

PV Module Tests, **From Safety Standards To Performance Checks**

A task force is working on developing new standards intended to make testing results more universally useful and understandable.

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Cimulation and testing is a criti-Ocal step in the process of module manufacturing. Standard procedures can be used in combination with experimental testing to help manufacturers evaluate the performance, reliability and safety of their photovoltaic modules.

In addition to meeting necessary standards related to quality, health, environmental and safety issues, PV module manufacturers can further demonstrate and validate the long-term performance and reliability of their products through additional simulation and testing - which can help them gain efficiencies in their manufacturing process and reduce risk.

This, in turn, can also help manufacturers gain a competitive advantage when performed beyond the required testing standards to determine extended lifecycle data up to 20 years or

For testing needs and beyond, it is important that process control systems be established for each step of the module manufacturing process. These systems measure certain parameters for the equipment in use and ensure that the manufacturer has the right systems in place to control the production line. Whether these systems are properly suited for the manufacturing line affects the pretesting that occurs before the initial qualification or certification is conducted.

Thorough module testing involves

conducting an audit and testing key components of the sample product to ensure consistent results. If the results have negatively changed in Paul Robusto comparison to those of



previous tests, manufacturing failure mechanisms must be determined. This step requires an emphasis on different types of testing in order to determine the right control.

Once the failure mechanism is identified, the production line is adjusted so samples can be pulled off for highly accelerated testing on either the components of the products or the whole assembly.

In the event that testing results have positively changed, it is important to determine what was done correctly to increase the lifetime or quality of the product. Once the change is investigated and identified, it can be permanently implemented in the production line, therefore sequentially improving the quality of the product as time goes

Regardless of the test results, it is imperative to run a statistical process control to verify consistency from one run to the next. These quality-control steps are important to ensure the manufacturing production line process is acceptable.

Required first tests

Manufacturers must obtain a performance and safety certification from a Nationally Recognized Test Laboratory before any new module can access the North American market. Specifically, requirements such as Underwriters Laboratories' (UL) 1703 safety standard in the U.S. and ULC/ORD C 1703 from the Standards Council of Canada must be met in order to sell flat-plate photovoltaic modules in North America.

Although there are many standards in the PV industry, a few are of particular importance: The standard for monocrystalline or polycrystalline silicon flat-plate photovoltaic modules is International Electrotechnical Commission (IEC) 61215. IEC 61646 is the standard for thin-film flat-plate photovoltaic modules, for which a required light-soaking test can be done outdoors or indoors with a simulated sunlight source.

IEC 62108 is the performance standard for concentrated photovoltaic (CPV) modules and assemblies. Lastly, IEC 61730 represents an additional safety standard for photovoltaic modules.

In order to obtain the required IEC certifications, modules must go through sequences of performance testing that constitute the four legs of basic IEC tests. The first leg is the outdoor exposure test and measurement of the temperature coefficients.

The second leg, TC-200, consists of a thermocycling of 200 cycles, when the module goes through cycling from -40 degrees C to 85 degrees C, up and

down in sequence - and must equalize at two extremes. A third leg is the damp-heat sequence, which subjects modules to 85% humidity and 85 degrees C for 1,000 hours.

Lastly, the UV leg, which is conducted indoors with a simulated sunlight source as part of the UV preconditioning test, exposes the modules to ultraviolet radiation. Modules then go through a temperature cycling for 50 cycles, followed by a humidity freeze environmental test.

Although the tests previously described are required as part of the certification process to ensure prod-

accelerated aging and lifecycle testing to prove they can maintain high energy output over the long term.

Overall, the industry has become less focused on the short term (i.e., what is the least expensive option for me right now?) and more focused on the long-term return on investment (i.e., what PV module will provide the greatest energy output over the next 20 to 30 years?).

Bankability testing

In order to verify that a manufacturing facility is producing consistent quality products, it is recommended

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ucts are in compliance with national and international standards, others that manufacturers may opt to undergo are optional. Naturally, additional testing can further differentiate a manufacturer's products from those of a competitor.

Certain non-required tests have recently increased in popularity. For instance, salt mist and ammonia corrosive testing can be used to determine if a product can withstand these regionally specific elements in climate and environment.

Extended outdoor testing can also be used for modules that may be exposed to different environments in the field - including hot and humid locations, hot and dry locations, snowy locations, seashore locations, farm field locations and industrial locations - in order to determine if the quality of the product can withstand these environmental conditions.

Over the last 24 months, performance and reliability have elevated to the forefront of the photovoltaic industry. As new product development has slowed, manufacturers are looking to prove the bankability of their existing products, particularly using

that module manufacturers employ bankability testing programs. The goal of bankability testing is to detect product defects, reduce risk and, ultimately, increase customer confidence. Such programs evaluate the current state of manufacturing at the time of testing and re-evaluate the product on a quarterly basis in order to ensure the quality of the product remains the same.

Depending on the size of the PV installation in question, at least 10 to 12 modules would be selected to sample-test at a testing facility for a megawatt-scale installation, in order to determine any quality changes. The more products being manufactured, the more units the company may want to test.

The sample products would undergo additional tests to determine if the quality of the module has varied from one business quarter to another. One bankability test is a peel test, which determines the strength of the adhesion for various layers. A second test, a gel content test, determines the gel content in tetrahydrofuran through extraction.

Another test analyzes electrolu-

minescent imaging, which allows the quality of the silicon wafers to be seen after they have been laminated together in the module. A AAA flash simulator is used to determine power, current and voltage readings. The simulator utilizes xenon light sources that flash in short periods of time to avoid heating the module.

In this test, the different current and voltage levels determined by the IV curve are important. The curve represents power as current multiplied by voltage, while the power-versus-radiance level shows how the module performs at low intensity. Both the IV curve testing and power testing can be performed outdoors or indoors with a solar simulator.

Data collected from bankability tests - which might be conducted on a quarterly basis - go beyond the minimum industry requirements and help PV manufacturers demonstrate the value of their product to investors and purchasers looking for proof that a product will produce the expected return on investment. Although there are many different tests currently being used by manufacturers, there is not yet a standardized approach to this kind of testing.

International task force

It is important to remember each component that goes into the finished module - from wiring to adhesives - must comply with certain standards. These standards can be different in North America, Europe and Asia, so manufacturers must make sure the components they select meet the requirements of their target markets.

Many third-party testing partners have established their own set of testing sequences for performance, reliability and durability to help support manufacturers' product claims about long life cycles. However, multiple requirements and test sequences make it difficult for investors to compare one module to another.

Because the National Renewable Energy Laboratory (NREL) has not yet

determined one overall standardized method, a committee of experts has formed the International Photovoltaic Module Quality Assurance (QA) Task Force. The task force is working to develop standards to help manufacturers and stakeholders better understand and benchmark results.

These industry stakeholders in the U.S., Europe, Asia and Japan include manufacturers, testing laboratories and investors that are seeking to agree on a new standard of performance that would ultimately become the next generation of reliability testing.

The task force will also develop a QA rating for the durability of the

module design, in addition to a guideline for QA of the manufacturing process. This effort is being led by NREL in conjunction with the National Institute of Advanced Industrial Science and Technology and the U.S. Department of Energy, with support from the Joint Research Centre and Semiconductor Equipment and Materials International PV Group.

The goal among all of these parties is to achieve consensus on a standard to set minimum test criteria so a product can carry an additional QA rating.

In summary, safety and quality are of utmost importance to manufactur-

ers and others involved in the value stream. Today, more than ever, product failure or less-than-anticipated performance can result in lost dollars and a tarnished reputation. Therefore, both manufacturers and investors are heavily invested in and affected by the success of a product.

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