Distributed Energy Resources (DER) Case Study

Voltage Control for High Penetration Residential Solar Feeders

GRIDBRIDGE

As the installed base of DERs continues to grow in volume and complexity, without proper planning, monitoring, and control, the number of disruptive effects on the performance and stability of the legacy electric grid will grow exponentially.

This industry-wide shift to a more distributed model drives a growing need at utilities to operationalize data coming from new grid technologies like smart meters, customer-sited generation and electric vehicle charging. While most utilities already have a mix of these resources in their service territories today, they struggle to translate these deployments into tangible benefits from the perspective of grid operations and customer satisfaction.

As the number of residential solar deployments have increased, so too has the number of utility grid related issues.

One issue linked to distributed generation (DG) that utilities have to address is the increase in line voltage due to solar generating customers backfeeding power during periods of light feeder loading. Many DG service calls can be attributed to high voltage levels at the customer site causing the inverters to shut down. This condition occurs when the customer's DG has reached a maximum operating voltage above the transformer load voltage, thus unable to backfeed power into the grid. Historically, the only viable option available to the utility to address this issue was to lower the line impedances in the reverse direction. Not only is this solution difficult to employ, time-consuming, and costly, but in some cases, is impossible to implement.

Another issue frequently associated with DG applications is the wide-ranging voltage swings caused by intermittent power generation. Residential customers with DG have notably different voltage profiles. For example, voltage levels at DG customers will be dependent on whether they are producing less power than is being consumed (and are therefore a load on the system) or producing more power than is being consumed. With any sudden changes, often coming from cloud cover reducing the amount of solar irradiance, customers can quickly shift from being a power supplier back to a consumer. The resulting voltage fluctuations present another obstacle to support increasing solar DG hosting capacity.

To address these and other issues, utilities have deployed the GridBridge Grid Energy Router (GER) as part of their network solution. The GER is an intelligent device that improves electrical distribution quality and reliability through active voltage control at the grid edge. It provides an extremely versatile solution improving reliability and efficiency of the distribution network via a pole mount, pad mount or integrated transformer application.

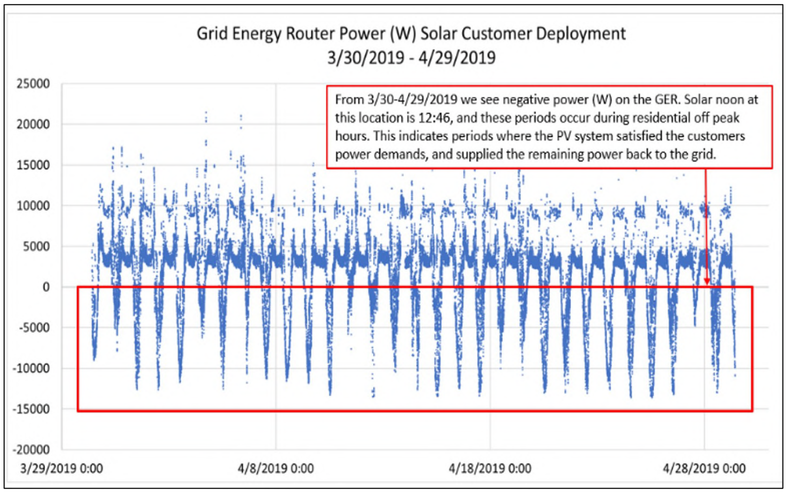
Grid Energy Router installed next to the distribution transformer.

Results of deploying a Grid Energy Router at a Solar Residential Site

After commissioning the GER on site, the unit began recording and storing data for future analysis. During operation, over the course of 1 month, 30 second data was downloaded and analyzed to determine if there were any unique trends associated with solar generation. What became apparent was that around midday (in this case roughly 12:46PM local time), peak negative power was recorded. This period of peak solar generation often coincided with lighter loading periods for most residential customers. For this application, negative power indicates power flowing in the reverse direction and being backfed into the grid.

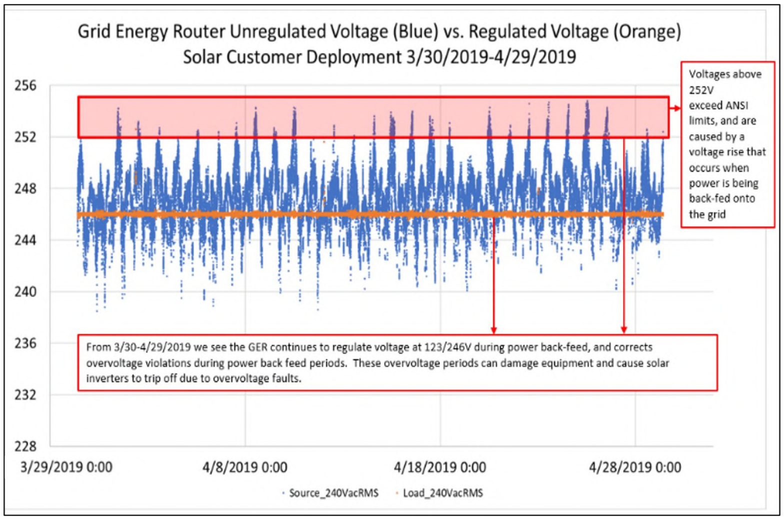
The following chart displays the backfeeding that occurred on a daily basis, where each negative power peak (W) represented a different day. As represented within the chart, there are 30 peaks correspond to each day of the 30-day sampling period.

At the time of these daily peaks, with power supplied back to the grid between 5 and nearly 15KW, the installed solar DG more than satisfied customer power demands. Along with an improved understanding of local feeder conditions, this provides insight for planning purposes as more solar DG installations are deployed in the future.



30 days of 30 second data showing backfeeding power from solar PV system back on to the grid each day.

The next chart is an illustrative graph showing the unregulated source voltage (blue) as well as the regulated load voltage at the solar customer location, (orange) plotted as a function of time. When power was flowing in a reverse direction into the grid, the source voltage as measured line to line ranged from around 240VAC to almost 256VAC. On several occasions, the source voltage exceeded the ANSI defined limit of 252VAC (126 VAC measured line to neutral).



GER control eliminates overvoltage violations while solar PV is backfeeding excess power.

The regulated load voltage generated by the GER is configurable and can be set within a range of 220VAC to 252VAC or +/-20V of the source voltage. At this location, the utility decided to set the voltage level at 246VAC (123VAC line to neutral), the average voltage observed at this site.

Using the GER to regulate load voltage prevented the customers on this feeder from experiencing overvoltage conditions. All this while still providing data essential to understanding how solar will affect grid stability. As solar gains momentum, utilties now have an important solution to support removing technical barriers for safe and reliable high penetration DG performance today and into the future.