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Fact sheet

Qualification of PV Power Plants using Mobile Test Equipment

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PV POWER SYSTEMS TASK 13

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Qualification

Portable on-site inspection methods are helpful tools to identify drivers for underperforming PV power plants.

On-site inspection allows targeted failure analysis, reduces downtime of PV systems and risk of damage during transport to off-site labs.

Inspection Methods

#1

DRONE-MOUNTED IMAGING

Optical testing of PV arrays using drone-mounted electroluminescence and thermal infrared imaging.

Detects: Cabling issues, combiner box issues, cell cracks, bypass diode failures, interruptions in the cell interconnection circuit, and induced degradation (PID, LeTID)

#2

MOBILE PV TEST CENTRE

Test sequence of a PV module using a mobile PV test centre with integrated solar simulator.

Detects: Output power degradation, resistive losses, cell cracks, interruptions in the cell interconnection circuit, bypass diode failures and induced degradation (PID, LeTID)

#3

PLANT TESTING VEHICLE

Testing the voltage characteristics of the PV array and the efficiency of the inverter using a meterological monitoring system, DC and AC combiner box testing devices, PV string and centralised inverter testing facilities, all housed within a PV testing vehicle, reconstructed from a delivery van or box truck.

Detects: Low performance ratio (PR) of PV power plant, DC wiring losses, inverter efficiency losses, shading effects during the day, soiling and snow coverage effects, and electrical mismatch of PV strings.

#4

DARK I-V TESTING

Measurement of the shape of the PV array's current-voltage characteristic (I-V curve) at night time and compared with the daylight I-V measurements.

Detects: DC wiring losses, electrical mismatch of PV strings, bypass diode failures and PID on PV string level.

#5

DAYLIGHT I-V TESTING

Measurement of the shape of the PV array's current-voltage characteristic (I-V curve) during daylight hours. An I-V curve analyzer is connected to the PV string terminals inside the field combiner boxes or at the DC cables entering the inverter.

Detects: Output power degradation, cabling issues, DC wiring losses, shading and soiling effects, electrical mismatch of PV strings, bypass diode failures and PID / LeTID on PV string level.

#6

UV FLUORESCENCE IMAGING

Measurement of the UV fluorescence of the polymer in the PV module to draw an indirect conclusion on the PV module's state of health or on the bill of materials used in the module. This testing method uses a UV source and photo camera.

Detects: Cell cracks, distinction between older and younger cell cracks, and differentiation of used encapsulation and backsheet materials.

#7

DAYLIGHT ELECTROLUMINESCENCE IMAGING

Measurement of optical radiation after application of electrical energy to solar cells using EL imaging.

Detects: Cell cracks, bypass diode failures, interruptions in the cell interconnection circuit, and induced degradation (PID, LeTID).

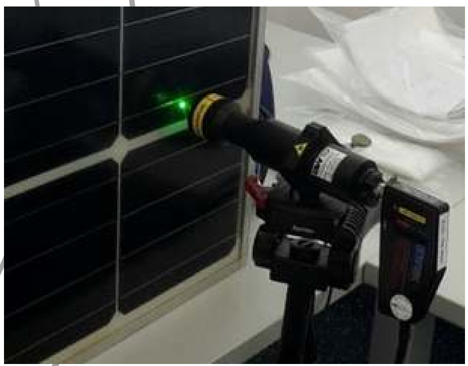
> " Quality assurance to increase performance and reliability in the field has been driven by the strong development and progress of PV field diagnostics in the past years, which allows in-depth failure analysis of PV modules and systems. This is key to build up confidence and continued investments in PV power plants worldwide.
>
> Ulrike Jahn, Operating Agent IEA PVPS Task 13

OUTDOOR PHOTOLUMINESCENCE IMAGING

Using the sun as an illumination source, and altering the operating point of the modules being imagined, to allow extraction of the weak luminescence signal.

Detects: Cell cracks, bypass diode failures, interruptions in the cell interconnection circuit, induced degradation (PID, LeTID).

#9



SPECTROSCOPIC METHODS

Measurement of the shape of the PV array's current-voltage characteristic (I-V curve) at night time and compared with the daylight I-V measurements.

Detects: Polymer degradation, differentiation between different types of encapsulation and backsheet materials (polymeric footprint of PV module).

#10

ELECTRICAL IMPEDANCE SPECTROSCOPY

Analysing the PV system's linear voltage response to an input sinusoidal oscillating (harmonic) current perturbation over a range of frequencies.

Detects: Non-operative PV modules, insulation/ground failures, bypass diode failures and induced degradation (PID, LeTID).

Task 13 objectives

- Gather the most up-to-date information on a variety of technical issues related to PV performance and reliability.
- Gather measured data from PV systems from around the world. This data will be used to test and compare data analysis methods for PV degradation, operation & monitoring (O&M), performance and yield estimation, etc.

Task 13 aims at supporting market actors to improve the operation, the reliability and the quality of PV components and systems. Operational data of PV systems in different climate zones compiled within the project will allow conclusions on the reliability and on yield estimations. Furthermore, the qualification and lifetime characteristics of PV components and systems shall be analysed, and technological trends identified.

International Energy Agency
Photovoltaic Power Systems Programme

Download the Report **here**.

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