Using Satellites to Remotely Manage PV Installations

By Andrea Casella, *Technical Director*, Santerno, Castelguelfo, Italy

Andrea Casella is the Technical Director of Santerno, an Italian company that manufactures and markets inverters for a broad range of applications with a special focus on commercial and utility-scale photovoltaic installations. He holds a degree in Electrical Engineering from the University of Padua.

Solar power is everywhere, but being solar plants self-contained systems, it's not always easy to access a solar plant and manage it effectively. By their very nature, photovoltaic installations tend to be in hard-to-reach places, whether it is the roof of an office building or a remote outdoor location. Solar power is ideal for both metropolitan installations providing clean, reliable, supplementary power, and for application in less developed areas where energy is needed, but often there is no real communication infrastructure to manage the solar energy production.

Providing autonomous energy, like a solar plant does, usually means supplying energy to a region potentially without infrastructure – no grid, no telephone lines, no cellular phone coverage, no fast web access. Therefore, managing the solar plant requires physical visits to the location, which are time consuming and costly.

Industry experts estimate that an annual visit on site could costs yearly up to four times more than establishing and maintaining a remote monitoring system. Moreover, regular visits do not represent any guarantee against system failures, whereas remote monitoring typically helps detecting and troubleshooting technical problems before they could become real system failures.

So how is it possible to implement a remote monitoring and control system for a PV plant that is difficult to access and has no local infrastructure? An answer today is the *satellite technology*.

Reliable, 24/7 monitoring via satellite can be applied to any PV systems anywhere in the world. Since a solar array needs to be exposed to sunlight to supply power, it also means that solar array can be seen by orbiting satellites, so what better way to check on an array or connect the PV system to the Internet so you can apply web-based monitoring? And using satellites lets you consolidate monitoring and management of your PV systems into a single view, since all of your solar arrays can be seen anywhere in the world.

The Strengths and Limitations of Satellite Internet

The main beauty of using satellite communications for PV monitoring is that plant location doesn't really matter. As long as your PV installation has a clear line of site with a geocentric communications satellite in the Clarke Belt, you can install a satellite dish that allows you to communicate with your PV plant enabling the typical features that a SCADA system offers (data-logging, remote monitoring and control, variables real-time access, system parameterization and optimization, software update, troubleshooting, etc.).

The bandwidth required for monitoring PV systems via the Internet is quite modest; if you have enough Internet bandwidth to enable a web browser, you can manage a PV installation. The satellite

signal needs to have sufficient strength to deal with conditions that may affect line of sight, such as cloud cover or rain attenuation, where raindrops actually absorb the signal. Lower radio frequencies, to below 900 MHz, are less susceptible to absorption and can even receive a signal through vegetation. Most satellite communications operates above 2 GHz and the higher the frequency, the more susceptible it is to interference. Satellite Internet communications typically runs over Ka band, which operates between 18.3 and 31 GHz – the uplink is between 27.5 and 31 GHz and the downlink is between 18.3 and 20.2 GHz. For data transmission, such as IP traffic, a Ka band connection over a shared satellite download carrier may have a bit rate of 1 to 40 Mbit/s. Since Ka band satellites use spot beams that target a smaller geographic area, they have a more focused signal and can use smaller, less expensive satellite dishes, but they do need a clear line of sight.

One of the biggest challenges with satellite Internet communications is latency. Latency is the roundtrip time between a data or packet sending an information request and getting a response. The roundtrip time required for data to be beamed to a geostationary satellite and back is 20 times that of a conventional, terrestrial computer network. For some more robust data applications, such as streaming or VoIP, latency makes satellite Internet a real challenge. For real-time monitoring of PV installations, however, latency can be overcome.

Santerno first developed its own satellite monitoring system for PV plants at isolated locations in Sardinia and Sicily in 2007. The only Internet connection available was via satellite, but even with a higher available bandwidth, high packet latency proved to be an issue. To provide reliable monitoring, we developed a means to ensure a reliable satellite connection under any conditions. With a secure two-way data connection, we can support both regular data updates (every 15 minutes) and historical data gathering of PV plant performance as well as instantaneous point-to point-access for technicians at each single inverter or system in the plant.

A web monitoring system can check local climate conditions as well as the correct functioning of plant components and performance anomalies. For example, if there is heavy cloud cover the web monitoring system can tell you what the revised system output might be. It also provides a remote means to modify the operating parameters of specific plant devices, and can provide troubleshooting information in case of a failure. And since the data is delivered via web browser, the visualization of data in graph form makes it easy to spot performance problems.

Getting a Bird's Eye View with Google Maps

In addition to Internet monitoring, you can use Google Maps for a sky-high view of your solar facility, which can be valuable. Google Maps are regularly updated, and by using the zoom feature you can get an overhead view of the PV plant as well as a street-level view.

Some large PV plants are located in off-grid systems and use real-time satellite weather monitoring to predict PV plant energy production. Accurate weather forecasts can reduce the number of batteries needed to stabilize the micro-grid.

Google Maps has an added advantage of providing a historical database of satellite images. For example, plant images of the first installations of our Santerno solar inverters in 1994 are still available in Google Maps, including street views, which can be valuable for comparison. Having both current views and past views for reference can reveal a lot about a solar installation, including changes in foliage growth or other factors that could impede performance.

GPS Technology Automates Maintenance

Satellite technology even plays an important role in plant maintenance. One of the biggest problems in large utility-scale plants in dusty climates, for example, is panel washing. A dust layer of one-seventh of one ounce per yard can cut solar power conversion by as much as 40 percent.

In remote locations, sending a crew out to wash the panels of a large array can be very expensive, especially if you have to do it regularly. Using global positioning system (GPS) technology you can remotely control equipment for panel washing. Agricultural trucks, typically used for crop dusting, can be equipped with special tools for panel washing and controlled remotely via GPS. GPS technology has evolved to the point that equipment can be operated with sufficient accuracy that these trucks won't damage the panels or miss their mark and do a poor job of washing off the dust.

So whether you are integrating PV and Internet technology for remote performance monitoring, using satellite views to keep an eye on your solar installation, or relying on satellite technology such as GPS for maintenance, satellite technology offers valuable support for PV systems management. The technological possibility of bringing together satellite communications and PV systems opens a range of new opportunities in cost-savings and systems management.