

Getting serious on module underperformance

Module reliability | With so many options open to them, EPCs and developers are faced with confusing choices to make over the right PV module technologies. Finlay Colville and Mark Osborne explore the importance of stringent third-party testing in avoiding asset underperformance



Credit: Suntech

As we have heard on the previous pages, with module supply globally seeing increased contributions now from countries outside China, developers and EPCs across the US, Europe, India, Japan and emerging global markets, are being confronted with greater choice in terms of companies offering modules and technology types that differ from the 72-cell p-type multi products that have dominated utility solar until now.

The preponderance of me-too 72-cell products, from so many channels, may actually be one of the key factors behind the number of solar parks underperforming today.

So many developers and EPCs seemed to be of the opinion that because this module type was in such widespread supply, it implied that the technology was both mature and dependable. In this way, it was much easier to justify driving down site capex, while creating somewhat of an auction across module suppliers when sites approach the build phase.

At the extreme end of this, we have the Indian market, which today epitomises the above narrative. Ultimately, component supply and site capex is of course a trade-off between upfront costs and how much sites can be sold for when it comes to flipping to the institutional investment sector.

Performance over 20-30 years, site yields and ensuing costs to fulfil IRRs sadly have no compromise in this regard; time-and-again, the conversations with asset owners and O&Ms in the past few years have sounded like a broken record when reflecting on module choice enacted prior to their acquisition phase.

Where is the system letting down asset owners, and can it be fixed easily? This would perhaps be the most mature place to start; to identify the gaps in the system that allow multi-MW sites to be populated with modules that can barely perform over 2-3 years, far less 20-30 years.

Plenty want to bury the fact that so many solar plants are underperforming today, as though this would be an indication that

Rigorous testing will help EPCs and developers make the right choices over which PV modules to choose from the many new products emerging

the industry was short-changing its funders (government, state or city-based). However, to a man, virtually all of these stakeholders would like nothing more than to know how their future investments can outperform prior rounds of financing, and that the solar industry as a whole recognises that module inspection, certification and testing is not just a bean-counting exercise, but a channel through which everyone can get their act together professionally.

OK, so now we have untried and untested modules coming on the market!

One can sympathise with asset owners today, when they are now starting to see module suppliers offer the next-best-thing after 72-cell utility-based p-type multi modules, to EPCs and developers that are lining up future portfolios of built solar farms.

The manufacturing sector seems to have hit the technology-upgrade button, almost overnight.

For sure, many developers and EPCs are confused. Which of the new product types – and companies supplying them – are actually offering a higher spec product that has inherently lower degradation and lower risk than products of yesterday? And which – despite what it says on the tin – just need to be side-lined until there is field data to show real-world performance?

Knowing the answers to these questions is probably what will differentiate the solar farm builders globally over the next 12-18 months, and right now, everything leading into the PV ModuleTech 2018 event is being configured to have an independent platform to allow rational decisions to be made by EPCs and developers. And not to mention informing the asset owners of today's multi-GW portfolios that can ultimately influence the lenders about component choice they need to pass down to the EPCs on-site.

Within the overall mix of higher performing products (let's classify by stated panel powers at STC here), there are some excellent choices to be made. For example, the move from multi to mono is intrinsically advantageous from a degradation standpoint; and the use of glass-glass modules (mono or bifacial) has many benefits also. And on the thin-film side, moving from a First Solar Series 4 to Series 6 panel size opens up plant capex benefits that are highly positive from a return-on-investment standpoint.

In short, the world is moving inevitably away from me-too 72-cell p-type multi modules to a mix of higher-performing and potentially more-reliable offerings. It is now down to the module suppliers to explain clearly what they are offering, to the third-party testing/auditing/certification labs to undertake the appropriate analysis of the companies/products, and of course to the EPCs/developers/owners to be adequately tooled to make qualified judgements.

Module reliability testing

In making such judgements, basic module certification tests provide EPCs and developers with little 'insurance' against under-performing modules, but accelerated lab tests such as DNV GL's annual 'PV Module Reliability Scorecard' tests do at least provide some transparency and comparative information on module reliability.

The annual PV Module Reliability Scorecard reports the results of DNV GL's PV Module Product Qualification Programme (PQP). The PQP and resulting Scorecard are actually voluntary programmes that enable PV module manufacturers to independently demonstrate the reliability and durability of their products to the global industry, and provide PV equipment buyers and power plant investors with independent and consistent module reliability data.

According to DNV GL, it has lab tested over 300 BOMs (bills of material) for more than 50 module manufacturers since 2014.

The 2018 PV Module Reliability Scorecard summarises the last 18 months of PQP testing results, which included key findings such as:

- An overall improvement in test results compared to 2017
- 9% of BOMs submitted failed one or more of the test criteria
- 12% of model types failed one or more of the test criteria
- 22% of manufacturers had at least one failure according to the test criteria
- Failure rates were not linked to the

geographic location of the factory or size of the manufacturer

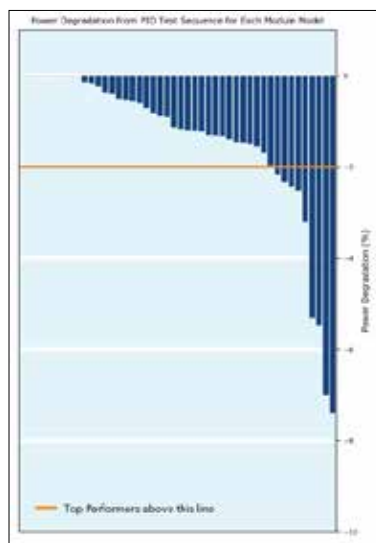
The scorecard has its weaknesses, not least that it is 'voluntary', providing inconsistent data from PV module manufacturers on a year-on-year basis as companies elect to be part of the testing and which specific modules are tested.

The scorecard also reflects the roller-coaster of an industry, which experiences regular bankruptcies and so companies such as SolarWorld, which had previously participated in the testing, do not appear in the 2018 testing results.

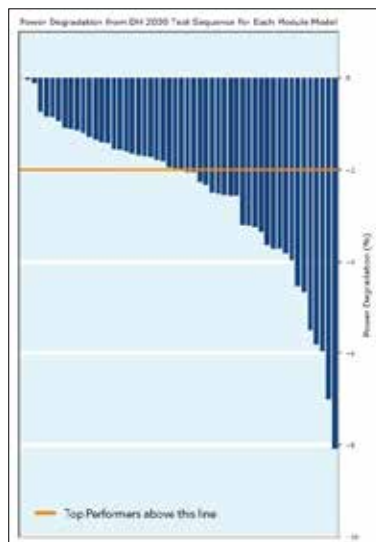
However, the scorecard has become increasingly important, not least due the growing number of PV module manufacturers and the number of modules tested on an annual basis.

We have chosen two of arguably the most import tests undertaken by DNV GL, the damp heat (DH) and the potential-induced degradation (PID) tests and compared the scorecard results from the two most recent test reports.

DNV GL Scorecard 2018, PID test results



DNV GL Scorecard 2018, damp heat test results



With respect to the PID testing, in 2017, 16 PV manufacturers participating achieved 'Top Performer' rankings with 24 modules degrading from zero to a maximum of 2%.

In the 2018 report, Top Performer rankings were given to 20 companies and 32 modules. According to DNV GL, the 2018 median was -1.4%, compared to -0.4%, -2.7%, and -18.4% in 2017, 2016 and 2014 respectively. However, some of the modules tested for PID were said to have not been claimed by the manufacturer to have been PID-resistant.

With respect to the damp heat test, a total of 13 companies attained the Top Performer ranking in 2017 with 19 modules achieving less than a 2% deviation in performance.

However, according to the report, 42 module models with 50 unique BOMs participated in this test, with degradation rates varying from non-measurable degradation to -5.5%.

In 2018, the number of companies with a Top Performer ranking remained unchanged but the number of module models meeting the Top Performer criteria increased to 23.

Yet, according to the report, higher degradation was seen, with the median at -2.5%, compared to -0.9% in both 2014 and 2017 reports. The maximum degradation was -8.8% in 2018, compared to -5.5% in 2017.

Considering that high ambient temperature and humidity can be found in a large number of countries and regions where PV is deployed in significant quantities, the damp heat tests have highlighted that the durability of modules for many markets with such conditions could be compromised.

Scoring manufacturers

We also undertook a sample analysis of module manufacturers that released press releases, specifically highlighting their success in the 2018 DNV GL Scorecard results as Top Performers.

Yingli Green

Yingli Green took a bold stance in the headline: "Yingli is Outstanding in the PV Module Reliability Scorecard of DNV GL for the Fourth Time".

Indeed, Yingli Green was highlighted in 2018 Scorecard by DNV GL to have been rated a Top Performer in at least one test criteria in each of the four annual test so far undertaken. This accolade can also be given to JinkoSolar and Trina Solar.

"The PV Module Reliability Scorecard

report is a voluntary programme initiated by DNV GL, presenting the most complete and transparent comparison of PV module reliability test results. Since 2014, Yingli's PV modules performed at the top level in reliability in the four reports," commented Dr. Dengyuan Song, chief technology officer of Yingli. "The reliability tests covered by the Scorecard include triple IEC thermal cycle, damp heat, humidity freeze, and dynamic mechanical load and PID attenuation. The test results demonstrated the strong reliability of Yingli's PV modules."

In our sample analysis of modules from manufacturers in the DH and PID tests in 2017 and 2018, Yingli's 'robust' YLxxxD-36b module was a Top Performer in three of the five tests in 2017 and in all four tests in 2018.

Yingli modules were not present in the 2017 Scorecard as a Top Performer for the thermal cycling and humidity-freeze test results.

JA Solar

'Silicon Module Super League Member' (SMSL) JA Solar took a more conservative approach with the press release headline "JA Solar Named 'Top Performer' by DNV GL for the Third Time".

However, the company also stated: "In both 2014 and 2016, JA Solar passed the product tests and received the product certification from PVEL (a wholly-owned subsidiary of DNV GL) and won the 'Top Performer'."

JA Solar did not participate in the 2017 report, but was a Top Performer in the PID test in 2016. In the latest report, JA Solar was a Top Performer in the thermal cycling (TC) test with its JAM6(K)(ZEP)-60-xxx/PR module and the dynamic mechanical load (DML) test with its JAM6(K)(ZEP)-60-xxx/PR and AP72S01-xxx/SC modules.

In the PID test, JA Solar had two modules rated as Top Performer, the JAM6(K)(ZEP)-60-xxx/PR and the JAM60S02-xxx/PR module.

Adani (Mundra Solar)

New market entrant, India-based Adani (Mundra Solar), proudly proclaimed it was the only India-based module manufacturer to feature in the report. This was true as Vikram Solar did not participate in the latest testing, although appeared in the 2017 report and had been a Top Performer in the humidity freeze test, dynamic mechanical load test and damp heat test.

"Adani Solar gets coveted global recognition on durability and reliability," was the headline but the press release did not

specifically use the Top Performer terminology, instead citing that it had been awarded the "top award for three rigorous tests".

Adani appeared as a 2018 Top Performer in three out of the four tests, which include the TC test with its ASP-7-xxx module and well as the DML and PID tests.

Ramesh Nair, chief executive officer of Mundra Solar PV Limited (Adani Solar) said: "Developers/investors should always be aware that not all manufacturers have their modules tested for quality and reliability to vouch for their product lifetime. Procuring unevaluated modules is always a risk that could have major ramifications for their projects. Adani is a committed manufacturer which has implemented state-of-the-art facility with best industry practices ensuring superior performance and reliability of its products."

LONGi Solar

Another recent market entrant was LONGi. Already an SMSL member and the largest monocrystalline wafer producer in the world. Also notable is that in 2017 it had the highest expenditure on R&D in the solar industry at US\$175.7 million, up 96.67% from US\$89.2 million in 2016 as well as setting a new record for R&D spending in the industry.

Ticking all the boxes, LONGi's press release headline was: "LONGi Solar is 'Top Performer' in DNV GL 2018 PV Module Reliability Scorecard"

The company also noted: "LONGi Solar was awarded 'Top Performer' for its monocrystalline PERC modules in all four

tests categories. This is a validation of the advantages of high efficiency, high reliability and high yield of LONGi Solar's mono-crystalline modules, and an endorsement of the advanced technology, equipment, product testing and R&D capabilities of the company"

LONGi Solar was awarded Top Performer for its mono-crystalline PERC modules in all four tests categories. Indeed, this was achieved for two modules, LR6-72PH-xxxM and LR6-60PB-xxxM. This was also achieved with the LR6-72-xxxM and LR6-72PE-xxxM modules in 2017.

Trina Solar

SMSL member Trina Solar also remained conservative in its press release headline, noting: Trina Solar recognised as "Top Performer" module manufacturer by DNV GL.

The company correctly highlighted that it was the fourth time it has received this award.

Although the company noted the four major tests undertaken, very little else was said about testing specifically in respect to its modules.

Unlike other companies, Trina Solar has put through the testing a notable number of different modules. As the table below shows, in 2017 and 2018 scorecards, a number of Trina Solar modules were awarded Top Performer status in all categories but not all modules in all the categories.

However, it is clear that Trina Solar has extensively used the scorecard since inception, as well as leading SMSL, JinkoSolar.

However, there would seem to be room for improvement in how PV module manufacturers reflect their Top Performer status. ■

Trina Solar's 'top performer' modules in the 2017 and 2018 scorecard

Trina Solar	2017	2018
Thermal cycling	TSM-xxxPD14.18	TSM-xxxDD05A.08(II)
	TSM-xxxPD05.1	TSM-xxxDD05A.18(II)
	DD14A(II)	TSM-xxxPE14A/TSM-xxxPD14
Dynamic mechanical load	TSM-xxxPD14.18	TSM-xxxDD05A.08(II)
	TSM-xxxPD05.1	TSM-xxxDD05A.18(II)
	DD14A(II)	TSM-xxxDD14A.18(II)
		TSM-xxxPD14
		TSM-xxxPE14A
Humidity-freeze	TSM-xxxPD14.18	N/A
	TSM-xxxPD05.1	N/A
	DD14A(II)	N/A
Damp heat test	TSM-xxxPD14.18	TSM-xxxDD05A.18(II)
	TSM-xxxPD05.1	TSM-xxxDD14A.18(II)
	DD14A(II)	TSM-xxxPD14
		TSM-xxxPE14A
PID test	TSM-xxxPD14.18	TSM-xxxDD05A.08(II)
	TSM-xxxPD05.1	TSM-xxxPE14A/TSM-xxxPD14
	DD14A(II)	