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## Utility Scale Solar Design, an Evolving Market

In the rapidly evolving industry of utility scale solar photovoltaic (PV) power plants, systems of 20 megawatts and larger are becoming the industry standard. But the electrical design for energy-efficient and cost-effective systems is anything but standard.

PV systems were originally configured to integrate directly into a home or building. Such building-tied systems produce direct current (DC) power to an inverter, which converts the DC signal to an AC signal at 480 volts (V) or less, thereby matching the voltage of the building. Since the electrical systems in most buildings are designed not to exceed 600V, the PV industry has tended to design the majority of its equipment around the 600V standard.

Unlike building-tied systems, utility scale systems send power directly to the grid through a transformer that boosts the power to match the utility lines, typically from 13,000V to 70,000V or higher. This allows utility scale systems to avoid the 600V limitation and increase the maximum voltage to 1000V.

Increasing the voltage has many design advantages, but developers of 1000V systems must weigh many factors that can affect the overall project performance. For instance, because more modules can be wired together in each string of a 1000V system, the total number of strings can be reduced. This decreases the number of combiner boxes, wiring homeruns and balance of system (BOS) components required for the system. The wiring and equipment must be rated for 1000V, but the amperage size does not change. Surprisingly, the cost of the wire remains relatively constant, and the price of a combiner box only increases by about 5 percent. Considering that only half of the BOS components are required, this can create a substantial cost savings. The downside to the higher voltage is that most of this equipment is not currently UL listed for 1000V. Third-party testing to UL standards is a requirement when installed for private industry and inspected by local electrical inspectors.



Hourly labor costs can increase with a 1000V system, as the 2011 National Electrical Code (NEC) requires all medium voltage work (over 600Vs) to be done by "qualified persons." As the NEC does not define what is required to be qualified for this work, the local Authority Having Jurisdiction (AHJ) will determine the requirements. OSHA also has some additional protection requirements for electricians working on equipment over 600Vs that will have to be addressed by the contractor, and may incur additional costs.

There are many considerations in the electrical design for a larger PV system. Weighing price differences and product availability with the overall efficiency of the system is essential to maximizing profits and return on investment.



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