Testing times

On-site testing | PV project owners are becoming increasingly conscious of the need to understand how their plants are performing in the field. Ben Willis explores how mobile testing units are emerging as an important tool in the early detection of faulty module equipment

Towards the end of last year, the financial backer of a 4MW PV project in Italy called in engineers from the testing house Photovoltaik-Institut (PI) Berlin to investigate what it believed were underperforming modules at the plant. PI Berlin, a specialist in module and plant quality assurance, had developed a new system for on-site module testing, and in less than three weeks, according to the institute, its engineers were able to test over 12,000 of the plant's polycrystalline modules.

"It was at the initiative of the bank that had financed the project," explains Steven Xuereb, head of the PV systems business unit at PI Berlin. "They knew there were issues in the plant, and they wanted to know the extent and what action they could take against the supplier or the EPC. It identified cracking."

The test set two criteria – one at a cell level, measuring the amount of cracking within one cell, the other at a module level. "Eighty percent in our hard criteria [at cell level] failed," says Xuereb, "but to say you're going to exchange 80% of the modules would have been very drastic so we agreed with the bank and the owner and module supplier that we would use the soft criteria, which was at the module level. And there a third of the modules were then replaced."

Instances of underperforming modules being replaced at such a scale reaching the public eye are a comparative rarity in the PV industry. But that is not to say this isn't happening; plenty of anecdotal reports circulate within the solar industry of mass module failure, but they rarely, if ever, see the full light of day as they are usually hushed up in non-disclosure clauses.

One clear indication that the performance of modules in the field is an issue about which the industry is becoming increasingly aware, however, is the growing number of mobile testing labs becoming available. PI Berlin's system is just one of a number of similar services now being offered to the market as a means for plant owners and investors to keep tabs on their asset and to ensure it delivers what it has been promised to deliver.

PI Berlin's system supplies modules with current at night for electro-luminescence tests.

The circumstances in which mobile testing facilities are brought in are varied. For PI Berlin, there are usually two main reasons for a call-out to the field, explains Xuereb: "The first would be if the asset manager or owner has noticed some kind of issue with the power, so they see some degradation when they're comparing the theoretical and performance; they're seeing there's some kind of funny thing going on there and they don't know what it is. That's on the one side.

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Suncycle's flexEL system in operation.

Credit: Suncycle

"On the other maybe they see something going on during installation, they're concerned about how the modules were transported or they were supervising the construction and saw some things that were abnormal. And because they know they've got a limited warranty either with the EPC or the module supplier, then they're concerned and want to get a second opinion."

Romain Elsair, UK project manager for the Spanish consultancy firm Enertis, which also operates a mobile testing lab, agrees that plant owners are becoming more vigilant of potential module problems emerging in the field and increasingly asking for on-site inspections.

"When clients first come it's usually because they have highlighted something or seen some cracks if they've done infrared, thermographic inspection," says Elsair. "Because this is not enough to claim or this is not enough to have a good idea of the behaviour of the modules, we can also do infrared, we have drones as well, and also electro-luminescence (EL) testing we can do by hand without dismantling the modules.

"So after these preliminary surveys have been conducted by clients they usually come to us and say can you check the actual performance of the modules. And usually it's about six months to two to three years after the plant has been installed."

Testing without dismounting

The big advance offered by some of the more recent mobile testing technologies offered to the market is the ability to test modules without dismounting them – a costly and time-consuming process that of course risks inflicting handling damage to modules that may have been in perfectly good condition in the first place.

Germany-based firm Suncycle has recently added a system known as the flexEL to its mobile testing laboratory. Its full mobile lab system offers a wider range of tests than just EL, but because it is certified to test equipment under certain standard conditions, it requires modules to be dismantled. The flexEL on the other hand is fully portable, allowing modules to be inspected either individually or as part of a string without having to be removed from their fixings.

"The flexEL is for mounted systems where you do have some damage assumption and then you use the flexEL so you don't need to dismount," says SunCycle's managing director, Mischa Paterna. "So that puts less stress on the module and is cheaper. And it has the same kind of throughput as with the mobile lab so you can do quite a high volume."

The company claims it can process up to 200 modules a day using its technique. A further advance offered by the system is that it can be used in daylight hours, when reflected sunshine can cause problems for the quality of EL image. "If you do [EL testing] during the day, you can cover the module, but you still get light through the backsheet," Paterna explains. "So that's a difficult task and we solved it through some software technology that filters out specific wavelengths of light. Through that technique we can get a crisp and clear picture even during daylight."

The PI Berlin system has also sought to improve the throughput of modules being tested by removing the need for dismantling. It limits testing to night time, to minimise operational impacts and claims to be able to process 1,000 modules a night by testing them at a string level.

"Being able to do EL testing in the field without dismounting the modules, not having to disrupt the operation because it's done at night, that was something that became very attractive to the operators," says Xuereb.

"Our test set-up allows us to take high-resolution electroluminescence images of several modules at once, thus saving time," adds Xuereb's colleague, Dr Juliane Berghold, head of module technology and research at PI Berlin. "These images are then analysed and automatically evaluated by our software, which is based on our years of experience with error analysis of PV modules in power plants. This expertise also helps us to evaluate these results very quickly and recommend specific courses of action for solving problems in the plant."

Fault detection

According to SunCycle's Paterna, EL testing is useful for identifying a range of different types of damage to cells and modules. Its particular strength is in detecting so-called "critical cracks", which can become larger over time and ultimately cause power loss in the module. It can also determine how a cell has been damaged by the kind of shape or pattern of the cracking.

"A typical story is if you have a hailstorm you might want to check what the modules look like afterwards," he explains. "When you look at hail [cracking] you have a little star pattern where you can see the big hail hit in the middle. Or if it's just pinched at a certain point it's probably a handling issue; perhaps when the module was taken out of the box it hit the frame of another module. So you can have a hint of what the problem is."

In the case of the Italian plant, says

Xuereb, the suspected cause of the widespread damage found was transportation. But further inspection in the laboratory raised question marks over the mechanical stability of the modules themselves, he adds.

"As part of what has led to this recent drastic reduction in module costs, suppliers are trying to cut costs everywhere," says Xuereb. "And part of that is even the thickness of the cells and the wafers, which makes them less stable and more susceptible to cracking through lighter loads. So when you're talking about transportation and maybe things weren't packaged optimally, then they're more and more susceptible to that."

Asset protection

The scenario outlined by Xuereb is one that perhaps adds most weight to the case for mobile module testing. The PV manufacturing industry's recent drive to squeeze out cost along the whole supply chain has undoubtedly been successful in doing this, to the benefit of solar's overall penetration. But there are concerns that in the long term, this could prove to be at the expense of product durability.

This clearly underlines the need for ongoing quality control measures such as in situ module testing, and emerging evidence suggests the industry is beginning to recognise this too. For example, Enertis' Romain reveals that in the first six months of 2015 his UK team has had the same number of testing contracts as it had in the whole of 2014. He concedes that this is partly because more and more companies such as his that offer quality assurance services are out in the market persuading investors and plant owners to be vigilant. But he also believes it an essential development in the market if investors are to make absolutely sure they will get the returns they are anticipating over the next 20 years.

Xuereb agrees that it is the holders of the purse strings that will have the most interest in making use of mobile testing facilities. "As often happens, the banks are the drivers," he says. "We saw that in the wind industry when the first gearboxes started to break down. That's when they started to take notice, so did insurance companies, and asked for some extra testing to be done on that particular component. So that's where it's coming from. You'll see it from a lot of the banks now asking for some sort of batch testing of modules in laboratories and also some sort of testing upon completion. That's where we see the pressure coming from."

Ultimately, as Xuereb points out, although modules have come down in price significantly in recent years, they still represent a hefty proportion of overall project costs and should on that basis alone warrant special attention from a quality assurance perspective.

"You're still looking at 30-40% of your investment on the modules," he says. "So it makes sense to spend a bit of money up front and to keep an eye on the process from the production [of modules] through to installation and then throughout the operation of the plant." ■

How PI Berlin's system works

PV Tech Power caught up with PI Berlin's Juliane Berghold for a closer look at the organisation's new on-site module testing system.

***PV Tech Power*:** How is the system able to process the claimed 1,000 modules a night?

Juliane Berghold: First of all we do not apply the current for the generation of the electroluminescence signal to every single module, but on a string level. For imaging we use a mounting hardware with two cameras allowing for picture capture of up to 10 modules at once.

***PV Tech Power*:** A key part of the speed of processing offered by your system is the software that sits behind it. How does the software work in analysing each module and identifying faults with them? And how does the analysis rank the severity of any faults it detects in individual modules so that investors are able to form a view on whether equipment requires replacing?

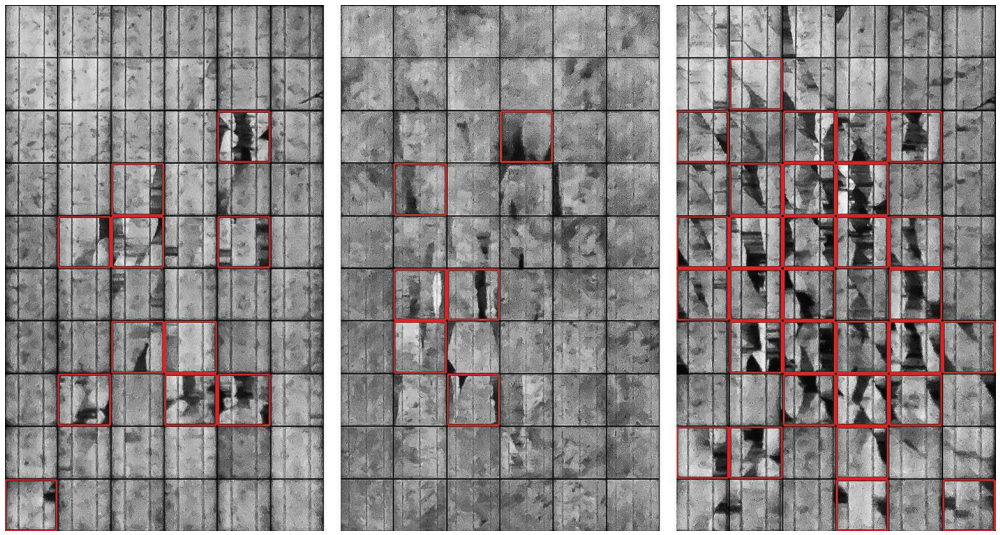
JB: For the moment, the focus of our software is on the detection and counting of heavy, isolated cracks. Cracks can cause significant power losses and resulting issues like hotspots. For the future the software will be extended to evaluate other failures such as potential-induced degradation (PID). The software analyses the EL images of the examined modules. Power-relevant failures such as isolated cell cracks are detected and counted. Therefore, it is possible to differentiate the modules in plant in 'pass' and 'fail' modules with respect to agreed criteria, allowing defective modules to be localised and replaced in plant. The final test reports help investors and operators to back up their claims to EPC contractors, module manufacturers and insurers.

***PV Tech Power*:** You have highlighted the example of a project in Italy that experienced a high failure rate and needed a large proportion of its modules replacing. How common would you expect such high rates of failure to be in PV power plants, or was this a one-off?

JB: This is not a one-off. Generally, the better the monitoring and the investigation tools to be used onsite become, the more modules are and will be identified as being 'low quality' or defect modules. As the warranties from the manufacturers are usually on module level, the testing and failure identification needs to be done on a module level. This means high-volume investigations in plant. This means also that more claims with high-volume module exchange will emerge. We see high volume module exchange claims also connected to PID and thin-film-related defects.

***PV Tech Power*:** Generally, how much demand are you expecting to see for your system as investors look to gain a better understanding of possible failures in module equipment?

JB: There is certainly an increasing need for high-volume EL investigations from investors and banks – also in the secondary market. We have inquiries for the investigation of plants that are known to be in bad shape. Our investigations are meant to estimate the technical risks of these plants.



Credit: PI Berlin

Electroluminescence testing can be used to detect cracking and other faults such as PID in modules.