

PHOTOVOLTAIC INSPECTION

Sector: Renewable energy generation – utility-scale photovoltaic.

Asset: Photovoltaic plant of approximately 20–50 MWp, composed of solar modules, string inverters, string combiner boxes, and the associated DC cabling network. It is considered a high-criticality asset due to its direct impact on production, electrical safety, and plant availability.

Initial situation: The plant operator detected a sustained deviation between the expected energy and the energy actually delivered in several generation blocks, with performance losses concentrated during peak irradiance hours. Operationally, there was no single clearly identified cause: SCADA data showed strings with intermittent low contribution, some inverters were reporting thermal derating events, and field personnel suspected a combination of anomalies in modules, DC connections, and protection devices in string combiner boxes.

The situation involved two main risks. The first was generation loss due to faults not visible to the naked eye, such as hotspots, degraded modules, blown fuses, or high-resistance connections. The second was the increased electrical and fire risk caused by localized overheating in connectors, terminals, or internal components of string combiner boxes.

Work methodology:

- Thermographic inspection of modules and associated infrastructure: review of panels, connectors, string combiner boxes, and inverters to identify hotspots, anomalous cells, non-uniform thermal patterns, and components operating outside the temperature range.
- Field visual inspection: validation of localized soiling, discoloration, visible cracks, incipient delamination, poorly crimped connectors, moisture ingress, and mechanical damage in cabling and enclosures.
- Electrical and functional verification of critical blocks: comparison of voltage/current by string, continuity review, and confirmation of out-of-service or underperforming strings relative to other comparable circuits.
- Review of operating data: correlation between field findings and production trends, inverter alarms, thermal limitation events, and performance by time window.
- Prioritization based on criticality and risk: classification of findings into safety, generation loss, and progressive degradation in order to define an economically reasonable intervention sequence.



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Identified technical findings:

- Modules with localized hotspots consistent with damaged cells or persistent localized shading.
- DC connectors and terminals with overheating compared to equivalent circuits, indicating high contact resistance.
- Blown or degraded fuses in string combiner boxes, with partial or total loss of contribution in some branches.
- Imbalance among strings connected to the same inverter, associated with uneven degradation, poor connections, or severe localized soiling.
- Thermal derating events in inverters, linked to poor ventilation, internal dirt buildup, or high ambient temperature combined with sustained load.

Conclusions: The inspection made it possible to transform a diffuse performance loss into a set of identifiable, prioritized, and actionable technical causes. The main value was not only finding anomalies, but also distinguishing which ones represented an immediate risk to safety or operational continuity and which ones could be planned without affecting the plant's overall availability.

After the recommended intervention, the client recovered part of the affected generation capacity, reduced the probability of thermal failure in DC connections, and improved visibility into the actual condition of its photovoltaic assets. The case demonstrated that a combined strategy of thermography, visual inspection, electrical verification, and data analysis makes it possible to act before an anomaly leads to greater production loss or a safety event.

Impact indicators:

- Estimated recovery of generation in the intervened blocks: 2% to 5%.
- Estimated reduction of undetected low-performing strings: 30% to 50%.
- Reduction of electrical hotspot risk in critical connections: high, after correction of terminals and fuses.
- Estimated reduction of thermal derating events in the intervened inverters: 20% to 40%.

