Quality control

Source: Suntech

Module quality | According to some industry observers, rapid growth and cost cutting in the solar industry have created the conditions for a module quality headache. Ben Willis investigates how the industry is responding to the challenge

In February 2013, the Dutch Food and Goods Authority issued a public notice declaring hundreds of thousands of PV modules made by Scheuten Solar Holding to be a fire hazard. The authority alleged that up to 650,000 of the company's Multisol modules had been made with a design flaw that could lead to the melting of the junction box, system failure and, ultimately, fire.

Indeed, the authority gave details of 15 fires in Europe it claimed had started as a direct result of faulty Multisol modules. Its warning prompted an extensive in-field repair programme and, later that year, Scheuten's second filing for bankruptcy following an earlier bailout the previous year.

In an industry so conscious of the consequences of any flaws associated with PV modules, instances of widespread failure such as this are extremely rare. Yet with global PV demand having exploded in the past few years at the same time as PV manufacturers having undergone a period of brutal cost cutting, observers believe that module quality is emerging as an area on which the industry needs to keep a watchful eye to avoid repeats of last year's misfortunes but on an altogether bigger scale.

"There's definitely a concern there," says MJ Shiao, director of solar research at GTM Research in the US. "The biggest issue with the industry is you just don't really know. We have all this historical data produced 20, 25, sometimes 30 years ago, but those modules are completely different to those being installed today; around two-thirds of modules in the field today were installed in the past three to four years.

"The PV market has also seen record declines in costs, the result of Chinese manufacturers squeezing out costs. So there really is a hazard there in the mismatch between how much the industry has grown and how much knowledge there is about long-term reliability. There should be a lot more concern than there is."

The rarity of massive module failures on the scale of the Scheuten Solar example last year is underlined by available data. According to a paper presented at September's EU PVSEC event in Amsterdam by researchers from the National Renewable Energy Laboratory, assessments of 50,000 PV systems totalling 1.7GW between 2009 and 2012 showed that only 0.1% of the systems were affected by underperforming or defective modules.

SolarBuyer's Gregory says large cases of field failures are routinely concealed.

Nevertheless, behind the scenes, cases of failure certainly are going on, generally not making headlines because they get hushed up in non-disclosure agreements between manufacturers and owners, says Ian Gregory, co-founder of Boston-based SolarBuyer.

"There are a good number of large cases of field failures that get wrapped up very quickly in non-disclosure agreements," Gregory claims. "There's no public reporting obligation in the industry. In the EU or US where there are failures, there's no requirement to report them. Nobody's sure what the full extent of these issues is, but we know they're out there because we're involved in real cases."

SolarBuyer is a third-party due diligence organisation that operates as a bridge between the investors in and makers of PV modules. The company carries out independent testing of modules as well as extensive auditing of manufacturers' factories and processes to assess consistency of product. So far it has carried out 140 audits of 60 manufacturers, in the process compiling a database of module performance that it uses to help investors make better-informed decisions over which modules to purchase.

Source: Suntech.

Gregory says the insights he has gained from these processes suggest to him that the "conditions are there" for an industry-wide quality problem to emerge. "We see it when we audit factories, when we look at materials, when we look at extended lab testing results," Gregory says. "How much of that is going to present itself in the market as failed systems or underperforming systems, we don't know. What we know is the risk is there."

Gregory points to a number of factors that are of particular concern. Like Shiao, he identifies as a big issue the recent cost-cutting drive across the industry: "It was a matter of survival, but of course the question then becomes: what price did the product pay?"

Another has been what he describes as an "awful lot of material proliferation". Whereas there used to be only a few suppliers of key module materials, Gregory says the building out of supply chains by companies as they aggressively globalised changed that.

"Now you come across many, many different suppliers of materials that don't have a long track record, so no one really knows how good those materials are," he explains. "And many manufacturers will use multiple vendors of a particular material – so when you buy a module from one manufacturer, if you buy multiple megawatts, it will be made of different materials. That proliferation of material is a risk in itself and isn't well understood. If you find you've got uncertified material you're just not sure it's going to last."

Testing, testing

Exacerbating these underlying dynamics in the industry is the fact that, as Gregory and many others assert, the current testing regimes to which modules are subjected in order to gain certification are currently not designed to ascertain a module's durability over time. The main certification standards for modules are enshrined in the IEC 61215 and 61646, which cover crystalline silicon and thin-film modules respectively and specify a range of qualification tests equipment must pass in order to be certified.

Cordula Schmid of Fraunhofer USA explains that this system is fine up to a point, particularly in detecting so-called "infant mortality" failures early in a module's life. "But they only give you pass or fail – and most modules pass those tests," Schmid adds. "They tell you nothing whatsoever about the long-term reliability or potential issues you will run into with those modules in the long run."

Another limitation of the IEC standards is that manufacturers can "cherry pick" a small number of modules to submit for certification testing. There is no process in place to verify that what has been submitted is representative of the module that will eventually be sold or, again, how long it will therefore last, Gregory says.

Together these two shortcomings mean there is no satisfactory safeguard enshrined in industry-accepted standards to give investors any assurance that the product they have bought for a system expected to generate a certain amount of power – and therefore money – over a certain period will do that.

Alongside that, there are concerns that current testing regimes simply do not subject modules to tests that would identify their propensity or otherwise to suffer what appear to be relatively common failures emerging in the field.

Earlier this year a report published as part of the International Energy Agency's PV Power Systems (PVPS) programme looked at the common types of failure modules are displaying in the field. After cross-referencing against the current test requirements for IEC certification, the report highlighted a number of areas where modules appear to be failing in the field but which don't feature in standard tests.

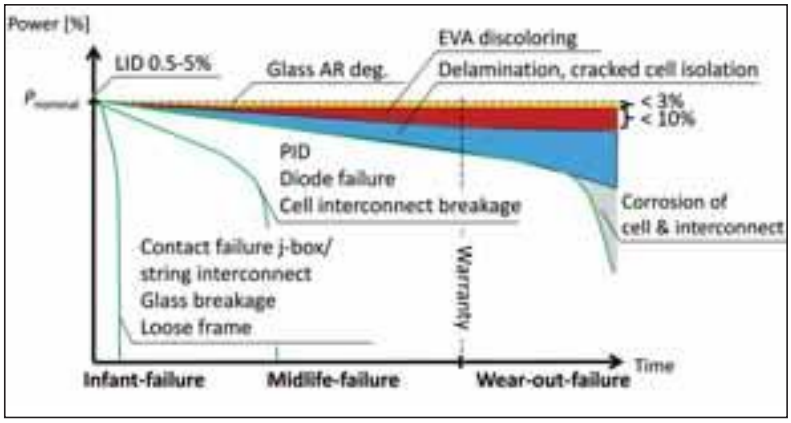
Among these the report picked out mechanical loads caused by transportation or snow loads on modules mounted on an incline, UV degradation, ammonia corrosion and potential induced degradation. Although testing is carried out on this latter, high-profile failing in modern modules, the PVPS report included it as it points out that a recognised standard for the determination of PID does not yet exist.

"These four things are very important because they're likely to affect modules but aren't covered by the current standards," says Mark Köntges of the Institute for Solar Energy Research in Hamlin, and lead author of the report. "They're the most important missing things."

New standards

Of course, the industry is well aware of the limitations of current standards. Since 2011

The IEA found a number of frequent causes of failure that were not part of IEC certification.



Source: 'Review of Failures of Photovoltaic Modules' IEA PVPS.

Three typical failure scenarios for wafer-based crystalline PV modules. Definition of the abbreviations: LID – light-induced degradation; PID – potential induced degradation; EVA – ethylene vinyl acetate; j-box – junction box.

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the NREL has been spearheading efforts through the industry-wide Quality Assurance Task Force to devise new standards that reflect some of the current deficiencies in testing regimes.

The NREL's John Wohlgemuth, one of the task force's main convenors, tells *PV Tech Power* that the group's aim is to come up with a single PV module rating system that enables a rapid assessment of a module's likely durability in any region of the world.

The draft standard, which is currently out for consultation and should be approved by next year, contains a variety of new or enhanced tests, including some of those identified by the PVPS, in areas such as thermal and mechanical fatigue, delamination, diode failures and PID. It will also set out guidelines for how manufacturers should ensure consistency of product through quality management procedures.

"It's got a lot more detail about things that module manufacturers should be doing," says Wohlgemuth. "For example, it says you have to have a system for ensuring that the suppliers continue to deliver the product they say they're delivering. It also says if you get warranty returns you have to understand why a failure occurred and put that information back into your manufacturing system."

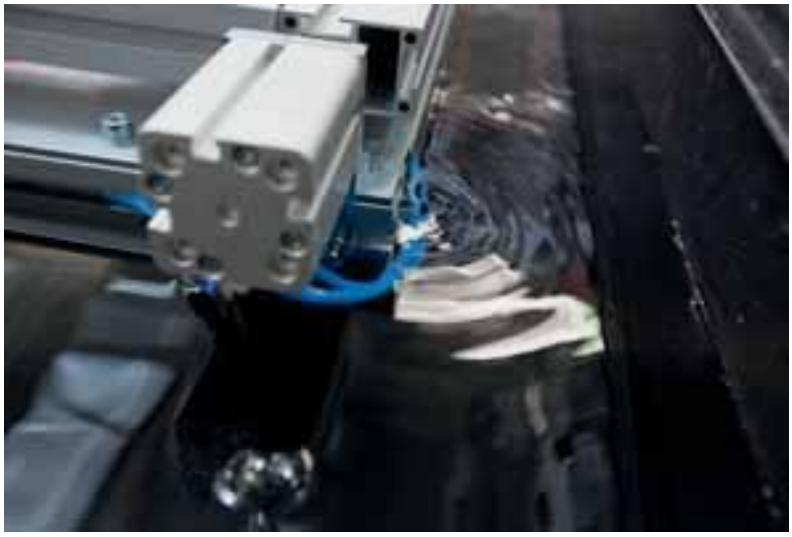
Key questions about the new standard are how quickly and widely it will be adopted, and who will enforce it. On the second question Wohlgemuth is hopeful that an entirely new IEC regime – IEC RE ('renewable energy') – due to come into force next year to regulate renewable energy systems will settle the enforcement question.

"The idea is that there be will a system in place by the end of next year [through the IEC RE] that will audit PV systems for design, installation and the components in it," Wohlgemuth says. He hopes the new system will work its way down to a module level, requiring manufacturers to follow IEC guidelines and have their factories audited to ensure consistency.

On the adoption question, Wohlgemuth believes two main factors will be the main drivers for the new standard: customers asking for it but also larger manufacturers taking an early lead and getting qualified for it.

"We've had four or five manufacturers on the group, including SunPower, Solarworld and First Solar, who are interested, as soon as this becomes standard, in getting qualified for it," he says. "When 1215 came out, in the beginning some people ignored it, others jumped right in, but it wasn't very long before if you didn't have 1215 you didn't sell into a lot of markets. And the new system is going to be the same way."

NREL's Wohlgemuth says the new IEC regime will become a must for firms looking to sell into multiple markets.



Source: Hanwha Q CELLS.

Source: Suntech.

Third-party testing

Opinion on how effective the new standards will be varies greatly, but the biggest concern is what happens until the new system is launched and beds in. Quality is an issue that requires attention now, but two years would seem to be about the earliest the industry could realistically expect any significant impact from the new regime.

To fill the space, a number of third-party quality assurance programmes are popping up that aim to offer investors the sort of hard information they need about module performance.

One example of this is the PV reliability scorecard published by GTM Research in conjunction with module testing company PV Evolution Labs in California. Shiao, one of the authors of the scorecard, explains that although not exhaustive, it begins to offer some comparative information on module performance in different circumstances.

Third-party quality assurance programmes are increasingly popular in the absence of new international rules.

"It compares different module manufacturers on an apples-to-apples basis through the same test regimes, which is something you don't necessarily get in the market today," Shiao says. "For testing like UL and IEC, they're really just pass-fail safety tests. What we're trying to do is to dig deeper and say it's also about how you perform and what sort of degradation you have – did you pass with flying colours or did you just barely make the cut.

"That makes the conversation around reliability more complex. But as we grow as an industry, we need to be a bit more mature in understanding what modules are going to look like in 25 years' time."

Another third-party assurance initiative is the PV Module Durability Initiative offered by Fraunhofer USA. This subjects modules to tests that aim to build up a picture of likely durability by simulating real-world conditions – for example carrying out snow-load tests at -40 degrees Celsius, rather than at

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BUILDING TRUST

Source: Hanwha Q CELLS.

Von Zitzewitz says Hanwha Q CELLS won't do extra audits just to prove it is one of the "good guys".

room temperature as is the industry standard, to create stress conditions in module encapsulants.

Fraunhofer's Schmid says the PVDI does not just test modules harder, but also seeks to correlate failures from accelerated stress testing with results from the field. "You can always test something to death in accelerated testing; but you want to develop tests that really simulate the failures you would see in the real world," Schmid says.

Ian Gregory, whose SolarBuyer is one of the pioneers of the third-party quality assurance model, believes that in lieu of more rigorous industry standards, such programmes are greatly needed to enable investors to start cranking up the pressure on the module manufacturers. "Buyers and investors need to be better educated and be proactive about it once they understand. That will drive manufacturers and standards," he says.

This would certainly seem to be the view among some of the larger players on the demand side of the solar business. Dirk Morbitzer is supply chain manager at US solar leasing company Sunrun. Sunrun recently announced it had enlisted SolarBuyer to provide independent quality assurance services on all the equipment it procures for its systems.

Morbitzer says of the tie-up with SolarBuyer that it is borne of a need to have greater certainty about a module's performance rather than any sense that it will prove defective. "The solar as a service model that Sunrun and other companies are following depends on the materials working for an extended period of time. So it's not driven by defects, but by a wish to know what the situation is," Morbitzer says. "It's not because of failure rates. It's based on: are we really sure? No we're not, so let's be sure."

For example, Sunrun puts modules through 3,000 hours of damp heat instead of the IEC's 1,000, through 800 thermal cycles instead of the IEC's 200 and subjects them to dynamic load tests where the IEC only requires static testing. "That's much harder on the materials than the standard programme," Morbitzer says.

Morbitzer echoes Gregory's point that third-party testing is needed in the absence of stronger standards within the industry, suggesting that even the new ones may not be enough.

"I do hope that the standards will be stringent enough; on the other side I'm aware that as a company we have enough influence on manufacturers to require tests however stringent we want them to be," he says. "So even if the task force's new standards would not meet our requirements, we would still be able to go back to the manufacturers and say if you want to supply to us, these are the tests you have to go through."

Among manufacturers themselves, certainly those who pride themselves on the quality of their products, the view is that additional testing, for example through a third-party body, is not needed. According to Hanwha Q CELLS' chief operating officer, Andreas von Zitzewitz, the motivation for manufacturers to strive to produce the highest quality product is simply one of "survival" (see box).

"Quality is the core pillar of our presentation into the market. And therefore we're certainly looking at what others are inventing, or whether there is an additional process which it makes sense for us to incorporate, but we're certainly not in the business of adding additional audits just to demonstrate that we are good guys," von Zitzewitz says.

But for now its looks as though the third-party quality assurance model is here to stay. A combination of the solar industry's growth trajectory, the concerns many are expressing over potential module reliability issues emerging and the apparent shortcomings in basic quality standards may mean that a manufacturer's word, however solid its pedigree, is no longer enough. Too much is potentially at stake.

"It's not like a 'playing with fire' analogy but we are coming to a point where even if you're talking about tiny percentages of failure that's pretty bad at the scale we're now at," says GTM's Shiao. "But I worry more about characterising long-term performance and understanding what that means, because as the industry gets more complicated and we're exploring new regions, little fluctuations can have a massive effect on the industry when we're at this scale." ■

Author

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Source: Suntech.