Beyond residential rooftop: module-level power electronics go large

MLPE | Microinverters and power optimisers have become increasingly common features of smaller PV systems. Sara ver Bruggen reports on the technologies' gradual transition into larger commercial and utility-scale applications

Credit: SolarEdge

Module-level power electronics (MLPE), such as microinverters and DC optimisers, have made rapid inroads into the residential solar PV market, particularly in the US.

Shipments of MLPE units reached 1.3GW in 2014 and are forecast to continue growing at an average annual growth rate of 39% through 2020, faster than any other inverter product segment, according to GTM Research, while IHS forecasts the market for MLPE technologies will reach over 9GW in 2020.

The Americas is forecast to continue to be the main market that will see most adoption to 2020 due to the concentration of MLPE suppliers and the higher awareness in the market of MLPE technology.

Microinverters are starting to see deployment in large commercial, whilst DC optimisers are finding traction in utility/ground-mount arrays, in conjunction with string inverters. The majority of MLPE suppliers – SolarEdge, Enphase and AP Systems – have tended to concentrate on the residential solar PV segment, but they are focused on new market segments. The exception is Tigo, which has focused on commercial and utility solar PV markets.

Power optimisers are likely to be used more often in larger installations, greater than a megawatt in size, as opposed to microinverters, due to the fact that they cost less and they only need to be installed on impacted modules, such as those in shadow or perimeter modules that might get dirty, according to Cormac Gilligan an analyst at IHS.

Module-level power electronics products are finding their way into ever-larger PV systems

Tigo has tens of installations over 1MW in size for its optimisers. Company founder Mauricio Ramos says: "We are experiencing increased deployment momentum in many markets, in addition to the US, including Europe, Australia and Japan. Systems as big as 8MW are using Flex MLPE with string inverters."

Credit: Enphase

The company's core platform – Flex MLPE – supports selective deployment in specific locations of the solar array. The product comes either as an integrated junction box format, which is mounted on the PV module in the factory, the TS4 and a retrofit product, the TSR-4, which is mounted to the PV module frame on a rack for both existing as well as new installations.

Unlike other optimisers, Tigo's TS4 platform is modular. Customers, which range from residential installers, commercial engineering, procurement and construction (EPC) firms to utility project developers, choose the appropriate level of Flex MLPE and pay only for the needed solution. Customers can choose to have monitoring, safety, optimisation and long string options, at different price points that all work with any PV module.

Selective deployment reduces cost. "For instance, a system can include a total of 15 PV modules with 10 TS4 optimisers, with safety options and five TS4 optimisers with optimisation options. Only five PV panels need to be treated for shading. This provides the lowest cost possible," explains Ramos.

Meanwhile, SolarEdge's vice president of market and product strategy, and co-founder, Lior Handelsman, says the company has supplied hundreds of commercial sites around the world using its optimisers.

Enphase has growing demand for microinverters in large commercial and community solar projects

These include ground-mount and industrial rooftop installations in different sectors, such as agricultural, public buildings and carports. Many of these are projects larger than a megawatt and include a 5MW ground-mount installation in Turkey and a 4.2MW rooftop in the Netherlands.

Wherever system owners are interested in the long-term value of their PV system and see it as a financial investment, there is a higher demand for MLPE, according to Handelsman.

He says: "System owners who are savvier about their investments and look at the capital expenditure costs and operational expenditure costs, see the value in MLPE. This is because MLPE offers commercial systems both higher system uptime and improved PV asset management."

SolarEdge's DC-DC power optimiser places hardware on the module that manages and monitors energy production, while leaving the conversion process at the string level, helping to keep the solution scalable for large projects.

The company offers a one-power-optimiser-to-two-panel configuration to improve the scalability of its technology. "There might be a bit of a higher upfront cost for the inverter system, but there are lower balance-of-system and O&M costs, and higher lifetime revenue," says Handelsman.

Strung out

The main demand for DC optimisers in commercial projects is the increased focus on improving return on investment. This has caused a trend in recent years of moving to a decentralised inverter architecture.

According to IHS, the market share of string inverters in the global three-phase inverter market grew from 28% in 2014 to 34% in 2015, a shift prompted by the drawbacks of central inverters in these types of projects.

DC optimisers enable the trend towards decentralised inverter architecture, which favours string over central inverters, since optimisers overcome the limitations of string inverters.

To lower balance-of-system costs, central and standard string inverter manufacturers are trying to increase string length by increasing inverter input voltage to 1,500 volts. Higher voltage allows for strings up to 50% longer than strings of 1,000 volts (DC).

An alternative way to achieve longer strings is with fixed-string voltage, an advanced operating mode for string inverters. This requires power optimisers to match current level drawn from the inverter, while the inverter maintains string voltage at optimal voltage for converting DC to AC, regardless of string length or temperature.

"String length is no longer governed by voltage, but by power. This technique allows for 100% longer strings than standard string inverters, while also keeping the voltage below 1,000 volts, achieving reductions in BoS costs," says Handelsman.

GTM Research's solar analyst Scott Moscowitz says: "Though we see very little use of MLPE – when talking about microinverters – in systems larger than a megawatt in size, where DC optimisers are seeing uptake is for string optimisation, in line with increased use of string inverters in the utility solar PV segment.

He cites companies such as Colorado-headquartered Ampt, which has

developed a DC-DC converter specifically for utility-scale projects. Ampt's string optimisers put voltage and current limits on each PV string, allowing doubling of string lengths when the system is designed, while reducing the number of combiner boxes needed, as well as disconnects.

The company's technology also enables full array power at a voltage close to the PV system's maximum voltage. Inverters can narrow their operating range and deliver more power, which reduces the cost per watt of the inverter.

"However the market for DC optimisers in very large or utility-scale projects is still nascent, owing to few vendors," says Moskowitz.

Microinverter producer Enphase has completed and continues to supply large-scale commercial rooftop projects. The first of these was a 2.3MW rooftop project on a greenhouse in Ontario, which has been operational since late 2013.

In 2015, Enphase supplied My Generation Energy, a Massachusetts-based solar installer and developer with its C250 commercial microinverters for a 900kW community solar project. The company began shipping the product, developed for medium- and large-scale commercial applications, in February 2015. More recently Enphase has supplied a multi-megawatt project in Panama.

Other projects include a district in San Diego where more than 40 rooftops together make up a 2.5MW system, all of which are using microinverters.

"We are also seeing demand from big box retailers. Typically they have fleets of buildings where using microinverters enables a discreet and standardised project approach. Retailers tend to have limited space for electrical and cabling, so they can't, for example, have a central inverter in a carpark or lots of string inverters taking up a room," says Teff Reed, senior director of Enphase's microinverter solutions group.

Commercial projects in other markets are also being built using Enphase's microinverters, including a project nearly a megawatt in size in the UK as well as projects in Australia.

"In other markets, voltages are the same for whether a residential or a commercial installation, unlike in North America, so this plays to the advantage of using microinverters as there are no different requirements, which would require making variations in products. We can leverage high volumes and economies of scale to reduce costs," says Reed.

The company's technology roadmap includes increasing the efficiency of its microinverters to 97.5% then 98%, increasing power output in line with that of modules' increasing power output and shrinking the topology of its microinverters to reduce manufacturing costs.

Enphase's customers tend to be mainly rooftop solar PV installers, often installing commercial projects, but who have become familiar with using microinverters initially in residential project installations. Reed says eventually microinverters will move into the market for string inverters. "In large PV projects there is potential for losses in systems through voltage differentials. Microinverters can also simplify the installation of projects and their design."

However according to Gilligan: "The challenge for microinverters in utility markets is still price, though Enphase has communicated in its statements and roadmaps its commitment to reducing costs. We expect project sizes in the 10-100kW range to be ripe for microinverters in future."

Demand drivers

National Electrical Code (NEC) standards have also helped to drive demand for MLPE products, in residential. NEC 2017 requires rapid shutdown in large rooftop installations.

Ramos expects stronger control requirements, such as rapid shutdown, to strengthen the value proposition of MLPE and broaden adoption.

Tigo recently announced 1,500 volt certification and is also working to expand the technical specification of its product offering so that each will be able to address a wide set of parameters. "A single product will be able to provide the functionality to a very wide array of PV module specifications, reducing inventory requirements in large projects and lowering cost so it is, therefore, more attractive to commercial and utility projects."

Smart AC modules as well as demand for smart inverters and energy storage are also creating new lines of business for MLPE suppliers. Demand for smart modules will in part be driven by reduced labour costs, which in the US are higher compared with other markets. Tigo's T4 optimiser, assembled with the module in the factory, is compatible with all makes of modules and inverters.

Early next year Enphase's partners, which include SolarWorld, will release AC modules.

The first product will be a 60-cell AC module, aimed at the residential rooftop market, followed by the launch of a 72-cell AC module for commercial projects. SolarEdge recently launched a new power optimiser for AC modules that has a modular design and low profile. Manufacturers that provide smart modules optimised by SolarEdge are Canadian Solar, JA Solar, Jinko and Phono Solar.

Whether AC modules, smart inverters and energy storage demand improve the opportunities of MLPE in utility-scale PV markets in future remains to be seen. SunPower, which has made the most significant investment in AC module technology, by buying Solarbridge, is commercialising smart modules initially as a residential solution. However these are all new opportunities that providers of MLPE technologies cannot afford to ignore. ■

How MLPE technologies benefit rising demand for storage and controllable distributed energy resources

In the US, the commercial and industrial market is where demand for solar-plus-storage is concentrating. However overall it remains a smaller market, compared with solar PV.

Solaredge's Lior Handelsman says: "MLPE, as part of their standard benefits, are able to increase energy harvest, which would allow for a storage system to store more energy. However, there is more potential for DC optimised inverters. With a DC-coupled battery there is no additional conversion from AC to DC and back to AC. This allows for an overall higher storage system efficiency."

Tigo's Mauricio Ramos says PV systems coupled with storage component have the same challenges standalone PV systems have. Shading will lead to the need for optimisation, and there will still be a need for rapid shutdown if it is a rooftop. These sorts of factors will ensure PV-plus-storage systems will also benefit from MLPE.

In June Enphase announced it is supplying Californian utility Pacific Gas & Electric with smart microinverters used in distributed energy generation. PG&E will evaluate how smart microinverters used with customer sited solar are controlled and coordinated with grid management and voltage optimisation, to support increased solar penetration.

Projects such as these are important if MLPE suppliers are to prove their technology works as tougher grid requirements become the norm and solar-plus-storage becomes more mainstream.