How O&M contractors can deal with issues in newly and recently built PV plants

O&M strategies | With either newly built PV plants or plants in operation for a couple of years, an O&M contractor may face a series of issues related to the plant's design and construction, the quality of the equipment and parts, and warranty claims. Vicente Parra and Gorka Oña highlight some of these issues and recommend how O&M contractors can address them

Expenditure related to PV facility construction and operation has fallen dramatically in the last eight years. Specifically, the reduction in capital expenditure (CAPEX) accounts for approximately 85% of this fall, and the operating expenditure (OPEX) has dropped by more than 50%. (It is also important to note that the costs for projects in countries where the solar industry is currently under development – such as India, Thailand and Central America – are 15 to 20% higher than in European countries that have a proven track record in PV development. However, these additional costs can be mainly attributed to the lack of efficient logistic networks and the shortage of qualified personnel.)

Given this reduction in operating expenses, O&M contractors have adapted to the new framework. Thus O&M budgets have been adjusted to allow the PV industry to compete with other sources of energy. In order to maintain the quality of the service, it is common to find global companies providing O&M services in numerous locations. On the other hand, small local companies are finding it difficult to compete in such a globalised market.

These economic variables have an impact on the O&M contractor's responsibility to operate and maintain PV plants. PV technology has significantly progressed and the result is high-quality equipment at a lower price. However, when an O&M contractor takes responsibility for a PV plant, it is essential that its business model be completely conscious of the design, the installation, the equipment utilised and the warranties in force. This aspect has even more importance in markets where regular incentive deadlines or financing structures are forcing developers to build plants quickly. In addition, O&M contractors need to structure more efficient strategies in order to comply with the contractual requirements at the current fees, while ensuring a high standard of performance.

Credit: Martifer Solar

O&M contractors can face numerous issues from a plant's design and construction, requiring the correct due diligence procedures.

One of the more recurrent schemes in the PV industry is the provision of O&M services by the EPC contractor during the period when there are some warranties in force related to the EPC contract. In many of these cases, however, the EPC contractor takes the risk of the O&M contract and subcontracts services to a third party; hence, it is likely that the risk is transferred to such an O&M subcontractor. After the EPC contract's warranty period expires, it is not uncommon that, upon the financing entities' consent, the owner of the plant looks for more economic alternatives and renegotiates the terms, or even appoints another O&M services provider.

Design and construction

A good way to prevent design-related issues being passed on to the O&M contractor is to ensure that a satisfactory commissioning system has been completed prior to the PV plant's provisional acceptance, which is the time when the facility is handed over to the operator. If the O&M contractor finds that this has not been done or that some part of the report is missing, Enertis recommends that verification tests always be performed.

Another aspect that the O&M contractor could possibly encounter is that the as-built drawings have not been updated. Not having the drawings that reflect the actual construction of the PV plant can greatly hinder the plant's preventive and corrective maintenance. Enertis therefore highly recommends that the contractor always obtain a good set of as-built drawings.

Regarding construction- and installation-related issues, as part of the routine work carried out by Enertis different construction defects have been noted. These include bad wiring (causing ground faults), under- or over-torqued wiring connections, and MC4 connectors that melt because of a bad part or simply

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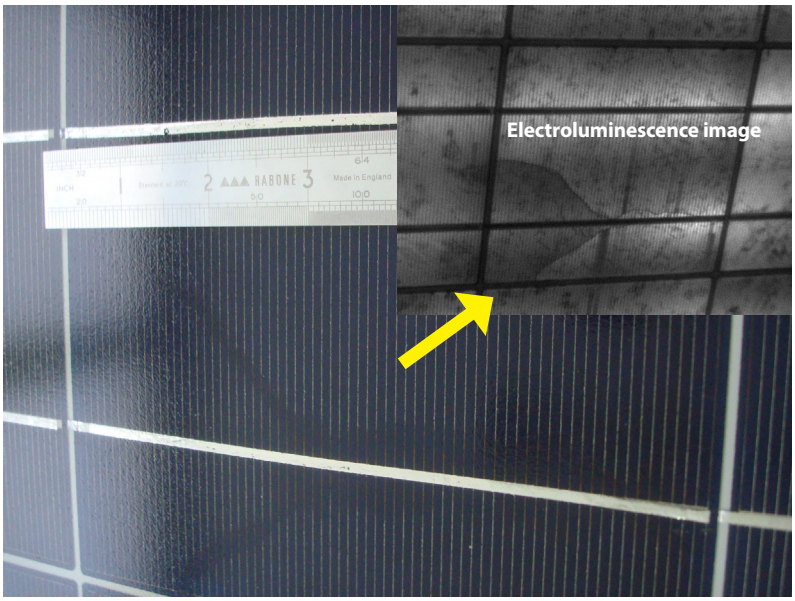

Credit: Enertis

Figure 1. Snail trail visual defect.

bad connections to inverters that have been wired incorrectly – the issues can be vast.

Quality of equipment and parts

At the PV module level, a non-negligible number of defects can still be encountered through standard technical audits on site, even during the early stages of the device's operation (within the common two-year EPC warranty period). These defects can occur by their very nature as a result of the inherent malfunctioning of the module, because of either manufacturing issues or poor quality of materials; alternatively, they can manifest during the installation phase as a consequence of improper practices implemented by installers throughout construction and commissioning rush periods. Among the first type of defect, it is worth highlighting issues such as the well-known discolouring of a module's polymer, or the presence of defective junction boxes with activated diodes, which entails episodes of major underperformance.

Special attention should be paid to the harmful potential-induced degradation (PID) phenomenon, a severe polarisation effect related to the solar cell architecture; the bill of materials used to produce the panel generally influences the PID-resistance behaviour. PID is strongly linked to the ambient conditions at the PV site, which are mainly high temperatures and high relative humidity rates. Indeed, besides the level of the effect within a PV plant, the high power loss per module makes PID the most important module degradation phenomenon leading to major underperformance in a PV plant.

In relation to issues associated with the mounting phase, anodisation damage to the aluminium frames of the panels, improper racking and torn backsheets can be systematically observed when conducting dedicated visual inspections on site. The so-called *snail trails* phenomenon (Fig. 1) is typically a result of internal cracking issues within the solar cells composing the panel. This cracking phenomenon, if it extends all over the PV plant or occurs in well-defined places, can be linked to inappropriate handling during transportation and installation of the modules. In this regard, quality control activities carried out beforehand at the module manufacturing location will help determine and trace the origin of such undesirable occurrences.

In many cases, these faults lead to performance losses that should be considered by O&M contractors at all times during the project's lifespan. For example, in the case of snail trails, this visual defect in itself does not imply any power loss; it could, however, be a sign of intrinsic breakage issues, which can lead to inactive regions within the cells, as observed by electroluminescence (EL) analysis. A proper and systematic visual inspection during the first year of operation can help detect this type of problem and will allow the O&M operator to prepare a mitigation plan. In fact, although this kind of defect does not typically fall under the O&M contract's warranty and liability, it can undeniably affect the correct operation of the PV plant.

Credit: Enertis

Figure 2. Enertis' PV Mobile Lab.

Identification of problems in the field

The most suitable ways of identifying PV module failures and underperformance in the field are still the classic methods, such as conducting visual assessments, determining the maximum power, analysing IR thermographs and inspecting modules by EL imaging. All of the equipment used for these tests must meet calibration requirements in order to authenticate the test results and meet industry standards; this ensures that the test measurements are accurate for all types of PV module. Mobile tester solutions equipped with high-quality solar simulators, such as Enertis' PV Mobile Lab, are very practical assets in this respect (Fig. 2).

Apart from the PV modules, it is important to consider other tests, such as *I–V* curve tracing at the module string level, IR thermography inspection of combiner boxes and inverter connections, and the assessment of the structure and PV module assembly (foundations, galvanised coating and corrosion, screw torques and bolt tightening, structure tilt, and module connection). Other aspects worth taking into account are the fence, the inverter houses, the spare parts warehouse and the drainage system. Furthermore, an O&M contractor should also verify the correct operation and performance of the monitoring system and check the weather station's equipment (design and equipment calibration). Finally, because vandalism acts may cause downtime and require additional labour costs to be borne by the O&M contractor, the security system is an important part of a PV facility.

Due diligence

O&M contractors should undertake a complete due diligence process that allows them to identify the previously mentioned issues. This analysis should be carried out in accordance with the O&M contract's framework. From the perspective of this paper, it is important to define within this contract a comprehensive preventive maintenance plan (tasks and frequency), the corrective actions (labour included but parts replacement borne by the client constitutes the more common scheme), and the overall liabilities and warranties.

As part of the due diligence process, it would be prudent to run verification tests and check to see if there are issues at the PV plant, especially if the O&M contractor finds that the commissioning has not been done or that there is some part of it missing. In this regard, a practical testing package for a 10MW plant in the UK includes a full thermography of the panels and connections, *I–V* curve tracing in a sample of strings, and the performance of accurate *I–V* flash and EL testing. A representative sample for the control of degradation of the panels or the identification of issues (using an accredited mobile tester at the site, for instance) can be around 5 to 10% of an average O&M annual cost; this could equate to just a 2% decrease in production. Thus, from an O&M perspective, having these kinds of annual verification would help to keep the PV plant operating at a reliable level, while the owner of the facility can maintain control over revenue risks.

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Plant location

It is also essential to understand where the PV plant is located in order to mitigate potential issues created by soiling factors or environmental conditions. For instance, Enertis served as an advisor for a utility-scale PV plant that presented severe drainage system problems, which led to flooding on site. This situation, combined with corrosive soils, caused issues with the racking foundations and early signs of corrosion in the racking structures. Mitigation measures were defined by all parties, and the O&M contractor provided labour, which was included in the corrective maintenance scope of the work.

The location of the PV plant is also a key aspect when dealing with the availability of spare parts or with the access to qualified technicians. Enertis' experiences in Europe and the USA indicate that the spare parts warehouse is often located outside of the PV plant's boundary, and parts are stored there for other plants managed by the same operator. However, in other regions, such as the desert areas in South America, warehouses are built on site in order to avoid downtimes caused by the lack of parts.

Warranty claims

O&M contractors are typically in charge of warranty claims. In these cases, it is necessary to analyse the supply agreement and the warranty conditions. In order to foresee potential problems, it is recommended that a reliable quality control be verified for the purchased equipment – the PV modules being the most important aspect. Enertis strongly recommends that a full quality assurance process be implemented during the selection and manufacturing of equipment (around 0.1 to 0.5% of the total PV module supply cost, depending on the size of the supply), since this will prevent potential production pitfalls and will facilitate the plant's operation.

Conclusion

With all this information, the O&M contractor will be able to gain a detailed understanding of the PV plant and assess the labour and tasks needed to ensure that the system is safe and can operate at maximum capacity. As an additional way of optimising the operation of a PV plant, centralised control centres are being utilised by companies for monitoring large portfolios. From this kind of centre, the O&M contractor can alert the on-site team and perform corrective actions in the most efficient way possible. Enertis has detected that there is an increasing interest from owners in having information about O&M activities, which requires an organised and automated structure to the strategies employed in order to comply with such a demand. Finally, it is also typical to find O&M contracts with relatively low fixed fees, compensated by a bonus scheme linked to PV plant performance. ■

Authors

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