

Under the microscope

Testing | Inspection companies are key in enforcing and setting the quality standards underpinning module performance. TÜV Rheinland's solar segment manager, Lukas Jakisch, tells Will Norman how they are keeping abreast of the rapid pace of technological change

Between 2012 and 2022 the world's total installed solar PV capacity increased more than tenfold, from 100GW to 1,185GW. There is now more solar PV on the ground than the entire installed electricity generation capacity of the EU in 2022. In short, the PV market is booming.

Simultaneously, the number of modules and technologies available on the market has grown and shifted and module prices have gone through the floor. By some estimates, annual production capacity in China is currently three times global demand, and 2023 has seen all the big players expand their capacities tremendously. This has led to concerns that manufacturers may resort to cost-cutting measures that could compromise module quality.

PV Tech Power spoke with Lukas Jakisch, solar segment manager at PV testing and certification company TÜV Rheinland, about the developments and challenges facing the sector.

PV Tech Power: To what extent are standards being monitored and updated to ensure they remain in step with the pace of technological change in the industry?

Lukas Jakisch: The answer is surprisingly simple: the legislator sets the rules and regularly publishes new or revised norms and standards through the relevant authorities or committees such as the IEC [International Electrotechnical Commission]. This is where industry experts such as testing companies, research institutes and manufacturers can contribute their experience from laboratory and field tests. We also use our findings to help make standards, and ultimately products, better and safer. The final decision on changes to standards and their content is made by the government authority or the relevant committee or body to which TÜV Rheinland, as a member, proposes appropriate adjustments and improvements.

How have testing houses kept up with the rapid development of PV technology in recent years? Can you give some examples of how you've had to modify your testing processes in step with the introduction of a new technology?

I can give you a couple of examples. First, let's look at the dimensions and

power of PV modules and their cell sizes. All three have continuously changed or increased in size in recent years and exceeded the capacity of current test equipment. One way to overcome this challenge is to work with so-called representative samples (e.g. for very large façade modules). In this case, smaller samples are tested. The results can also be scaled up to larger samples for a selection of tests. Another obvious consequence is that test centres such as TÜV Rheinland will have to adapt or expand their facilities accordingly. This is particularly true of climate chambers and solar simulators. For example, we have recently invested several million euros in new facilities at our company, which also take into account a further increase in system dimensions in the future.

Another example is new (cell) technologies. The Polish PV start-up Saule recently launched a PV module with a new cell technology, so-called perovskite cells, which we have tested and certified according to the IEC TS 63163 standard. The challenge: new cell technologies require new stabilisation processes and new methods for measuring performance. In this context, test centres such as TÜV Rheinland often develop their own test procedures, known as 2PfGs. These take into account both the currently applicable standards and the challenges of a new cell technology arising from the specific case in question. These standards can be adapted to the respective market situation much more quickly than international standards, which involve many different market players. Often enough, these standards, in turn, serve as a model for IECs. For example, when bifacial cells came onto the market, TÜV Rheinland was the first testing organisation in the world to respond to this technological innovation with a corresponding 2PfG standard. This standard was and still is the model for today's IEC standard 61215:2021. The "Sharp Edge Test" requirement in IEC 61730:2023 (the current safety standard for PV modules) is also due to measurement experience and preliminary work by in-house solar experts, who thus developed a template for a new IEC standard.

What can ensure that current testing standards and guidelines are up-to-date and sufficiently comprehensive?

The interplay between technological change and the evolution of the regulatory



Credit: TÜV Rheinland



Test centres such as TÜV Rheinland have to continuously adapt test facilities in step with changing PV technologies

framework to ensure that innovations can be used safely is a matter of course – whether in the energy sector, mobility, or digitalisation. In this respect, the process of adapting to technological change is part of the day-to-day business of testing organisations such as TÜV Rheinland. However, it is important that new findings are regularly and promptly incorporated into new or revised standards. This is where the relevant authorities are called upon to catch up with the regulations. But testing companies are also actively involved in further development. For example, by offering audits that go well beyond existing legal requirements, TÜV Rheinland can identify anomalies that would not have been noticed in “standard” audits. In turn, we share these findings with the regulatory authorities and incorporate them into standards and norms.

What are the most common defects you encounter when dealing with new technologies?

In general, the durability, performance, and range of applications of PV systems have improved over the past decade. This has been helped by the fact that experience gained in the laboratory and in the field has been fed back into current standards, and quality assurance processes have thus been continuously improved. At the same time, however, we have seen that there is always a lack of basic knowledge about new technologies. This is partly due to the constant changes and partly to financially motivated savings potential in materials and components, some of which are not sufficiently qualified. In addition to quality problems, this also leads to failures in the field due to both light-induced and potential-induced degradation. The latter can often be countered with simple measures, provided the problem has been identified by the manufacturer. Other degradation phenomena include: LeTID, UVID, chalking, browning and cell microcracking. Static factors also play a role. Plants are getting bigger and heavier. In open-air systems in Spain, we have investigated glass-glass modules that bend. Their own weight was too much for the support structures that had been installed. In the field inspections we have carried out, installation errors are one of the most common defects and causes of failures. For example, combinations of connectors from different manufacturers are used (cross-installation), or connectors are left open for long periods of time, exposing them to the elements, dirt, and corrosion. For several years, TÜV Rheinland has offered to qualify and certify installation companies. All processes, staff qualifications and materials used in the company are assessed and installations are randomly tested on site. The audit is repeated every year.

There are concerns that the combination of falling module prices, oversupply and increasing global production capacity will impact on PV module manufacturing, particularly as companies look to cut production costs – can you address this?

Well, we don't have a crystal ball. But we do have the ability to counteract this very risk by offering testing services. For example, we often see safety-related quality defects in cable and insulation material. One possible reason is that if extruders run too fast, the extruded insulation sheath can show irregularities. In special ovens, we test photovoltaic components for their long-term thermal behaviour between minus 40 and plus 125 degrees Celsius. The target for conductor material, for example, is 125 degrees Celsius for 5,000 hours. Our services, therefore, also include component testing that takes into account typical manufacturing defects that can occur in times of high price pressure and production cost reductions.

Another example is solar glass: to reduce cost and weight, solar glass is becoming thinner and thinner and may not be able to withstand the stress. The thickness is now down to 1.6mm – five years ago it was 3 to 4mm. We can simulate the required and real stresses on solar glass in our laboratories and materials that are not suitable for the application would stand out.

However, I would like to point out one thing in this context. In the EU and the UK, there is no requirement for manufacturers to have equipment tested by independent testers such as TÜV Rheinland. The legislation only requires imported products to be CE-compliant. It is up to the manufacturer to decide how to



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A strict definition of quality requirements when purchasing PV modules and components would help further minimise investment risks

meet this requirement. In light of the current public debate, we urge manufacturers to rely on independent testing expertise such as that provided by TÜV Rheinland. Investing in quality assurance reduces the likelihood of serial defects and thus the risk for investors, and ultimately benefits the entire industry.

What are the main challenges facing PV module quality control today and how do you anticipate having to adapt to ensure your testing services remain attuned to the demands of a fast-changing industry?

The fact that technological change brings both technical progress and new technical challenges is nothing new. Particularly in the case of more recent innovations, certain new features sometimes only become apparent under real external conditions, because the corresponding problems only occur in certain – previously unknown – constellations. Of course, it is important that new, reliable findings are quickly incorporated into the applicable standards and norms. In this respect, the further development of existing technology and standards is an ongoing process. At the same time, it can also be said that it is precisely because of these interactions that numerous standards have been further developed or newly created in recent years, leading to an improvement in quality assurance in the PV module sector.

What lessons have been learned from the solar boom that could inform manufacturers or testing houses in the face of a coming downturn?

From the point of view of a testing company, the following conclusions can be drawn from the laboratory and field tests carried out in recent years. For existing systems, early and regular inspections would help to counteract degradation such as PID, thus meeting quality requirements and reducing additional costs for repairs and maintenance.

For new systems, a strict definition of quality requirements when purchasing PV modules and components would go a long way towards further minimising investment risks. This includes tests such as performance measurement, mechanical tests (mechanical stress such as snow and wind loads, environmental simulation in climatic chambers with humidity, high and low temperatures, mechanical stress due to temperature changes), electrical safety, simulation of electrical faults (e.g. PID, LeTID, UVID).

The application of minimum standards according to IEC norms, combined with extended stress tests and characterisation, enables consistent qualification of the bill of materials (BOM), accompanying production inspections to check the BOM and production quality. In addition, the demand for safety, durability and cost-effectiveness of PV products requires the professional and quality-assured use of laboratory services, high-quality products, professional installation, and regular maintenance. What is needed are system investors who do not invest from the outset based on calculated maximum returns with considerable risk, but instead give quality and quality assurance financial leeway, practise risk management and thus ultimately lead the entire project to economic success. ■