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Photo: Cobalt Energy

Troubleshooting efforts in PV plants

Plant maintenance: Troubleshooting in solar plants requires not only trying to find a diagnosis of why the performance ratio is reduced, but also to localize faulty modules. John Davies, Operations Director – Solar and Energy Storage at operations and maintenance firm Cobalt Energy, shares with **pv magazine** his thoughts on fault detection, troubleshooting, and thermography in the field.

Soiling, insulation errors, broken bypass diodes, and failed module strings are only some of the possible causes for yield loss that operators of solar plants have to take into account. **pv magazine** has reported on cases where causes were researched and faults have been detected using today's standard technology. John Davies, Operations Director – Solar and Energy Storage at Cobalt Energy Limited, offers his insight into what technologies and techniques prove most effective in the field when troubleshooting plant defects and faults.

Davies explains why I-V measurements are often not a very effective means of troubleshooting despite being regularly requested by investors and plant owners. He also examines a couple of case study scenarios that were first discussed in a **pv magazine** webinar at the end of last year.

pv magazine: ***In two separate cases we have seen costs for thermography range between €500 and €1,000/MW for a multi-megawatt plant. What is your experience of typical cost points?***

John Davies: Certainly in the U.K., costs range from GBP 250 to 450/MW for the aerial thermography service on a site-wide basis. However, the price and the selection of the contractor varies significantly in terms of quality of service, and quality of data output and presentation. As is normally the case, you get what you pay for.

When you carry out thermography, how do you quantify economic losses? What are the alternative and the latest techniques for detection of (partial) failures?

As an O&M service provider our contacts have annual aerial thermography as part of the scope. Before the high irradiation months of the summer, we generally plan to carry out the first spring season grounds maintenance in late spring, followed by a module clean, and then carry out the IR inspection. This way you get the best results from your survey. IR is a great tool, which enables you to assess entire sites at a reasonable cost. However, the IR method is limited in its effectiveness of providing conclusive detail on module defects or deterioration phenomena. IR will find 'low hanging fruit,' such as strings out, modules out, activated diodes, and then pretty much everything else is an interpretation of hot spots. In some cases aerial IR surveys have diagnosed potential-induced degradation (PID) on sites, where the owners then requested our services to carry out electroluminescence (EL) testing to verify the PID. Unfortunately, the patterning identified was simply the natural variance in the cells on these particular modules – the delta in temperatures was only 1°C, which is simply too small to be anything of concern. The EL images, carried out at high and low currents, categorically proved that there was no PID in these modules. So our advice is: Don't rely solely on thermal IR when it comes to warranty-based claims or situations where large levels of money are concerned. Invest in high quality EL/flash testing, and you will at least be certain what the issues are.

Is thermography the best way to spot bad bypass diodes, as has been seen in some cases in the field?
In Cobalt Energy's opinion, yes. If you are searching for activated or faulty bypass diodes on a site that does not have any module level monitoring, then this is the cheapest and quickest method. Certainly a lot cheaper and quicker than string testing your entire site. However, it would rarely justify the cost of the drone survey just to send it up and carry out a full site survey, just for the identification of diode issues. Drone IR enables you to see strings that are out, modules that are out, and indicate where you have issues causing hot-spots. So collectively in many cases it is justified. Of course, if you had a module-based digitalization system, you wouldn't need drone IR or to string test.

What types of reduction in performance ratio normally trigger a troubleshooting action? What is the uncertainty of the performance ratio determination?
Of course, the performance ratio (PR) figure as a key performance indicator is something that we keep an eye on, but this is typically calculated on a monthly basis in retrospect. Troubleshooting actions are generally triggered by monitoring system alerts and alarms, which can be set specifically on a site-by-site basis. If a string wasn't performing correctly, if an inverter wasn't performing correctly, or if we encountered an area of the plant out of operation, then this would trigger an intervention.
For us as an O&M provider, PR is purely an indicator of how a plant has been effectively designed, what irradiance levels there have been that particular year, and how much 'uptime' we have been able to provide. The uptime is the only thing we can control as an O&M service provider.

How effective will the performance ratio be in judging plant output? Is there any new and better parameter available?
Following the SolarPower Europe O&M Best Practice Guidelines, O&M providers are turning away from PR as standard in modern O&M contracts. The emphasis is now turning to availability (typically 99%), and response and rectification times. Both of these KPIs require a strong work management system and skilled and organized resources in close proximities to your sites. This is an interesting logistical challenge that continuously changes as you onboard new sites in different locations.

Some plant owners request their O&M service provider to conduct string I-V curve measurements, and provide an estimation of costs. How often do you find issues with these measurements that trigger action?
I-V Curve measurement is an indicative method that provides you with clues that something isn't right, but it is not intelligent enough to tell you which module is faulty and what's wrong with it from a single string measurement. The tool needs to be used by a skilled and experienced solar technician who knows how to interpret the curves and data output, to point in the direction of chasing that defect or fault. As well as this complexity, it is also irradiance dependent, so you have a limited window of opportunity to carry out the tests, especially within countries like the U.K., which does not have reliably sunny weather. We estimate that we find irregularities in 10-20% of I-V curves that we take. However, these could vary in production impact.

How often do plant owners request these I-V curve measurements, and why?
Typically, in the majority of our O&M contracts I-V curve testing is part of the standard O&M scope of work. The quantity varies from 10% of a plant annually, to 100% of a plant annually. The reason that I-V curves are required is that technical advisors have probably recommended that I-V curve tracing is best industry practice and they need to be in the scope to compare and contrast string performance.
The reality that we have experienced, however, is that the huge bulk of paperwork that this produces simply does not get looked at by most owners. Our advice would be to be more specific in the scope as to what owners are trying to achieve. If an O&M was tasked with plotting the performance of the strings on a site, in a type of priority list, then this would be a useful tool for both owner and O&M service provider. Whereas at the moment, I believe that it's being done as it is stated in the contract. ◆

Interview by Michael Fuhs