Guest Column

Application Advantages and Technical Considerations of 690-800V AC Inverters

By Brian Nelson and Mark Sauls

The opportunity for community solar/distributed generation PV plants, typically at 5 MW and below, is growing. To take full advantage of this opportunity, the industry is in the midst of a technical transition to higher power densities in the solar collection system.

The solar power industry is constantly evolving, driven by the need for increased efficiency, reduced costs, and enhanced sustainability. One of the most impactful shifts in the industry is the move towards higher AC voltages, specifically 690-800V AC. This trend is particularly significant for community solar and distributed generation (DG) PV plants. By leveraging these higher voltages, developers can achieve reduced balance of system (BoS) costs, simplified plant architecture, and enhanced overall performance. This article explores why 690-800V AC is gaining traction in the U.S. and globally, and how it affects system design, equipment selection, and operational efficiency.

Historically, most AC collection equipment for solar PV plants has been rated at 600V AC. However, since 2018, string inverter manufacturers have started offering equipment with nominal output voltages ranging from 690-800V AC. This shift is largely driven by the need to maximize efficiency and minimize costs in increasingly competitive energy markets. Higher voltages allow for more efficient energy transmission, reducing resistive losses and increasing overall system performance.

Modern string inverters with 690-800V AC capability offer Multiple Maximum Power Point Tracking (MPPT), allowing for optimal energy harvest from each string of solar panels. This eliminates the need for a DC combiner box, simplifying the system architecture and reducing the number of components that can fail over time. In addition to simplifying the design, removing DC combiners reduces thermal losses and improves overall energy yield. Furthermore, by utilizing multiple MPPTs, the system can efficiently manage shading or mismatched modules, further enhancing performance. However, in some cases where a DC combiner box topology is advantageous (repower and virtual central requirements) there are now inverter offerings at 690-800V AC with single MPPT functionality.

Higher AC voltages allow for more efficient power distribution across the plant. By increasing the voltage, current is reduced for the same power output, leading to lower resistive losses and improved overall efficiency. This facilitates a simpler plant architecture by reducing the number of parallel circuits needed, leading to a more streamlined and cost-effective design. Additionally, higher voltages allow for longer cable runs without significant power losses, enabling more flexible plant layouts.

One of the most compelling reasons to move towards 690-800V AC is the significant reduction in BOS costs. Higher AC voltages allow for smaller conductor sizes, reduced conduit requirements, lower ampacity switchboards, and fewer connections. These cost savings are especially impactful in large-scale community solar and DG projects, where extensive cabling and infrastructure are needed. By optimizing the system design with higher voltages, developers can achieve substantial cost reductions without compromising performance or safety.

The 690-800V AC systems enable higher power throughput, allowing for more efficient energy harvesting and distribution. This is particularly beneficial for maximizing the output of community solar installations, where space and infrastructure costs are critical considerations. Additionally, by reducing material usage and increasing system efficiency, 690-800V AC contributes to enhanced sustainability and a lower carbon footprint for solar energy projects. This supports global renewable energy goals by promoting efficient, scalable, and environmentally friendly solar power solutions.

Main breakers for 690-800V AC systems (now UL listed and readily available in the U.S.) must be designed with higher insulation distances, separations/phase barriers, and appropriate positioning of anchor plates. Separations and phase barriers are essential to prevent phase-to-phase faults and ensure safe operation. Insulating materials with high dielectric strength are necessary to withstand the increased electric field intensity associated with higher voltages.

Feeder breakers (also UL listed and available in the U.S.) play a critical role in protecting individual inverter circuits within the AC collection system. For 690-800V AC systems, considerations include insulation distance, separations/phase barriers, and reliable power connections. Increased insulation distances are required to prevent dielectric breakdown. Additionally, robust phase barriers and secure power connections are necessary to ensure safe and reliable operation under high voltage conditions.

In summary, the shift towards 690-800V AC in community solar and DG PV plants offers significant advantages, including reduced BoS costs, higher power output, and enhanced sustainability. However, it also introduces new challenges in system design, equipment selection, and safety compliance. Developers must carefully consider switchboard design, main and feeder breaker requirements, and compliance with UL and NEC standards to fully realize the benefits of 690-800V AC systems. By understanding the global trends driving this shift and making informed design decisions, solar developers and engineers can enhance the efficiency, reliability, and profitability of their solar PV plants.

As the industry continues to evolve, embracing higher voltage solutions will be essential for staying competitive and meeting the growing demand for renewable energy.

Brian Nelson is the Renewables Segment Leader at ABB (https://electrification.us.abb.com/industries/renewable-energy). Mark Sauls is Vice-President of Sales/Operations for EPEC Solutions (https://epecsolutionsinc.com/).