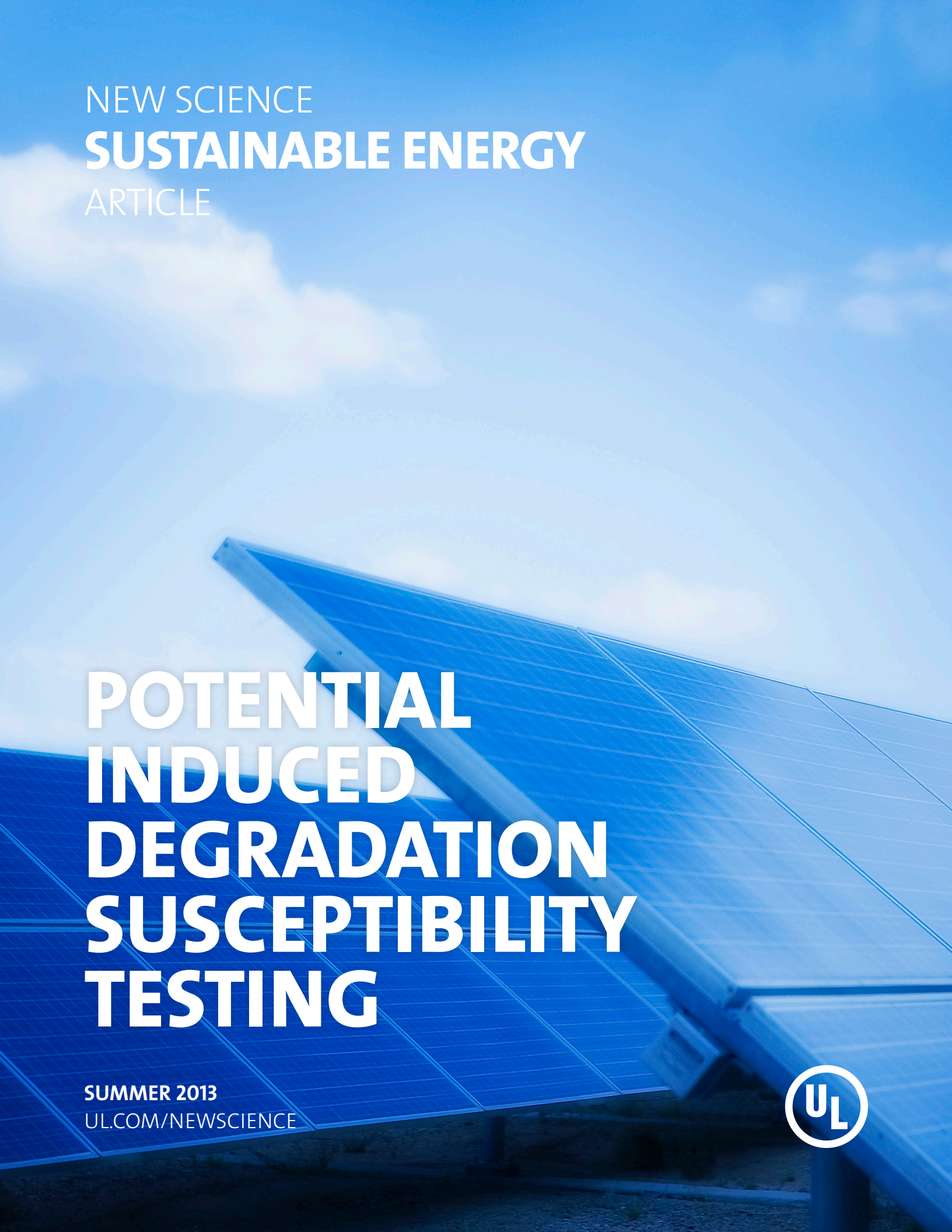
NEW SCIENCE

SUSTAINABLE ENERGY

ARTICLE



POTENTIAL INDUCED DEGRADATION SUSCEPTIBILITY TESTING

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UL.COM/NEWSCIENCE

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OVERVIEW

Rising costs, energy efficiency and environmental impact demand innovations in energy generation, distribution, management and usage. UL's team of dedicated scientists, engineers and researchers are developing New Science to make energy cleaner, more reliable, more efficient and more secure.

WHY SUSCEPTIBILITY TESTING MATTERS

By making it easier and less costly to test solar photovoltaic (PV) modules for PID (potential induced degradation) susceptibility, UL is helping enhance PV reliability and, ultimately, promote PV adoption. Helping make PV systems a more economically sound investment is essential to achieve the environmental benefits of solar energy.

The PV industry is now projected to install an additional 400 to 600 GW of PV capacity by 2020 as the underlying costs of PV energy drop by an estimated 10 percent per year.[3]

CONTEXT

By 2009, the global installed capacity of PV energy reached 7.3 gigawatts (GW). At that time, demand had grown by an average 30 percent per annum over the previous 20 years against a backdrop of growing environmental concerns and rapidly declining costs and prices. The cost reductions were driven by economies of manufacturing scale, manufacturing technology improvements and the increasing efficiency of solar cells.[1] With rising overall energy prices and an expanding awareness of environmental issues, PV continued to become an increasingly important form of energy around the world. Global installed capacity grew by 1,270 percent in four years, crossing the 100 GW threshold in early 2013.[2] The industry is now projected to install an additional 400 to 600 GW of PV capacity by 2020 as the underlying costs of PV energy drop by an estimated 10 percent per year.[3]

The explosive growth of PV energy is being driven as much, or more, by its declining costs as by its environmental impact. Because investments in PV systems are sometimes planned for a 20-year service life, product reliability plays a crucial role in the overall PV energy cost profile and return on the initial investment — related to both higher and more consistent power output and the need for fewer, less frequent PV panel replacements.[4]

One of the more severe threats to PV module reliability today is the potential induced degradation of crystalline silicon PV modules. This degradation can result in a power loss of nearly 100 percent in modules at the end of a system string (i.e., a number of PV panels aligned in series) in a time frame of just one month.[5]

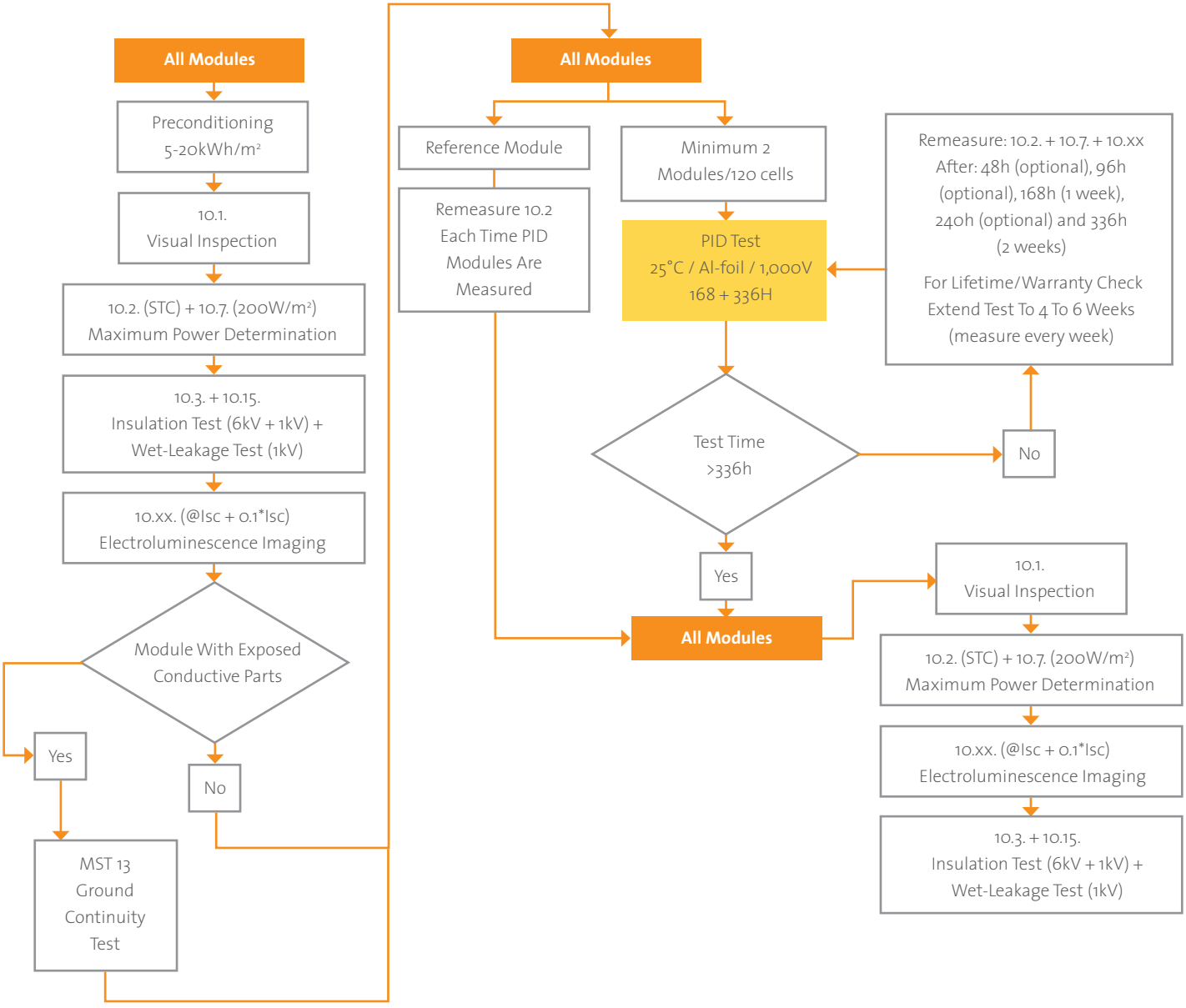
WHAT DID UL DO?

UL consolidated several years of PV industry research and developed a unique and proven scientific test procedure to screen modules for PID and several critical safety aspects with a high degree of reproducibility.[6] The UL PID test is innovative both in its simplicity and in the comprehensiveness with which it assesses PID susceptibility. The procedure starts with a preconditioning of the modules to remove any initial degradation influence from the PID evaluation.

The preconditioning and other tests are conducted in accordance with UL standards (i.e., 61215 for power output performance of crystalline PV modules[7] and 61730 for safety standards for PV modules).[8] The preconditioning and use of standards help to ensure more objective and reproducible results from the subsequent PV module testing.

To evaluate the initial PID effect and compliance with several module safety requirements, several spot check tests are performed after 168 and 336 hours of testing. Additional optional measurements can be conducted after 48, 96 and 240 hours for research purposes. These initial tests include a visual inspection, insulation test, wet leakage test and grounding continuity test. For purposes of analysis, electroluminesce (EL) images are taken at each stage of testing.[9]

The UL PID Test Procedure[10]



The test module's performance is measured and evaluated at a standard test condition (STC) of 1,000 watts per minute (W/m^2) and at low irradiance ($200W/m^2$).[11] We use these as the susceptible criteria because PID causes shunting of the solar cells, which results in a significant negative affect on the module's low-light behavior. A PV module is identified as PID susceptible if one of the following applies:

- Power loss (ΔPmpp) > 5 percent after 168 hours
- Power loss (ΔPmpp) > 10 percent after 336 hours[12]

Temperature range and test time are easily controllable with the UL procedure, which results in very high reproducibility. A change of ±3°C in the test environment can lead to variation in the results by nearly a factor of two over two measurements.[13]

IMPACT

UL created the most simple and effective PID susceptibility testing methodology available. The UL test is easier, less expensive, safer and more consistent than other procedures. It does not require a climate chamber, which can add significant costs to the test. High-voltage safety measures can be easily established because the difficult grounding protocols required for testing in a climate chamber are not required. Our PID susceptibility test uses aluminum foil and water, materials that are low cost and readily available. UL's unique methodology also promotes consistent test results. The method eliminates any kind of corrosion effect due to moisture and potentials.

SOURCES

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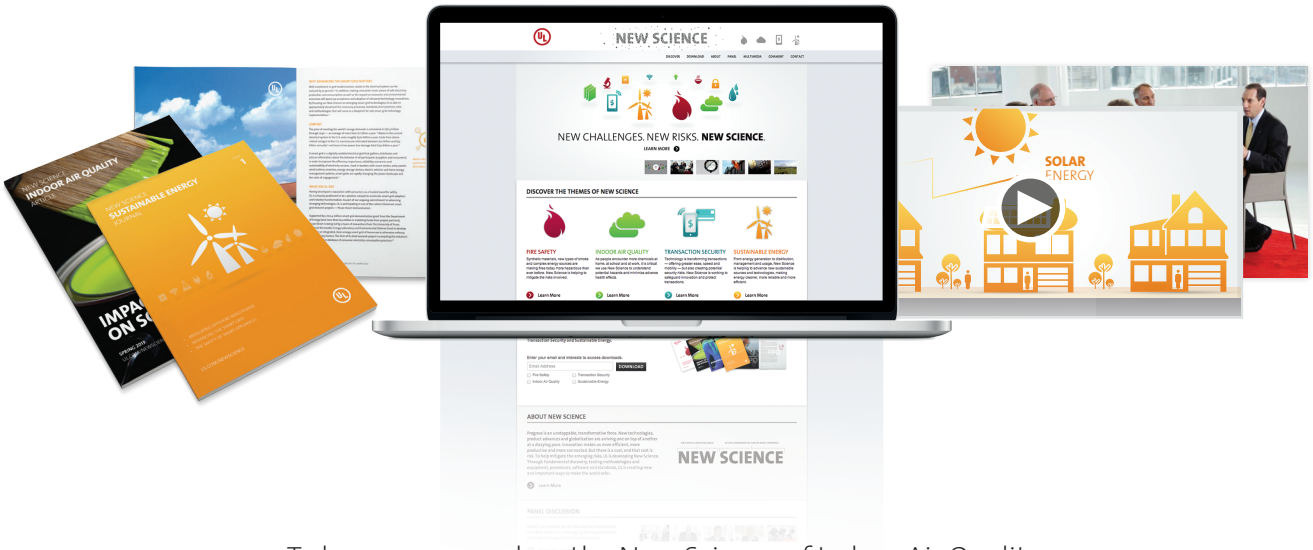

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