



Solar installations: putting safety to the test

Despite advances in technology, Brad Perryman, Product Specialist Engineer at Seaward, argues that electrical inspection and testing of solar PV installations remains a critical requirement to ensure optimum safety and system performance.

The installation of a PV system by property owners or third party investors is almost always undertaken after careful consideration of the costs involved and the potential long-term return on investment provided by lower energy bills and avoided/mitigated demand charges.

It's therefore critical that the verification of system performance and energy output from the panels is foremost in operators' thoughts and planning, and why scheduled or preplanned periodic verification and testing of the system is vitally important and should be included as part of the planned O&M schedule.

It also ensures compliance with warranty and PV system guarantees.

The impact of avoidable electrical faults or wiring failures can cause a serious inefficiency in the ability of the panel to function properly. Moreover, system down



time and repairs can eat into operator profits, compounded with expensive diagnostic and repair costs, causing unnecessarily elongated payback periods. To address the problem, scheduled and reliable electrical testing is vital, not only to prove that an installed system is safe, but also to determine and verify ongoing functional performance over extended periods of time.

In fact, the safe operation of solar PV installations under both normal and fault conditions is an essential consideration at the system design stage, to ensure that proper system production and safety levels are achieved. And once in operation, it is important to ensure that the long-term performance of the system is not compromised by sub-standard installation or poor maintenance. In this respect, there are some key solar PV system features that rely on adequate and appropriate electrical testing and inspection being undertaken on a regular basis.

IEC 62446 / NEC 690 compliance

International, national, and many regional codes recommend periodic verification of an

existing installation be performed. The standards define the minimum requirements for system documentation, commissioning tests and inspection for PV systems. As such, these standards not only specify the minimum electrical testing and inspection requirements but equally importantly how the inspection and test results are documented and supplied to the owner after installation. Whenever possible, the results and recommendations of previous periodic verifications shall be taken into account. A periodic verification report shall be provided and include a list of any faults and recommendations for repairs or improvements, such as upgrading a system to meet current standards.

Effective grounding

As with all electrical equipment, solar panels and their racking systems must be grounded to mitigate potential electric shocks and fire hazards. If the grounding system degrades over time, anyone who comes into contact with a metal piece of the system may receive a shock. While the likelihood of shock is low,



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should one occur, the chance of substantial injury is great, because of the high voltage arrays, and the added danger of falling from roof mounted systems.

Ground faults

PV systems, in particular large-scale systems, have thousands of feet of wiring, much of which is buried underground. Insulation that's been compromised will allow energy generated by the PV system to leak to earth. This can be particularly problematic during damp or wet conditions where the insulation monitoring or residual current monitoring function within an inverter prevents the inverter from powering on. Given their nature, these types of isolation faults are notoriously difficult to track down in ill-maintained systems and can have a significant negative impact on overall system financials, unnecessarily drawing out payback periods.

Environmental degradation

PV systems, by their very nature, are exposed to some harsh natural elements. Damage or corrosion to cabling and connectors caused by moisture ingress and regular thermal cycling can result in degradation in performance or increased risk of fire. Regular electrical testing will enable system performance to be monitored and any necessary repairs or remedial actions to be taken, while implementing proactive maintenance schedules and programmes will undoubtedly go a long way towards easier and quicker fault finding. This means repairs can be completed sooner rather than later which helps to avoid larger, more costlier problems.

Surface contamination and physical damage

PV modules can become dirty or contaminated over time and this can reduce the operational efficiency and system performance. Similarly, exposure to the elements can result in physical damage to the component parts of a PV installation. Objects dropped by birds can result in physical damage to PV modules which may result in reduced output performance. Periodic electrical testing as part of regular maintenance will enable any problems to be identified and diagnosed.

Damage to wiring

The most obvious example of bad wiring is when wires hang below the panels and touch the roof or underlying vegetation. Eventually, the insulation will degrade, or be damaged by rodent activity, and become detached and potentially expose the copper wires, presenting a shock hazard. Any deterioration of cable connections and wiring can be detected and resolved by applying regular electrical testing to identify potential faults. Proactive preventative maintenance can also contribute to reducing costly system downtime and time-consuming repairs to damaged parts.

Verification of system performance

The installation of solar PV systems is only undertaken after careful consideration of the costs involved and the calculated return on investment provided by lower energy bills and



avoided demand charges. As a result, the verification of system performance and energy output from the panels is particularly important. In many cases simple electrical faults or wiring failures can cause a serious inefficiency in the ability of the panel to produce peak power. Although proper metering will give an indication of system performance, periodic electrical testing is vital to verify ongoing functional performance over extended periods and ensure that system degradation over time is in line with manufacturer expectations and warranties.

Warranty fulfillment

Periodic electrical testing of solar PV systems to identify and confirm continued safe operation and maximum energy output performance can be required as part of product warranties and PV system component guarantees. Additionally, testing and documenting with proper equipment arms an O&M provider or owner with all of the necessary data to ensure manufacturers honor any existing warranties.

Avoiding fire risks

As the number of rooftop solar installation systems have grown over the years, so have the number of reported incidents of fires. Household fires started by electrical faults in rooftop solar PV systems have been reported in the UK, Australia, the USA and France, among others. The periodic testing of the electrical cabling and components associated with solar PV systems will ensure the safe operation of the system and reduce the potential fire risk associated with any electrical faults.

Customer documentation

All solar PV installations require the provision of various documentation and forms to the customer. System documentation usually includes system data, installer details, electrical diagrams, operation and maintenance instructions and other

information that may be required by certain standards or regulatory bodies. Copies of all test and commissioning data should also be provided and as a minimum this should include the results from the electrical safety and verification tests undertaken as part of the system installation procedures.

It's also worth mentioning the importance of a baseline for system performance as part of any solar EV installation test and measurement programme. If we make the assumption that every system owner will have to test their system at some point then a well-documented baseline for comparison will be essential for any future tests to be effective.

It's clear that solar PV installations must be capable of generating the required power to ensure they operate efficiently. This requires regular testing for accurate fault diagnosis and repairs, but also associated capabilities such as remote monitoring, data collection and analysis, and the transfer of on-site measurements and results to a central database or effective records repository. This can be achieved successfully with testers which are very accurate and reliable instruments.

The solar industry is currently at a very exciting time, as it's clear that investments in generation capabilities of any size can be both financially viable and environmentally sustainable. To ensure the continued growth of the industry, it's critical for transparency across the design, installation and operation lifespans, and utilizing the right PV testing equipment ensures accountability at several key milestones. When these tests are paired with associated capabilities such as remote monitoring and accurate performance database documentation investment expectations can be met and exceeded. Seaward's latest generation of testers supply the accurate and reliable instruments necessary to these tests at industry competitive rates.

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