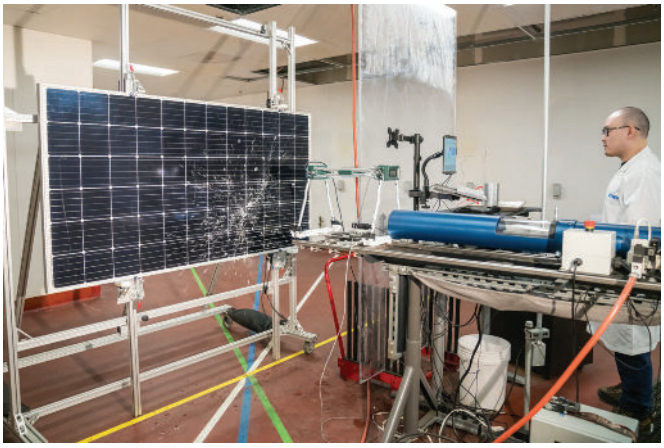
pv magazine

Module reliability scorecard reveals widespread quality risk

Independent testing laboratory Kiwa-PVEL today published the 11th edition of its PV Module Reliability Scorecard, having extensively tested PV modules from 50 different manufacturers. The scorecard reveals improvements in energy yield per watt-peak and resistance to potential-induced degradation, but an increase in breakage under mechanical stress and hail simulations, and an overall higher failure rate are cause for concern to many.

JUNE 4, 2025 MARK HUTCHINS



The hail stress sequence test, part of Kiwa-PVEL's PQP testing protocol, showed the weakness of some modules that use very thin glass.
Image: Kiwa-PVEL

The Module Reliability Scorecard, published annually by PV module testing laboratory Kiwa-PVEL, released its 11th edition today. The scorecard summarizes the results of extended reliability testing of commercially available PV modules, designed to expose any weaknesses that may show up in the field after installation.

The 2025 scorecard features results from 50 module manufacturers, a slight fall from 53 included in last year's scorecard. Tristan Erion-Lorico, vice president of sales and marketing at Kiwa-PVEL noted that 15 manufacturers featured in 2024 did not return to participate in this year's round of testing, while several newcomers also signed up.

The good news

Of the 50 manufacturers and many products included in the tests, 21 achieved 'Top Performer' status in all categories. Overall, resistance to potential-induced degradation showed improvements across most manufacturers, and PAN-performance – where tested module characteristics are used to simulate energy yield performance – also improved, with the latest crop of modules shown to generate more energy relative to their power class than in previous years. Erion-Lorico attributed this to improved bifaciality and better temperature coefficients for the latest cell and module technologies.

Resistance to ultraviolet-induced degradation, which has emerged as a particular concern for the tunnel oxide passivated contact (TOPCon) cells that now represent most of the market, was also shown to improve, but still represents an area where manufacturers need to take precautions.

Quality concerns

Modules tested for this year's scorecard revealed minimal performance loss following hail and other mechanical stress test sequences – potentially a sign of improvement on cell cracking that has long been seen a big risk to PV module performance in the field.

But this stage of the test also demonstrated one of the biggest concerns for the PV industry in 2025, with a pronounced increase in module breakage. Cracked module glass, broken frames, and other issues such as junction box damage all saw an increase. Erion-Lorico noted that 20% of models tested experienced at least one failure during mechanical load testing, up from just 7% in both the 2023 and 2024 scorecards, and that the load testing conducted as part of the Reliability Scorecard goes up to 1800 pascals of pressure, rather than the 2400 specified in IEC testing standards. "These are the types of conditions that with wind loads and snow loads can occur in the
field. And I don't know what other industry would accept a 20%failure rate."

Increased frame and glass breakage was a worrying trend in the 2025 Module Reliability scorecard testing.
Image: Kiwa-PVEL

These increased breakage rates have been seen in the field already in recent years, and the move to larger module formats, made with thinner glass, is one part of the problem. But it also comes down to cost cutting efforts as manufacturers look to cut back on material consumption in times of low prices for PV components. "Probably the biggest concerning aspect of this report is that module breakage has really increased, which has a direct correlation to cost cutting," said Erion-Lorico.

In some cases, lack of encapsulant material at the edge of a module was shown to be enough to cause glass breakage, with solder points on the glass creating stress concentration points. With these, even day-to-day temperature changes could be enough to cause glass to break at the edges. "There's a range of causes, whether that's glass strengthening issues, flaws within the glass, weaker frame designs, edge pinch on the laminates, poor frame sealant approaches, and more aggressive mounting systems," Erion-Lorico added.

20% of models tested in this year's Module Reliability Scorecard saw one or more failures during mechanical load testing.
Image: Kiwa-PVEL

The tests also showed an increase in overall failure rate, with products from 83% of manufacturers registering at least one test failure, and increase from 66% in the 2024 scorecard. Breakage during mechanical stress or hail testing represented the largest increase, but Erion-Lorico also said that modules failing either power loss or visual inspection after thermal cycling also increased, as well as junction box related issues, and for the first time 'witness' failures, where a manufacturer decided not to ship modules that had gone through PVEL's selection process, were seen in 2025.

Overall, improvements in the simulated energy yield for many products demonstrate the value of the PV industry's innovation and rapid introduction of new technologies into production. But as PV module manufacturers continue to seek all possible cost reductions in the face of extremely low component prices, impacts on quality are showing.

"The rapid pace of innovation in the PV module landscape is encouraging, and it's great to see more products achieving Top Performer status," said Erion-Lorico. "However, we continue to caution buyers not to assume all modules are created equal. Our testing continues to uncover significant variability in performance and long-term reliability.

The full scorecard is available at scorecard.pvel.com