Getting on the right track

In this article, Marco Trova, Senior Global Product Manager at FIMER S.p.A., talks us through some of the myths associated with Maximum Power Point Tracking (MPPT) technology to help engineers and installers specify the right approach to maximize yields and efficiency.

MPPT is often fitted as standard in state-of-the-art inverters, yet many users still don't understand its use and functionality within a solar array to get the optimum results from the technology.

Headlines for MPPT tend to focus on efficiency and it is often positioned as an inverter feature to help the user improve energy harvest.

At a technical level it is an algorithm that is used for extracting the maximum available power from the PV module by dynamically detecting the voltage operating point that results in the maximum energy transfer under certain conditions.

These statements are true. However, MPPT is not solely focused on increasing yield but also on optimization, as energy within the solar array constantly modulates and changes. Optimization is dependent on several factors including: shading from clouds, solar radiation levels, ambient temperatures, PV plants that are built with varying degrees of topology and/or strings exposed to different angles of irradiation right through to the condition of the PV module itself.

I have been working with MPPT technology for over 15 years and have often witnessed the misuse of the technology.

As such, I wanted to take look at some of the core myths to assist installers and engineers further when selecting MPPT technologies.

Myth 1: In your PV system, you can use either a single or Multi MPPT and the yield will not be affected.

Before we start to dispel this myth, we first need to identify the fundamental differences between a Single and a Multi MPPT. Single MPPT inverters are typically single stage converters that directly convert the DC power produced by solar array into AC power. This approach to convert PV power is straightforward and offers some benefit in terms of high conversion efficiency, and simplified design and installation being the most prevalent factors for purchase.

However, with a single MPPT the DC voltage window available to the inverter for MPPT operation is narrower when compared to double stage converter designs and may not allow the system to fully exploit the energy generated by the solar modules under specific conditions. The single MPPT is the appropriate choice whenever the system is made by identical strings with uniform orientation and irradiation (no shading) and the string length can be optimized to match the narrow MPP voltage window that typically characterize this class of inverters.

By way of comparison, multi-MPPT inverters are double stage converters with multiple DC/DC converters acting as front-end stages for implementing the MPPT of multiple and independent arrays.

At the price of a slightly lower conversion efficiency and higher complexity, this solution is very effective and flexible, since the MPPT voltage range is wider and completely decoupled from the AC voltage. Therefore, the energy coming from multiple arrays can be efficiently converted even in uneven or suboptimal array operating conditions (for example, in case of cloud shading).

The choice of using a single or multi-MPPT must be taken during the system design stage because of the potential impact on the overall system yield. Due to the complexities of plant design and requirements, at FIMER we offer a complete portfolio including single as well as multi-MPPT inverters, so that the system designer can define and select the most appropriate option for the 'best fit for application', according to the specific system constraints and characteristics.

Myth 2: You can only use multi-MPPT for residential and C&I (Commercial & Industrial) applications, and not on utility or large scale solar inverter projects.

While it is universally recognized that the sweet spot of multi-MPPT inverter architecture is within the residential and the C&I segment, based on the capabilities to harness and optimise across different string lengths and during superior shade immunity.

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But multi-MPPT can offer several advantages that are valuable across a broad spectrum of different applications and site conditions and should not be reserved solely for the residential and C&I sectors.

In our sector from example, we are seeing a continuous trend towards a higher adoption rate of the multi-MPPT string inverters in the small scale utility segment (up to 20/30MW), which have been historically dominated by monolithic single-MPPT single stage designs. This trend is a consequence of the advancements in power electronics that are further driving miniaturization of products and efficiency improvements enabling inverters to reach high power densities and increase the power capacity of a single unit from less than 10kW in 2010, up to and exceeding 250kW today.

Utility scale system operators are increasingly looking into multi-MPPT technology, particularly when they are designing and maintaining plants that are built within irregular terrains or where they need to maximize land occupancy.

However, at this point, we should still not discount single MPPT inverter designs for utility scale and large industrial rooftop installation. These can be largely adopted and deliver strong results when land is flat and occupancy factor is not an issue, or if inverters are mounted in the basement on rooftop PV systems, or even if the ability to perform onsite repair and O&M of a large central inverter is not an issue for example, in medium to large PV systems.

Myth 3: Module level power electronics (MLPE) are viable alternatives to MPPT in scaling-up PV systems

During the last decade, several companies around the world are now specializing and promoting the use of so-called 'module-level' power electronics in the design and scaling-up of PV systems to large commercial or even utility systems.

As such, we are seeing a rise in module-level power electronics across North America and in the residential segment based on claims that suggest 'easy install, smart and efficient capabilities'.

The reality though is something very different. Scaling-up the plant size with the use of MLPE can contribute to increased risks and costs, and in so doing outweigh the scalability benefits.

When trying to understand how a system can be scaled and whether it is a reliable system designers should look at the number of components in the system.

For example, in a commercial system of 100kW, which comprises up to 300 PV modules, when the power conversion is made with micro inverters the component count is much greater than a system injecting power into the grid from a single multi-MPPT, or a monolithic single MPPT inverter. The probability and rate of failure rises together with the associated cost of ownership. The economic viability of the project using module level power electronics may therefore be compromised, since replacing all failed power electronics installed behind the modules adds further operating costs to the hardware.

These large systems will not benefit from the use of MLPE but use of multi- MPPT string inverters (100-300kW) or large monolithic single MPPT central inverters (1.5 - 5MW).

When considering reliability of the PV system, designers need to look at future proofing their installations and inverters with MPPT offer greater flexibility and scalability for long term.

Myth 4: Utility scale MPPTs reduce LCOE.

When integrated in the same converter, multi-MPPTs offer several desirable benefits which may contribute to preserve maximum system yields, improve diagnostic capabilities and reduce O&M efforts. But many systems still choose central inverters rather than multi- MPPTs.

So where is the truth? Which system design approach generates the lowest LCOE? Why have central inverter solutions traditionally dominated the large scale solar market? And why are they now being challenged by multi-MPPT string inverter solutions?

The simple truth is that there is not a single winning solution that can suit all applications.

The most recent market analysis confirms that the global utility market is specifying an equal proportion of string and central solutions.

FIMER was pioneer in this technology, launching the first 3-phase multi-MPPT string inverter in 2008 (10kW, Intersolar Munich) followed by a complete series of new additions that today are covering the larger portfolio in the solar inverter industry, from 10kW up to the latest generation characterized by a power rating of 100/120kW.

The PVS-100/120 integrates all the desirable features associated with string inverter technology.

While offering six MPPTs as standard to ensure maximum yield when integrating solar in complex ground mount or roof designs, the same family has recently been complemented with a single and double MPPT variant, to ensure optimal cost compromise in any system where one or two separate DC combiner boxes shall be required. In one product system designers can now fine tune their design, while minimizing the overall system cost and preserving maximum system yield.

Conclusion

As we all look for new ways to maximize and optimize the use of renewables and enhance the role of solar in our day to day lives, MPPT will continue to be very important for the installations of today and tomorrow.

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