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APP NOTE

THE CRITICAL ROLE OF POWER QUALITY EVALUATION IN SOLAR INSTALLATIONS

EXECUTIVE SUMMARY

As solar photovoltaic (PV) systems become more prevalent in commercial and industrial environments, the emphasis on financial return and concise performance expectations has rightly intensified. However, one often-overlooked aspect of solar deployment is the comprehensive evaluation of power quality (PQ)—both before and after installation. By identifying existing grid or facility issues and evaluating the impact of PV systems on power quality, stakeholders can protect infrastructure, enhance performance, and uphold warranty and compliance standards.

This white paper explores the strategic benefits of PQ assessments in solar installations, drawing insight from field operations and test data, such as those captured during site evaluation in Xalapa, MX.

UNDERSTANDING POWER QUALITY IN THE CONTEXT OF SOLAR

Power quality refers to the stability and purity of the electrical power supplied to a facility or distributed across a grid. It encompasses factors such as voltage regulation, harmonics, flicker, and transients. These all can degrade equipment performance or signal systemic issues.

STANDARDS APPLICABLE TO SOLAR INSTALLATIONS

These PQ compliance and monitoring standards apply to all PV installations:

- IEEE 1547.1 – 2020
- IEC 61000-4-30
- IEEE 519

IEEE 1547, a widely adopted standard for interconnecting Distributed Energy Resources (DERs) with electric power systems, must be taken into consideration, and all PV systems must comply with it. A recent amendment, IEEE 1547.1 - 2020 defines conformance testing and requires that IEC 61000-4-30 Class A compliant PQ meters are used for voltage and current distortion, and other evaluations.

PV systems, while beneficial, can interact with the grid in complex ways. Inverters and interconnection points may introduce harmonics or voltage fluctuations. Additionally, grid conditions that exist outside of expected parameters can prevent inverters from operating, negatively impacting PV system production and potentially damaging expensive componentry.

Without prior and post-installation PQ testing it can be difficult to identify the source of PQ problems as being caused by the PV system, previously existing on the grid, or an interaction between the two systems. Also, anomalies may go unnoticed, potentially leading to preventable and costly system inefficiencies or failures.

REAL-WORLD INSIGHT: LESSONS FROM THE XALAPA SITE

A recent evaluation was performed at a rooftop pergola mounted PV array in Xalapa, Mexico. The site can generate 16kW AC / 16.35kW DC with two single phase inverters of 10kW and 6kW.

The purpose of the evaluation was to conduct a ‘health check’ and demonstrate the benefits of a

PQ study in a PV system. The field engineers utilized both PV and PQ instruments to evaluate the performance of the system and interaction with the grid. The instrumentation used was:

- Seaward PV210 IV-curve tracer, a tool specifically designed to verify that solar modules are performing at a consistent level
- Dranetz HDPQ Xplorer Plus, an IEC 61000-4-30 Class A, portable PQ instrument

OBSERVATIONS AND FINDINGS

PV Performance Issue Identified

IV-curve tracing is a method of testing solar modules and arrays to assess their performance and identify potential problems. It involves plotting the current (I) and voltage (V) relationship of the module. In this case, I-V curve trace data collected by the Seaward PV210 revealed an imperfect (defect) for one of the three solar strings tested. The root cause, which could be a problem like soiling, shading, or hardware failure, required further investigation to pin down. Without this test data, however, the defect may have gone unnoticed, potentially leading to long-term performance issues.

PQ Harmonics Issue Identified

Using the HDPQ meter, the site engineers were able to detect that harmonics on the inverter AC outputs were very high and well beyond the recommended limits of IEEE 519. As shown in Figure 1 below, Vthd was about 60% and there were significant even order harmonics which typically do not exist in most power systems. Harmonics can cause overheating in inductive devices such as transformers, resonances, high neutral currents, and overvoltage issues, and ultimately can cause system shutdown. Further investigations needed to be carried out to determine the source of the harmonics.

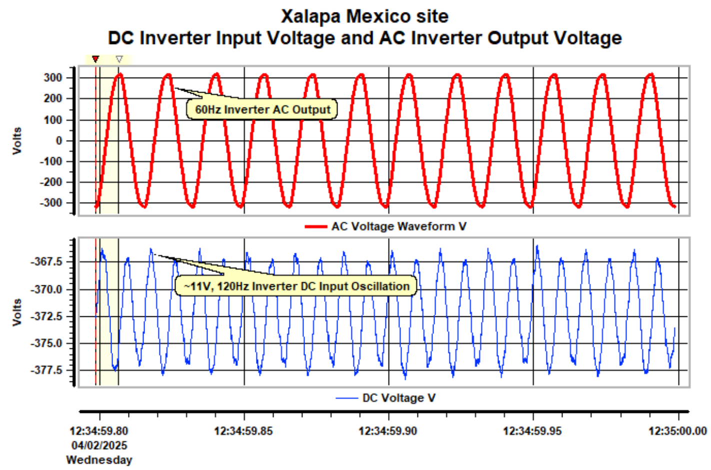

Figure 1. High harmonic content and significant even harmonics on the inverter AC output.

As shown in Figure 2, the DC input to the inverters has an approximately 11V oscillating at 120Hz. This is twice the 60Hz fundamental frequency and most likely due to the significant second order harmonics (120Hz) as described above.

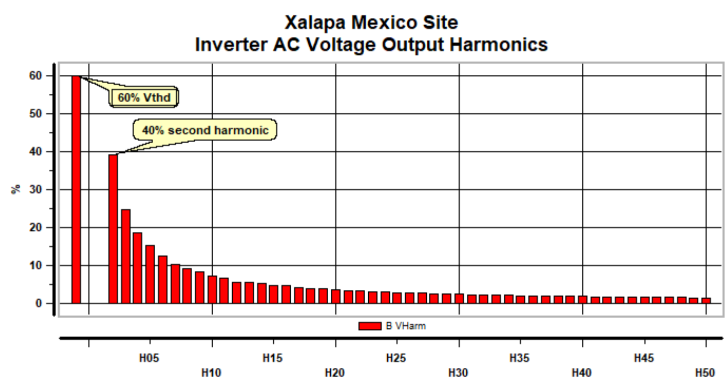

Figure 2. Inverter AC output (top) and DC input (bottom). DC input oscillates at twice the grid frequency.

STAY OUT OF TROUBLE WITH THESE BEST PRACTICES

Conduct PQ testing pre- and post-installation. PQ testing before the PV system's commissioning can provide a baseline to identify legacy issues, insulating the PV installer from preexisting issues. Post-commissioning tests can then isolate any PQ disruptions introduced by the PV installation itself.

This two-phase approach ensures grid readiness and verifies that PV integration has not degraded power quality. For the Xalapa site, it is difficult to determine if the harmonics problem existed before the PV system went online, or the PV system is the source.

Implement annual PQ and electrical health audits.
By testing power quality at least annually, project teams can assign responsibility for faults, validate performance, and ensure long-term reliability.

Correlate system performance with PQ metrics.
Make it part of your system maintenance process to conduct PQ tests and correlate PQ metrics to system performance. This helps you spot issues before they become problems and provides deeper insight into potential degradation and operational health.

Incorporate PQ results into acceptance and warranty protocols.
Doing so increases accountability across all stakeholders, from suppliers to installers, and site owners.

Spec in and install a fixed, permanent PQ meter.
While more expensive, a permanent PQ meter installation will provide far more data, on a consistent basis, into PQ events. Moreover, this may be the best option for problematic sites.

Compile warranty and compliance evidence
Creating a paper trail of electrical performance test data goes a long way to supporting warranty claims. In addition, it satisfies regulatory requirements.

THE BOTTOM LINE

As demonstrated in the Xalapa project, a structured approach to PQ testing that incorporates power quality evaluation into the lifecycle of solar installations can keep equipment up and running longer, and more importantly, keeps you out of trouble.

For more power quality resources, visit our Case Studies page.

To Contact Dranetz

- Call 1-800-372-6832 (US and Canada) or 1-732-287-3680 for Technical or Sales support.
- To submit a support request online, please visit: dranetz.com/contact-us