phasor data for the algorithms. For the test, two SEL-451 Protection, Automation, and Control Systems were used as phasor measurement units (PMUs) to provide the synchrophasor data.

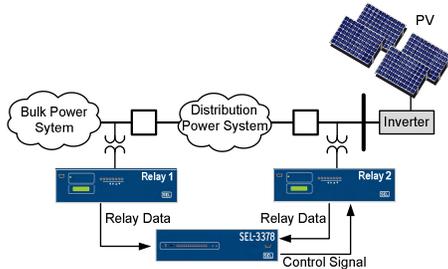


Figure 2—Anti-Islanding Scheme Using Synchrophasors

During the test, using synchrophasor data from each of the relays and utilizing the slip-acceleration method consistently detected islanding in less than 2 seconds. In fact, times ranged from approximately 1.15 to 1.7 seconds to both detect islanding and trip the breaker.

As generation and load become more evenly matched, islanding detection becomes more difficult. Generally, when a source separates from the power system, there will be both slip and acceleration, and these parameters can be used to define islanding regions. For the demonstration, a fiber communications channel was used between the relays and the SVP. For DG schemes, the communications latency is impacted by the need to coordinate the reference measurement, Relay 1, with multiple generation locations.

Summary

The witness evaluation test successfully demonstrated that using wide-area measurements and the SVP provides a robust means for islanding detection. Synchronized phasor

measurements provide precise wide-area measurements and therefore provide a means for detecting islanding under nearly all load and generation conditions. Furthermore, the scheme can be extended to allow PV generation to improve low-voltage conditions under heavy loading or to provide power for an islanded set of customers. This is a must as higher levels of PV generation are incorporated into the grid.

About PV Powered

PV Powered is an innovation leader for grid-tied PV inverters in the residential, commercial, and utility markets, setting new industry standards for innovation in reliability and efficiency. Recently acquired by Advanced Energy Industries, Inc. (Nasdaq: AEIS), the company has pioneered the use of advanced reliability engineering to design inverters with a 20+ year operating life. PV Powered was selected to receive a Stage 2 award under the Solar Energy Grid Integration Systems (SEGIS) program by the U.S. Department of Energy. The company is leading a team of recognized distributed energy and smart grid partners in developing innovations that increase energy harvest, reduce the cost of PV systems, and remove barriers to high levels of PV grid penetration. For more information, visit www.pvpowered.com.

About SEL

SEL has been making electric power safer, more reliable, and more economical since 1984. This ISO 9001:2008-certified company serves the electric power industry worldwide through the design, manufacture, supply, and support of products and services for power system protection, control, and monitoring. For more information, visit www.selinc.com, or contact SEL by phone: +1.509.332.1890; fax: +1.509.332.7990; or mail: 2350 NE Hopkins Court, Pullman, WA 99163, USA.

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