

# PV Module and System Level Standards for De-Risking PV Investments

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**29<sup>th</sup> ISA SunMeet, November 18, 2020**



# Background of NCPRE, IIT Bombay

- IIT Bombay QS 2020: #1: India & #172 Global. EE, IIT Bombay: #49 Global.
- National Centre for Photovoltaic Research and Education (NCPRE) was set up in October 2010 by MNRE as part of NSM at IIT Bombay.
- Phase-I 5 year Project (47.5 Cr), now in Phase-II 5 year Project (2016-2021, 62.5 Cr)
- 29 Faculty Members from 9 different departments, ~150 students + staff.
- Thrust Areas: Thin Film (Perovskite Solar Cells), Advanced industrial c-Si Solar Cells, Energy Storage, Power Electronics, PV Reliability, Education & Training, Industry Interaction.
- Widely recognized as one of the world leading research centers in Solar PV by international PV community.

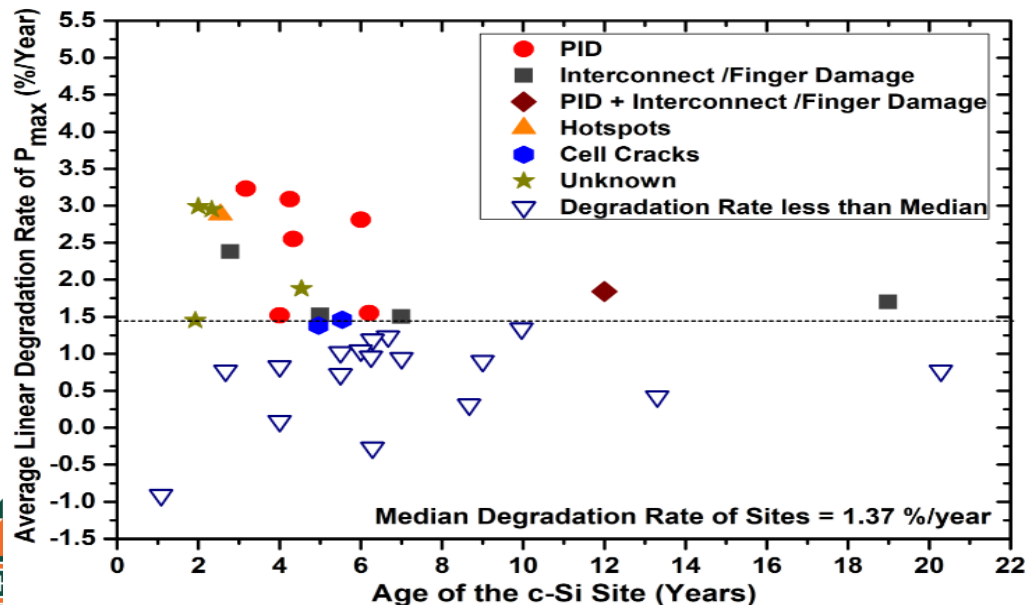
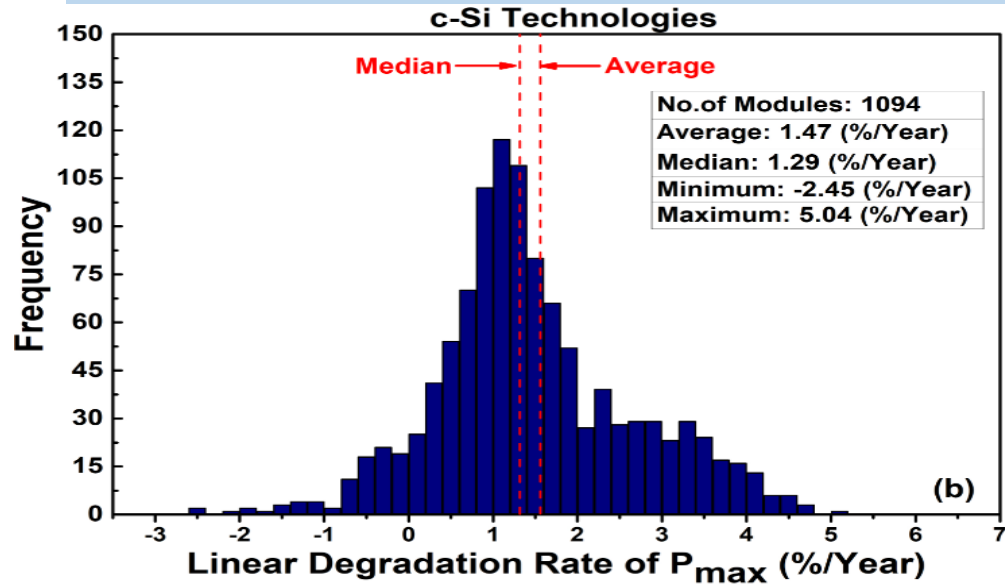
# NCPRE's PV Quality and Reliability Activities

- All India Surveys of PV Module Reliability: 2013,2014,2016,2018 (with NISE). Largest field study of PV module degradation in hot climates.
- Startup Spinoff: SolarMarQ: PV Test Instruments (7 EL Systems sold globally).
- IEEE PVSC 2018, 2019, 2020 : 11 Oral Presentations, Several Posters
- PV Reliability Workshop (NREL) 2018, 2019, 2020: 3 Invited Talks
- Membership of IEC TC82/WG2, BIS ETD28,
- IEC TS 63126:2020 ED1: Durability of modules in Hot Climates.
- Invited to be part of IEA PVPS Task Group 13 Working on O&M Guidelines for Various Climates and Soiling

## International Projects:

- Indo – US: Waterless cleaning of PV modules with EDS screens
- Indo – UK: Reliability of Perovskite Modules
- Indo – Norwegian: LID in New Technology Wafers
- Indo – UK: Joint workshop on soiling

# How to Achieve Low Module Degradation Rates in Indian Conditions?



Mechanism	How to prevent / correct?
PID	PID resistant cells, high resistivity encapsulants, negative grounding, PID recovery solutions
Cell cracks	Good quality packaging, transportation, handling and installation, Crack-tolerant module designs through DML.
Interconnect damage	Choose module from a reputed manufacturer with automated soldering stations
Over-rating	On-site I-V measurements before installation

- Good quality modules show  $<0.7\%/yr$  degradation rates even in hot climates
- Installations in cold zones of Leh – Ladakh almost always show  $<0.7\%/yr$  degradation rates

# Key Certification Standards at PV Module Level

1. PV Power Plant will produce expected energy & revenue specified at design.
2. Modules have a linear degradation rate of  $< 0.7\%$ / year (25 year lifetime)

IEC Standard / TS	Category	What Does it Do?
IEC 61215-1-1:2016	Qualification (Module)	Ensures robustness of module design.
IEC 61730-1:2016	Safety (Module)	Ensures safety of module design.
IEC TS 62804-1:2015	Potential Induced Degradation (Module)	Ensures robustness against potential induced degradation under high voltage bias.
IEC 61701:2020	Salt Mist Corrosion (Module)	Ensures robustness of modules against corrosion in coastal/ humid environments.
IEC 62716:2013	Ammonia Corrosion (Module)	Ensures robustness of modules against corrosion in atmospheres with high Ammonia content (e.g. farmlands).
IEC TS 63126:2020 ED1	Qualification at High Temperature (Module)	Ensures robustness of modules in high temperature end use environments.

- Module Level Standards Increase the Confidence in Robustness of Module Designs\*

# Key Standards at PV System Level

IEC Standard / TS	Category	What does it do?
IEC TS 62738:2018	PV Plant Design	Provides design guidelines for ground mounted PV plants
IEC TS 63049:2017	Installation	Provides guidelines for PV plant installation & operation
IEC 62446-1:2016	Documentation & Commissioning	Provides guidance on documentation, commissioning tests and inspection
IEC 62446-2:2020	Maintenance	Provides guidelines on preventive and corrective maintenance of PV systems
IEC 61724-1:2017	Performance Monitoring	Provides guidelines for performance monitoring equipment, methods and metrics.
IEC TS 61724-2:2016	Capacity Evaluation	Provides framework for comparing measured power output to expected power output on sunny days.
IEC TS 61724-3:2016	Energy Yield	Provides framework for comparing measured energy production to expected energy production.

- IECRE – Conformance Assessment Certification for PV Plants

# Reasons for Gaps in Standards

- New BoM / Module Design → New Failure Modes.

Unique issues concerning quality and reliability of PV are seen in India due to a combination of following factors (also applicable to several ISA countries):

- Hot Climate
- High Soiling Rates
- Scarcity of Water
- Paucity of Land
- Harsh Microclimates: Pollutants in Air, Floods, Cyclones, Salty Land..
- Transportation and Road Quality
- Cost Sensitive Market
- Wildlife

**New standards pertinent to Indian conditions are needed.**

# The Need for Standards Specific to Indian Conditions: An Example

- Currently, there's no standard for testing whether the water on-site is suitable for cleaning the PV modules.
- **Option 1: Just use whatever water available on-site (typically from bore wells)**
- **Option 2: Just use whatever closest standard available for qualifying the quality of on-site water for PV module cleaning.**

## Option 1: Effect of Cleaning with Unsuitable Water



## Option 2: BIS Standard: IS 10 500: 2012

- It's a drinking water standard!
- If the on-site water fails, the suggestion is to install RO plant.
- In already water-scarce environment, an RO plant would waste 4 liters of water for every liter it cleans.
- Significant waste of scarce resource and high cost

Image Courtesy: PV Diagnostics

# Target Areas for Research & New Standards

**NCPRE / IIT Bombay is focused on following areas:**

- Hot climate effects on PV reliability (e.g. IEC TS 63126)
- Reliability Evaluation of Anti-Soiling Coatings
- Cleaning Water Quality, Efficacy of Robotic Cleaning
- Simulating the Effect of Transportation on Typical Roads
- Accelerated test for predicting worst-case power loss from cell cracks
- IP rating for PV modules (to identify submersible PV modules)
- Thermal cycling, high temperature reverse bias operation tests for bypass diodes.
- Data Management at PV Power Plants.

# Acknowledgement: PV Reliability Group at NCPRE

(March 2020)

## **Faculty:**

B. M. Arora, Parag Bhargava, Anil Kottantharayil, S. V. Kulkarni, Sudhanshu Mallick, K. L. Narsimhan, Narendra Shiradkar, Aparna Singh, Juzer Vasi  
(Visiting: Rajiv Arya, Larry Kazmerski, Ardeshir Contractor)

**Senior Scientific Staff:** Hemant Kumar Singh, Sanchit Khatavkar, Bhuwanesh Kumar Sharma

## **Staff and Students:**

Sonali, Yogesh, Bhavya, Umang, Baloji, Karan, Ruchita, Kedar, Ajeesh, Rambabu, Ritesh I., Devan, Makrand, Ali, Subhasree, Amey, Ritesh, Stanzin, Rohan, Albin