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SMALL BUT MIGHTY

NEXT-GEN MICROINVERTERS RAMP UP RELIABILITY, POWER, STORAGE OPTIONS

By **Chris Crowell**

Don't let the term microinverter fool you. Sure, they are scaled-down versions of conventional inverters and are usually connected to individual modules rather than a string, but the microinverters of today are capable of adding extra value for the right installation.

Value in terms of price can be tricky. The initial per watt cost of a microinverter is higher, and needing so many of them compared to a string inverter might be impractical for certain jobs. A rule of thumb is typically anything above 3 kW favors the economics of string inverters.

But value is a nuanced concept. With a single microinverter rated to handle the output of a single panel, some extra design issues and components, like the need for a larger transformer, can be eliminated. Plus, the single-panel-to-microinverter relationship helps to isolate and accommodate fluctuations in power output. What if it's a complex roof with three orientations and multiple obstacles or random shading issues? An extra upfront expense could deliver more lifetime value and better performance for the life of the project. Also, a string inverter, rated to a specific output, can limit the potential to add more panels to the array down the road.

This value story has resonated most with installers who are newer to solar or whose core business is outside of solar (electrical, plumbing, roofing and satellite) and have a preference for working on the AC-side of the system. Often, microinverters can be installed using the same, less skilled labor pool, which can hold real economic value.

Obviously there are microinverter-specific pain points as well. And while some of them are just inherent tradeoffs, microinverter manufacturers have made strides the last few years to address several of these issues as well as tie in additional value for the installation.

RELIABILITY

A microinverter issue typically cited is unreliable communication. This can happen while running communication through a powerline into a home because of all the other communication from other systems and appliances being sent through the same line. A trend happening now is to use a dedicated line to avoid these potential interference issues.

"Installers generally lose money when they run a truck for replacement or troubleshooting … [the dedicated line] is a little more labor intensive to install, but there are reliability gains long term," says Brad Dore, director of marketing with SMA America.

Since a microinverter is sitting right where the action is, under the panel, on the roof, where temperatures can rise to 140 degrees or more, there is often more of a need for technical help on site.

"When you think about O&M risk associated with microinverters, remember there are 20 to 30 of those on a roof," Dore says. "You don't want to have to roll out multiple times to replace damaged microinverters."

An answer from microinverter

manufacturers has been to reduce the part count and the number of soldering joints within the inverter itself, which makes for a more reliable, hard product. Any slight simplification in design that also shaves time off the installation process — even just a minute or two — has serious implications when multiplied by 20 to 30 microinverters.

POWER AND STORAGE

Even the most common attribute of a microinverter is changing. As installers move toward higher-wattage panels to maximize system output — while also trying to simplify installations overall — microinverter manufacturers have boosted their product specs. According to Jason Higginson, senior director of marketing at APsystems, there are now residential and commercial microinverter products that handle multiple modules (60- or 72-cell modules) per microinverter unit — two modules per residential microinverter, and up to four modules per true three-phase commercial microinverter. The YC1000 from APsystems, can handle four modules per inverter.

"These products will increase in wattage, voltage ranges, efficiency and utility connection capabilities in the coming year," he says. "Advancements like this will allow more 72-cell modules to be utilized in microinverter applications where they could not previously. This is big for installers and end-users who have wanted to take advantage of the benefits of microinverters but were previously limited."

Storage-related products are also coming over the horizon very soon and will offer new value and applications for solar customers.

"We have seen an increased interest in storage, as several companies make their way into this new market space," says Teff Reed, senior director of product management — residential with Enphase Energy. "We are seeing consumers who want to store the excess energy produced by their solar system during the day and save it for future use."

Certainly storage systems will use string inverters as well, but Reed says microinverters are particularly well suited because they allow the sizing of battery packs for better safety and a longer lifetime without costly environmental controls. From a product standpoint, this allows for modular and easily installable energy storage units that enable homeowners to make a small investment and grow their system as their needs change.

NEW APPLICATIONS

This next evolution in microinverter functionality may start to change their applicability. Residential applications currently account for approximately 80 percent of microinverter use, but Higginson believes the commercial segment (think minimarts and carports) is poised as the next big growth area for MLPE applications thanks to the current and upcoming microinverter innovations.

Reed agrees: "We definitely see more applicability of microinverter technology in the commercial solar space, which greatly benefits from the modularity and distributed nature of a microinverter system."

The play for solar energy, more and more, is grid interaction, and microinverter technology is moving to meet this demand.

"As the energy sector moves toward a time when more and more distributed generation [DG] will be installed on the grid, and with the addition of more PV, storage and electric vehicles coming online, the grid is constantly changing," he says. "To accommodate these changes, utility companies are beginning to work with solar companies, using smart inverters to improve stability of the overall grid."

As technology continues to evolve, the next generation of microinverters will have to be bigger, in terms of power output, to handle today's module sizes and the potential for future growth. Look for improvements in wattage, voltage ranges, efficiency and utility connection to continue, and as codes and regulations in states and municipalities change as distributed PV becomes even more integral to local and regional energy solutions, microinverter product offerings will continue to adapt.

"Microinverters that have the easiest installation methods, full monitoring capabilities and lowest total cost of ownership [TCO] will prevail as the winners," Higginson says.

"It's the nature of microinverters to change project applicability, allowing for more buildings with odd roof design and other factors to now be solar-friendly where before it wasn't practical to place modules in odd quantities or in places that could only fit a few," Dore says.

Each of the microinverter manufacturers we spoke to are expecting more and more innovation in terms of fleet management, service, grid support and energy management — more robust solutions that combine energy generation, storage, control and management into a single solution.

"We believe that eventually people won't be going out to buy a solar system; they'll be buying an energy management system," Reed says.

"Microinverters that will continue making inroads will be achieving a balance between reliability and price as market demands shift," Dore says. "If you can provide installers with a solution that improves their installation experience, optimizes long-term profitability and corrects existing pain points while meeting the demands of changing grid requirements, you have a recipe for growth."

Chris Crowell is managing editor of *Solar Builder.*

TIME HACKS

FOR INSTALLING MLPE

By **Jason Higginson**, Senior Director of Marketing, APsystems

Time is money, and if you're a solar installation company, it absolutely rings true. Labor is expensive, so the longer a project takes, the more it costs an installer to put in a solar system — and it comes right out of their bottom line. According to the U.S. Department of Energy, soft or "plug-in" costs of solar account for as much as 64 percent of the total cost, and labor is one of the largest culprits.

One challenge in the effort to reduce labor costs is the growth in utilization of module-level power electronics (MLPEs) such as microinverters and DC optimizers. They provide a better LCOE, but are more labor intensive.

By using these solar hacks, installers can still perform profitable, streamlined MLPE installations.

TIME-SAVING PRODUCTS

Microinverters that serve multiple modules exist today, and with 2-to-1 and even 4-to-1 module-to-microinverter options available, homeowners can still get the benefits of an MLPE system with independent MPPT per module, while installers cleverly reduce the amount of units they're having to put on the roof by 50 to 75 percent.

MLPE ARCHITECTURE

Most MLPE systems use a trunk bus cable to which installers then attach every microinverter. Not only are trunk cables an expensive part of the system, but placing it on the roof and securing the cable to the racking takes time. Products, such as the APsystems YC500A, utilize a daisy-chain method of cabling and do away with the trunk cable. What's more, the daisy chain is pre-integrated into the unit so it comes completely pre-cabled and ready to go.

FREE TRAINING

Most solar equipment manufacturers offer free training webinars and videos on their products anymore, so absolutely take advantage of this.

GATEWAY SET-UP

The gateway communication unit for microinverter installations can be a breeze if installers follow a few simple tips for commissioning the system. Connect the gateway to the internet via a standard ethernet cable so it can download the most current firmware before you begin to commission the system. Ideally, you'll want to do this after the inverter installation but before module installation so the unit can update while your team puts panels on the roof so you don't lose time.

Be sure to connect cables in the right order as some gateways may take longer if power is applied before the network cable (unless the system will be connected via Wi-Fi). Obtaining the homeowner's Wi-Fi network information and password before hitting the jobsite will also save you time in connecting the gateway.

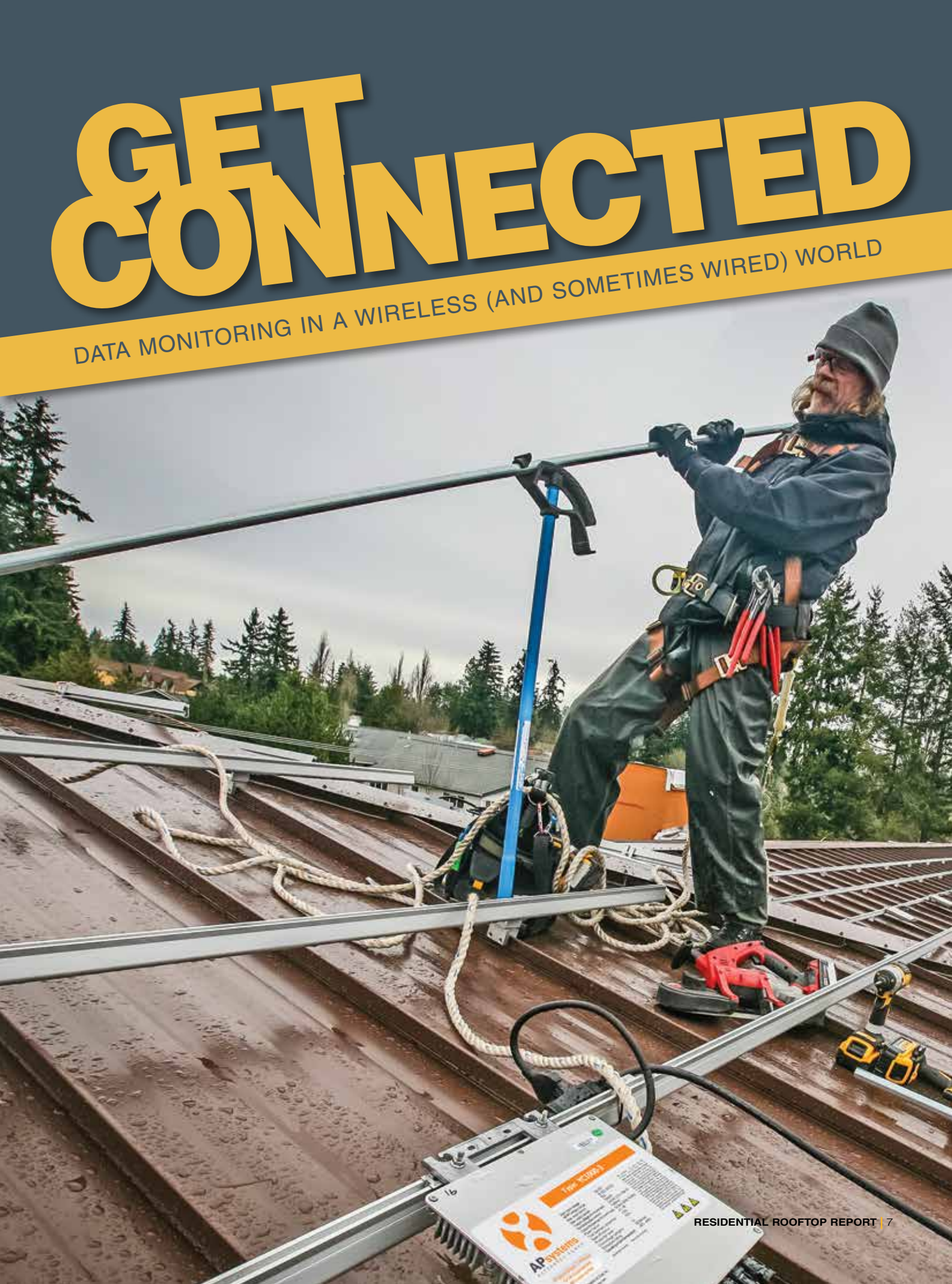
TIME-SAVING APPS

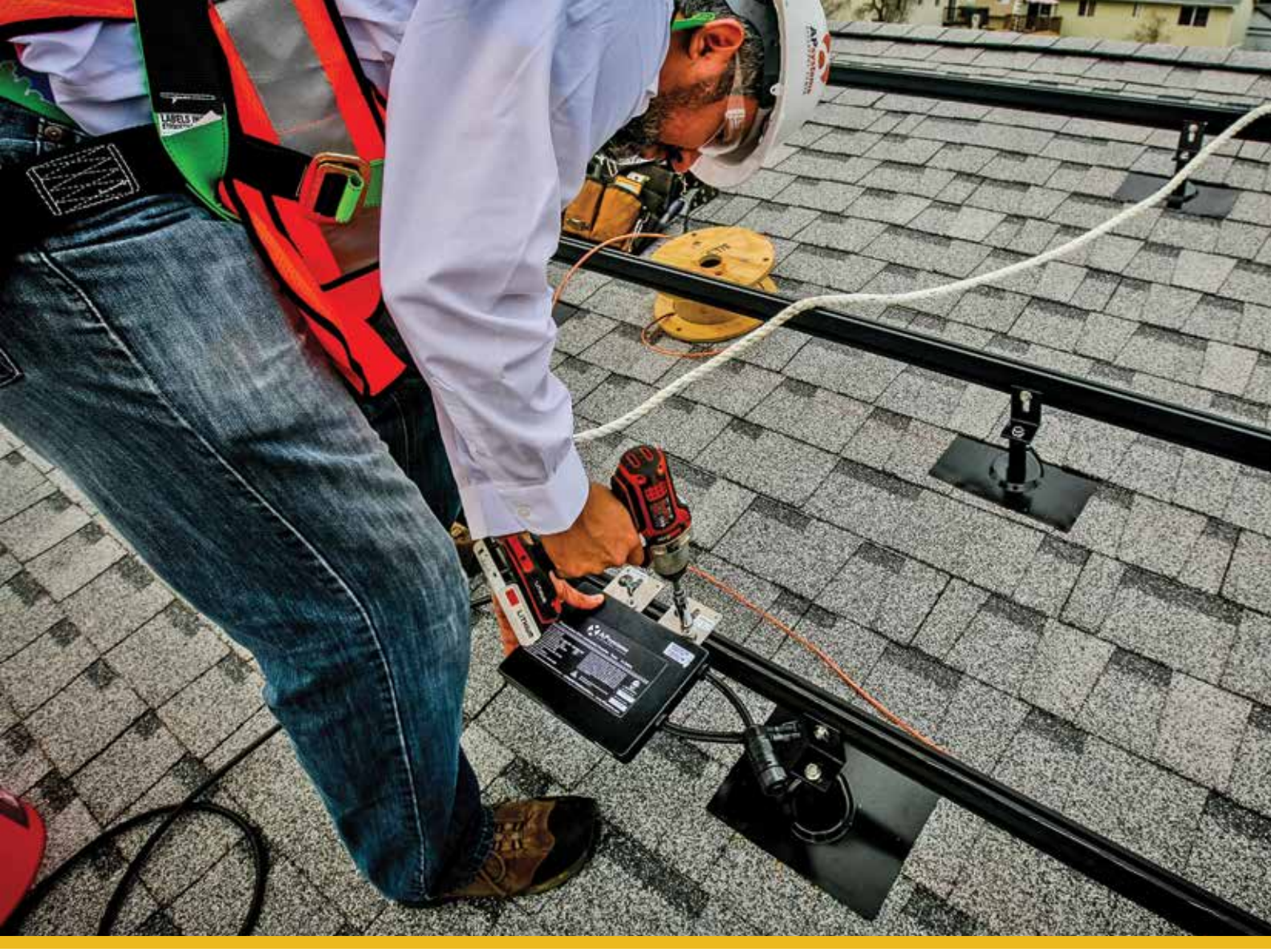
There are some amazing apps out there for solar installers that can help streamline system setup. ArrayApp by APsystems, for example, allows installers to create the homeowner account for online monitoring, scan units directly without having to wait for up to 30 minutes for auto-detection of the inverters and create the array site map all from their mobile phone or tablet.

Taking advantage of these time-saving measures can save an installer money but also help them get more installations completed in a single day. As the solar industry continues to lean toward MLPE systems, finding ways to install faster and more effectively can mean the difference between a profitable operation and one that struggles to be competitive. Be sure to do your research, training, find out what other installers are doing and build your own list of valuable solar installation hacks.

GET CONNECTED

DATA MONITORING IN A WIRELESS (AND SOMETIMES WIRED) WORLD





By **Christopher Barrett,** Director of Engineering & Technical Services, APsystems

You're a solar installer, not "the IT guy," so why spend time dealing with "connectivity issues" and helping your customers reboot their Wi-Fi network?

While precise, real-time monitoring is an essential feature of today's PV systems, communication between monitoring devices and the customer's router is often the overlooked link in the chain.

Understanding the options for today's connectivity — and making smart choices for your customers up front — can save you a costly return visit to one jobsite after you've already moved on to the next.

THE CHALLENGE

Relaying performance data to both the customer's computer or smart device and the manufacturer's database relies on constant, reliable communication between a number of specialized components.

The typical signal chain: the solar array → the data collector, typically called a gateway (e.g. the APsytems ECU or the Enphase Envoy, to name two common examples) → the home internet router, and from there to the various monitoring stations.

It sounds straightforward, but differences in home size and layout can mean the gateway and router are separated by both distance and space.

How to bridge the gap?

Today's solar customers now have an almost bewildering array of choices (and acronyms) for linking the gateway and router, from Wi-Fi extenders to TDMA to EOP, even old-school CAT-5 or CAT-6 ethernet cables. Each option has its particular strengths and weaknesses, and the right answer for one installation may not work for another.

Let's consider the pros and cons of each.

WI-FI EXTENDER

This common "bridge" device can be used when a gateway and router are at opposite ends of the customer's home, for example.

Signal chain: Gateway → Wi-Fi extender (via hardwire) → router (via Wi-Fi).

Pros: It's wireless, and in our new "wireless world," that's a big draw.

Cons: Like any wireless system, it can be prone to dropouts and disconnects, leading to annoying hardware reboots. Remember, your goal is to have an uninterrupted signal 24/7/365 — a much more rigorous standard than customers hold for their laptops or phones.

EOP (ETHERNET OVER POWER LINE)

The Power Line Connection (PLC) option relays data through the wiring of the home or commercial building.

Signal chain: Gateway → EOP device (via hardwire) → router.

Pros: Essentially a hardwired connection, this technology actually offers faster speeds than typical wireless. EOP also offers a higher level of network security.

Cons: Because the signal travels through the home's internal power lines, it can be subject to signal degradation and PLC "noise." Synchronization of devices can also be a technical challenge.

CELLULAR

This system typically features mobile broadband connected through a mini-router. Equipment is an off-the-shelf item, although it's sometimes available from your cellular provider.

Signal chain: Gateway → router (via CAT-5 cable) → cellular dongle to connect to the internet.

Pros: Anywhere there's cellular service, there's connectivity.

Cons: Local signal strength may be weak or spotty depending on the carrier. Also, coverage means ongoing monthly costs to maintain cellular service.

TDMA POLLING TECH (POINT-TO-POINT ETHERNET)

Because it is effective over longer distances, this can be a good choice for remote installations, say, a ground-mount array in a backyard or at the far side of an agricultural spread.

Signal chain: Gateway → TDMA device → router.

Pros: Works over longer distances — 1,000 ft or more, depending on signal strength.

Cons: Requires a higher level of IT knowledge to configure and pair up the devices. As with Wi-Fi, connection can be interrupted or lost — the antennas are not omnidirectional and must be oriented toward each other for reliable communication. TDMA devices may also cost more than alternatives.

ETHERNET CABLE (I.E. CAT-5, CAT-6)

Perhaps not as sexy in the wireless world, it's still the cheapest and most reliable option — fast speeds, no dropouts and no signal that may be picked up by other devices. It's also a good choice for new construction, when the network can be wired into the home. All you need is a spool of cable, two connectors and a crimping tool.

Signal chain: A single cable. Plug one end into the gateway and the other into the router.

Pros: No IT calls, ever.

Cons: You may spend more time running wire around the outside of the customer's house, like CATV providers run coax. Also, remember to purchase outdoor-rated (UV-protected) cable to ensure longevity against the elements.

MAKING THE RIGHT CHOICE

Solar customers want reliability: reliable modules, reliable inverters, reliable production. It's time for installers to add reliable connectivity to the equation.

Match your hardware choices to the size and layout of the house, with proven technologies and products to ensure uninterrupted, round-the-clock monitoring — and keep your customers happy. The best solution is the one that requires the least follow-up once you've left the jobsite.

Christopher Barrett is Director of Engineering & Technical Services for APsystems.

RAPID SYSTEM SHUTDOWN RUNDOWN

HOW TO KEEP YOUR NEXT PROJECT CODE-COMPLIANT

By Chris Crowell

The 2014 National Electrical Code's (NEC) manual, Section 690.12, says that a PV system needs to be able to reduce the voltage and current to 30 volts and 240 volt-amps, within a 10-ft perimeter of the array after rapid shutdown is initiated. It's a straightforward name and concept, but there are still unknowns for meeting the requirement and who is enforcing the code.

As Brian Lydic, standards and technology integration engineer for Fronius, points out, what's missing from the current requirement is an explanation of where the solution needs to be. For one, the 2014 NEC does not exactly define the boundary of a PV array.

"'The phrase 'a mechanically integrated assembly of modules or panels' could possibly be interpreted differently by different AHJs. This may be particularly important on commercial rooftops where sections of the array may be separated, or even a row could be considered an 'array,'" Lydic says.

Even on a residential rooftop, different portions of the array might need different rapid shutdown devices where the sub-arrays are more than 20 ft apart. Another detail up for interpretation, at least until the 2017 NEC, is where the initiation device needs to be located.

"It's rogue out there," says Kim Silva, sales with MidNite Solar, in reference to inspection standards. "Manufacturers jump through hoops to meet UL standards, but the inspectors decide what they are going to do and when they are going to do it."

Twenty-two states adopted the 2014 NEC as of Jan. 1 with Massachusetts most ardently adhering to RSS. Jurisdictions in New Mexico and California were also mentioned as enforcing it but still not a majority of California counties.

SOLUTIONS

At the moment, there are a variety of solutions available to meet RSS code: DC/DC electronics (module-level or otherwise), remote-disconnecting string combiners, string/array-level rapid shutdown boxes, inverters mounted near the array and so on. For inverters to comply, they must have a way of discharging their input terminals/conductors; otherwise an extra isolation device may be necessary at the inverter and not only the array.

"A lot of solutions out there rely on the building's AC power to give that signal to shutdown," says Sarah Ozga, ABB's commercial inverters product manager for NA, which has a line of three residential rapid system shutdown boxes available (RS2-1CN6/RS2-2PN6/RS4-2CN6) that do just that, in any design configuration needed. "So, when firefighters shut down the power to the home, the RSS disconnects those conductors on the roof."

Since microinverters operate below the voltage threshold for the 690.12 rapid shutdown requirement, they are inherently compliant.

MidNite Solar's Birdhouse, for example, provides a disconnect switch at ground level.

"Some people said, 'we don't want to go up on the roof; we don't even want to look for inverters — just do it quickly,'" Silva says. "When you push the button on the Birdhouse, it will disconnect everything tied to it. In some setups, the primary grid-tied inverter has to be shutdown. With batteries, you have power there all of the time, so you have to be able to turn it off and not push back to the grid."

"It makes sense that an initiation method should be accessible to firefighters," Lydic says. "If only a meter is accessible from the outside of a building, the fire service may or may not be comfortable having the rapid shutdown initiation device located inside. The option to add a mechanical initiation device in addition to upstream AC switches may be convenient when the AHJ requires it."

If the rapid shutdown box acts as a combiner, according to Lydic, then it must include a manually operable load-break disconnect per 690.15(C), otherwise an additional DC disconnect needs to be installed next to the box. Yet with all the chaos caused by the rapid shutdown requirement causing string inverters manufacturers to develop add-on fixes, there is one immediately available solution: microinverters.

"Since microinverters operate below the voltage threshold for the 690.12 rapid shutdown requirement, they are inherently compliant and do not need any fixes or additional equipment," says Christopher Barrett, director of engineering and technical services with APsystems. "When the AC circuit goes down for any reason, each of our microinverters performs its own shutdown function in just 100 milliseconds – 100 times faster than the code-specified standard of 10 seconds for shutdown."

Whatever solution you choose, Ozga, who worked for years as an installer, says to consider the value or efficiencies new RSS requirements bring to a project, instead of seeing it as just another added cost.

"Consider a situation where there were supposed to be four strings running from roof to inverter and an installer used PV wire for six of those. Now you can use a rapid shutdown box, which adds cost but can combine those strings. Now you can transition to a less expensive wire, have fewer conductors and require less labor to install."

Different applications and regions will require different combiner solutions. Check with your AHJ to fully understand what is required for each install and source accordingly.

Chris Crowell is managing editor of *Solar Builder.*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