The 30 Advanced Energy (AE) 500 kW 1kV DC Utility PV Inverters at PG&E’s 15MW Westside Solar Station successfully passed multiple low voltage sag events. Engineered and constructed by Cupertino Electric, Inc., this site’s inverters are equipped with Voltage Ride-Through (VRT) capabilities and are connected to a Pacific Gas & Electric substation outside of Fresno, CA.

On March 17, 2012, there were a total of 4 low voltage events caused by momentary phase to phase faults on an adjacent 12 kV circuit which is fed from the same substation where this Solar Station is connected. The Solar Station is equipped with a Schweitzer Engineering Laboratories (SEL) relay at the 12kV switchgear. The oscillography traces from the SEL relay at Westside Solar Station showed close to a 50% voltage depression at the 12 kV bus for approximately 7 cycles. During each of these events the units were between 20% and 80% of full-power. All the inverters remained online, demonstrating the Low Voltage Ride-Through (LVRT) capability of AE’s Utility inverters.

A similar event occurred on February 7, 2012, when the adjacent feeder experienced a short circuit condition causing both A and B phases at the connected substation to experience a 50% voltage sag which activated the inverter’s LVRT capabilities. The protective relays on the faulted 12 kV circuit detected the short circuit and cleared the fault in approximately 7 cycles. The inverters successfully rode through the event and returned to normal operation upon clearance of the short circuit condition. The SEL graphs were collected and reviewed by PG&E’s Renewable Resource Development department.

Graph 1: The VRT profile for the AE Utility PV inverters is programmable to multiple regional profiles such as for FERC 661, NERC, & ERCOT, shown above.
VRT timing profiles are features offered in the AE Utility inverters. They provide the inverter the ability to stay connected with the grid under these external fault conditions. While there are no specific VRT requirements imposed by the existing interconnection requirements at this time, PG&E voluntarily implemented the VRT feature at this solar site to demonstrate the benefits of having these features.

VRT enables inverters to stay online during grid disturbances and produce reactive power in an effort to stabilize the grid. As part of the VRT offering, the AE Utility inverters can perform Zero Voltage Ride-Through (ZVRT), High Voltage Ride-Through (HVRT) and LVRT. The AE Utility inverters followed the utility required timing profile and quickly ramp back up after an event has cleared. VRT allows the inverters to ride through disturbance events and enables the generation station to stay online, and limit the revenue lost to the investors while helping to stabilize the grid.

This event successfully demonstrated the LVRT capabilities of the AE Utility PV Inverters. The Solar Station's graphs provide data for PG&E to better understand the impacts of inverters with LVRT capabilities to support the grid in areas with a high penetration of distributed generation.

Figure 1 displays the voltage and current waveforms captured by the SEL relay at Westside Solar Station during the February LVRT event. It can be seen that the current temporarily increases for approximately 2 cycles at the inception of the fault. This is expected behavior as the units are operating at less than 50% of their nameplate rating. When the line voltage began to drop, the units attempted to maintain a constant output power and the AC current increased up to the AC current limit before the LVRT features were activated.

The February and March LVRT events at Westside Solar Station provided PG&E with the actual data to demonstrate the effect of successful LVRT. It is expected that large PV Solar Stations, such as Westside Solar Station, will be required to be equipped with VRT features in the near future. The following are the two guiding documents that utilities and the system operators are using to develop the VRT requirement for large PV generating stations:

- NERC Standard PRC-024

As utilities connect more large PV projects onto the grid, it becomes more important that these large PV projects be equipped with VRT capabilities to stay online during grid disturbances.