

# When Certifications are Just Not Enough—Extended Reliability Testing of PV Modules and Components

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## Accelerated Testing of Raw Materials and Modules can help to Identify Potential Weaknesses, which if Undetected can Reduce the Reliability of the Solar Panels, causing High Degradation Rates and leading to Financial Losses to the System Owner.

### INTRODUCTION

- **Solar PV industry** is rapidly expanding in terms of production capacity and also **upgrading the technology** at the same time.
- Reliability of the new technologies like **Mono PERC, TOPCon, Multi Busbar, Bifacial etc.**, are projected to be higher as per **laboratory tests** but there is not enough field data from real world installations.
- Many new raw material suppliers are coming up backed by the Government incentives to **develop Green Energy Technologies**.
- Existing price pressure on the PV modules means the raw material prices have to be strictly controlled which may lead to compromises in the material quality by the suppliers trying to cut the corners.

### COMPONENT LEVEL TESTS

- **Backsheet**
  - Pressure Cooker Test (121 °C, 100% RH, 48 hours) to **identify quality of the PET layer** and also adhesion between the airside PVDF layer and the middle PET layer.
  - Sequential testing with **Thermal Cycling and UV exposure** for detecting resistance to cracking.
- **Encapsulant**
  - Pressure Cooker Test (121 °C, 100% RH, 48 hours) to identify adhesion of the **encapsulant to glass and also encapsulant to the backsheet**.
  - Potential Induced Degradation (PID) testing at **85°C, 85% RH, 1500 V for 288 hours** (i.e. 3 cycles of 96 hours each, necessary for Hot Humid climates).
  - Combined UV + Damp Heat testing to identify various failure mechanisms like yellowing, delamination, snail track etc.
- **Bypass Diodes**
  - Pressure Cooker Test (121 °C, 100% RH, 48 hours) to identify resistance to high temperature and humidity
  - Bypass Diode **Thermal Test at 75 °C with 1.25 times** of the module short circuit current for extended duration of 98 hours.
- **Solar Cells**
  - LID and LeTID testing
  - Hot Water Corrosion test (at 85 °C for 1 hour).

### CONCLUSIONS

- In-house accelerated tests help to identify sub-standard raw materials which can **impact the long term performance of the modules** in the field.
- Reliability testing for modules meant to be deployed in **Hot climates should have more stringent requirements** as compared to regular modules meant for cooler regions.

### IEC 61215 – WHY NOT ENOUGH?

- **IEC 61215 standard** is the design qualification standard for PV modules [1].
- The test parameters and test time are chosen to ensure that the **test can be completed in a reasonable time and can detect serious design / material flaws** that can lead to module failure in the infancy (within approx. 5 years)

### FIELD DEGRADATION RATES

- Dirk Jordan et al. have compiled the degradation rates of PV systems reported in literature and **have found that more than 30% of PV systems** (having crystalline silicon modules) **have degradation rate > 1%/yr** [2].
- All India Survey of PV Module Degradation done in 2018 puts the **average degradation rate of cSi PV modules installed in India at 1.47%/yr** [3].

### CAUSES OF HIGHER DEGRADATION

- Hot climates have higher degradation rates than the cooler climates (1.57 %/yr versus 0.52 %/yr) [3].
- Potential Induced Degradation (PID) has been found to be the root cause behind higher degradation at many of the surveyed sites (which had “PID-resistant” modules). Soiling on panels has been found to assist the PID process in humid weather, particularly near sea shore [4].
- **Micro-cracks in solar cells have been found in many of the installations in India** which is leading to Hot spots and loss in power output of the modules [5]. **Transportation and installation issues are mostly considered as the culprit for such cracks in solar cells.**

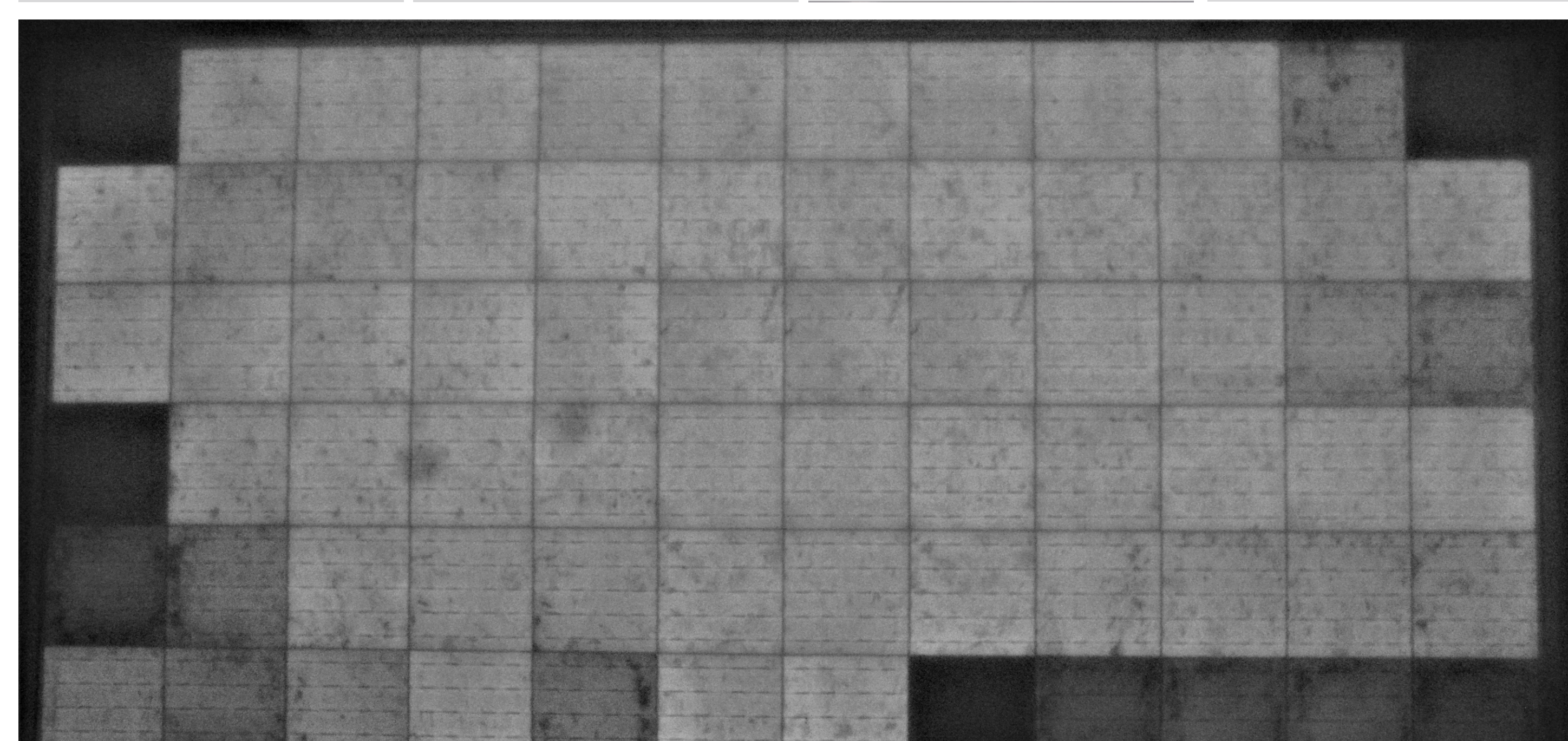
### MODULE RELIABILITY TESTS

- Various test laboratories have developed PV module reliability **test protocols which essentially extend the tests in the IEC standard**, but also some **new tests are added based on industry experience**.
- PVEL PV Module Reliability Score Card [6]
  - Thermal Cycling (TC200 x 3)
  - Damp Heat (DH1000 x 2)
  - Backsheet Durability Sequence
  - Mechanical Stress Sequence
  - PID (2 cycles)
  - LeTID test
  - IAM profile
  - Outdoor exposure (12 months)
- Thresher Test [7]
  - Thermal Cycling (TC200 x 3)
  - TC50 + HF30
  - DH2000

### REFERENCES

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### MODULE RELIABILITY TESTS AT RAYZON SOLAR



EL Image of a PID Affected Module