PVEL
MAKE DATA MATTER.

PV Module Product Qualification Program (PQP): LeTID Sensitivity Test

The recently identified phenomenon of light and elevated temperature-induced degradation (LeTID) reduces PV module performance. Degradation rates as high as 7% have been observed in the field to date. PVEL's new LeTID sensitivity test helps buyers avoid modules that are vulnerable to this unique degradation mode. The test is included with PVEL's updated PV Module Product Qualification Program.

Defining LeTID

LeTID is a form of PV module degradation with several unique characteristics:

- LeTID affects modules with advanced multicrystalline and monocrystalline cell architectures (i.e. PERC, PERT).[1]
- Degradation rates as high as 10% have been observed in lab studies.[1]
- It occurs when cells reach high temperatures (over 50°C) while operating.
- Degradation eventually stabilizes and efficiency can improve over time, but regeneration rates vary and are not yet well understood by the scientific community.

PERC technology in the field at PVEL's outdoor test bed

Why LeTID Testing Matters

1. PERC Technology is Becoming Dominant

PERC cells now capture over 40% of the global market, and market share of this technology is expected to grow.[2] Investors and asset-owners need test results to avoid procuring LeTID-sensitive products that could cause unanticipated high power loss in the future.

2. Data is Critical for Accurate Energy Yield Modeling

Without well-validated third-party data that confirms modules are not susceptible to LeTID, independent engineers may use conservative estimates for their energy yield models that can ultimately result in undervalued projects.

LeTID in the Field

A broad range of LeTID degradation has been reported in independent studies. Publicly available field data is limited, but the research available today indicates that power loss increases in hotter climates. One study[3] found:

- 7% performance loss due to LeTID over three years for modules installed in Cyprus.
- 2.5% performance loss due to LeTID for equivalent modules installed in Germany.

LID vs. LeTID

Like boron-oxygen related light-induced degradation (LID), LeTID is caused by exposure to light. However, these degradation modes differ in important ways.

	LID	LeTID
Industry experience	Fairly significant (decades of research)	Growing (~4 years of research)
Timeframe to onset	Hours/days/weeks	Weeks/months/years
Cell types affected	p-type x-Si	Mainly x-Si PERC/PERT
Temperature required to induce	Wide range of cell temperatures	Higher cell temperatures
Maximum power loss	Typically < 3%	As much as 7% in the field

Gottschalg, Ralph; Pander, Matthias; Bauer, Jan; Turek, Marko; Luka, Tabea; Hagendorf, Christian; Ebert, Matthias. (2018). "Benchmarking light and elevated temperature induced degradation (LeTID)." https://www.researchgate.net/publication/329963303_BENCHMARKING_LIGHT_AND_ELEVATED_TEMPERATURE_INDUCED_DEGRADATION_LETID

[2] ITRPV. (2019). "International Technology Roadmap for Photovoltaic, 10th Edition." https://itrpv.vdma.org/download

[3] Kersten, Friederike; Fertig, Fabian; Petter, Kai; Klöter, Bernhard; Herzog, Evelyn; Strobel, Matthias ; Heitmann, Johannes; Mueller, Joerg. (2017). "System performance loss due to LeTID. Energy Procedia." https://www.researchgate.net/publication/319982594_System_performance_loss_due_to_LeTID

PVEL's LeTID Sensitivity Test

Factory Witness

Light Soaking

Characterization

LeTID 162 hrs (75°C, Isc-Imp)

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Characterization

Step 1: Factory Witness and Intake

As with every sequence in PVEL's Product Qualification Program, the LeTID test begins with a factory witness of the modules that will be sent to PVEL for testing. The factory witness records all key steps in production – including in-depth cell information – and all components of the module's bill of materials.

Step 2: Light Soaking

Modules undergo outdoor light soaking until stabilization of LID as defined by IEC 61215:2016.

Step 3: LeTID Testing for 162 Hours

Modules are placed in an environmental chamber at 75°C while connected to a power supply and injected with a low current. The use of a low current is equivalent to the module operating in full sun at maximum power point.

Step 4: Characterization

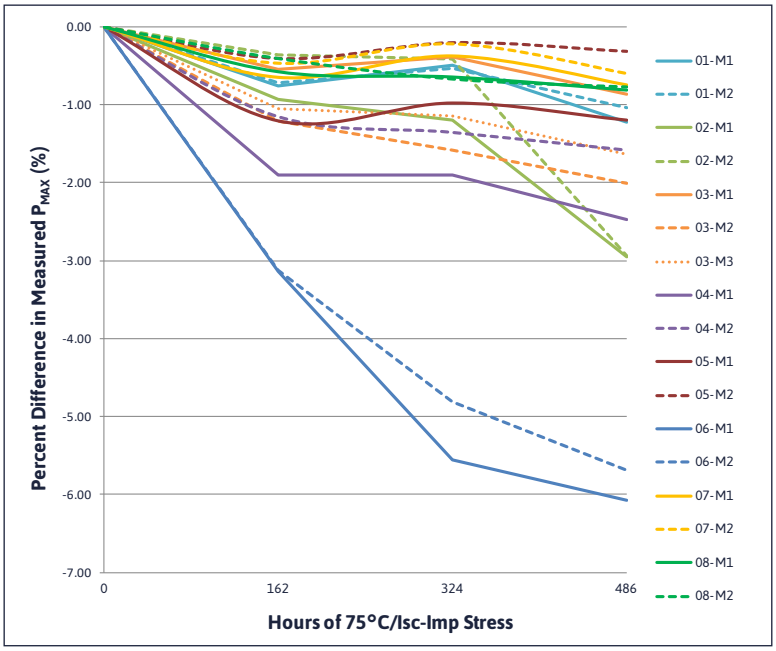
- IV flash testing to measure power loss
- Visual inspection and wet leakage testing to ensure that power loss can be attributed to LeTID
- EL testing to show the visual signature of LeTID

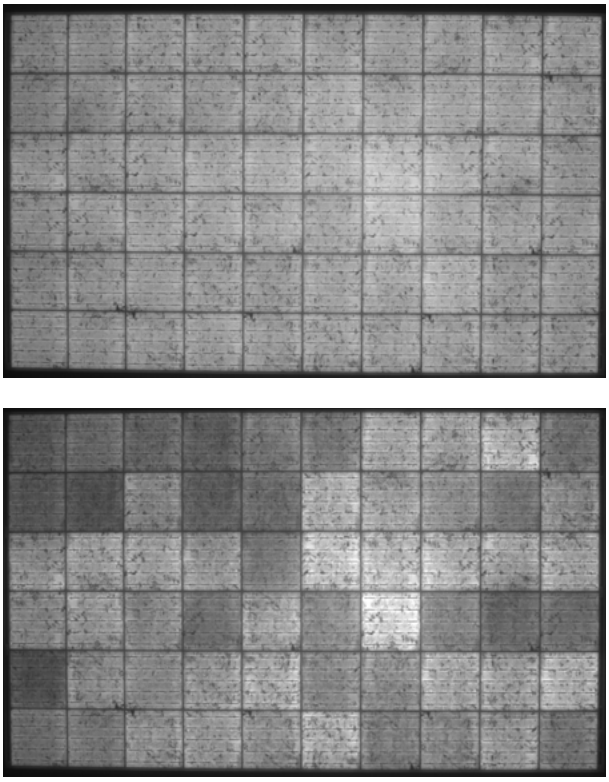
Step 5: Repeat and Measure

The 162-hour LeTID sequence is then repeated two more times for a total of 486 hours, which is equivalent to about 1.6 years in the field in Cyprus. The test conditions are designed to slowly approach maximum degradation, so as not to trigger additional degradation mechanisms. Characterizations are conducted every 162 hours so that power loss is measured before regeneration occurs.

PVEL's LeTID Test Results

PVEL conducted extensive testing to develop its LeTID sensitivity test. Selected results (below) show that while many of the manufacturers/module types tested have relatively low degradation, failing to control LeTID can lead to much higher degradation.





The images above show IV flash images of an LeTID-sensitive module before and after testing. The "checkerboard" pattern shown in the bottom image is the visual signature of LeTID.

Next Steps

The industry needs more data that explains the complex phenomenon of LeTID. In the meantime, we advise solar project stakeholders to confirm that the modules they purchase and projects they finance are not susceptible to unexpected performance losses caused by LeTID.

PVEL's LeTID test is carefully designed to provide valuable, independent data that informs procurement strategies and mitigates technology risk. Our test sequence is aligned with the LeTID test in the updated draft of IEC 61215, a certification standard that PVEL is helping to develop. LeTID data will be provided in all reliability reports included in our updated PV Module Product Qualification Program.

For more information about PVEL's LeTID sensitivity test, please contact:

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