Best practice guidelines for high quality utility scale project development and module manufacturing

Quality Roundtable – Renewable Energy India Expo 2019

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Agenda

Part I

12:00 **Welcome and introductions**

12:05 **PANEL DISCUSSION**
Utility scale project development guidelines, and key considerations for ensuring quality and durability, NSEFI Quality Taskforce stakeholder discussion

12:35 **Learning from 2GW field data analysis: specifying the right PV materials to achieve maximum solar returns**

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Agenda

Part II

12:45

PANEL DISCUSSION

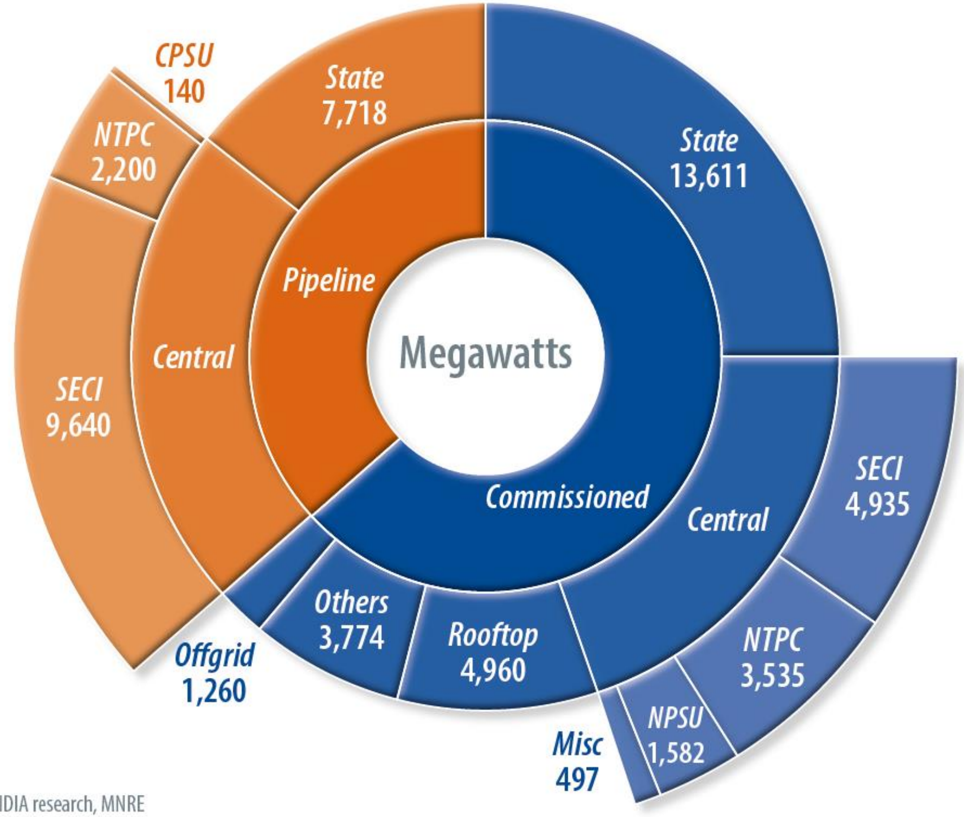
Made in India modules: setting up manufacturing locally. Practical guidance to ensure quality standards and supply international markets, and addressing opportunities and challenges under current policy frameworks, tariff structures and subsidies

13:25

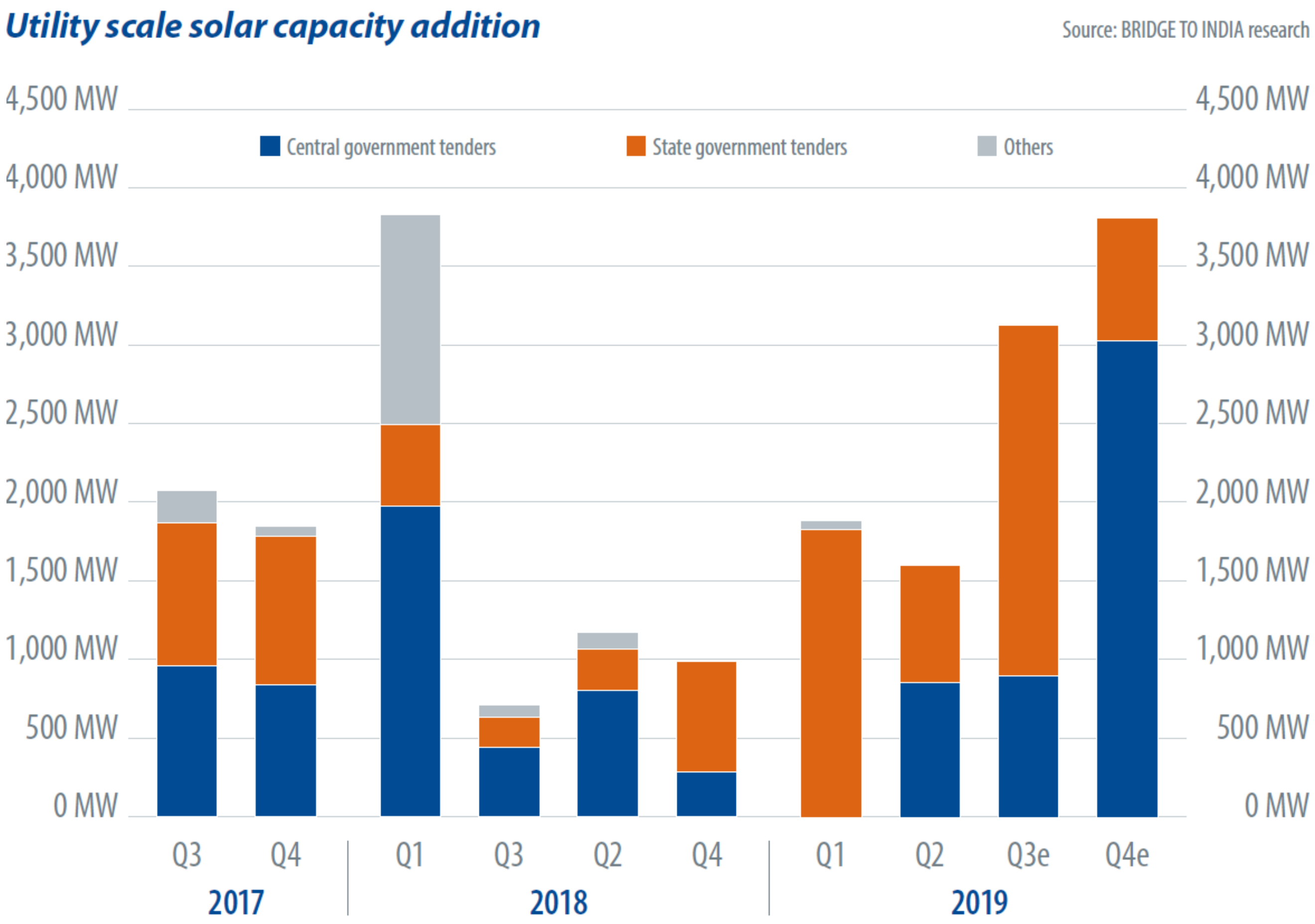
Closing remarks and invitation to the Networking Session

Networking

Total installed and pipeline capacity at the end of June 2019



Source: BRIDGE TO INDIA research, MNRE


Utility scale solar capacity addition
Source: BRIDGE TO INDIA research
4,500 MW
4,000 MW
3,500 MW
3,000 MW
2,500 MW
2,000 MW
1,500 MW
1,000 MW
500 MW
0 MW
Central government tenders
State government tenders
Others
Q3
Q4
Q1
Q3
Q2
Q4
Q1
Q2
Q3e
Q4e
2017
2018
2019

Subrahmanyam Pulipaka

CEO

NATIONAL SOLAR ENERGY FEDERATION OF INDIA
NSEFI
MAKING SOLAR ENERGY AFFORDABLE


Operation & Maintenance
Best Practices
NATIONAL SOLAR ENERGY FEDERATION OF INDIA
NSEFI
MAKING SOLAR ENERGY AFFORDABLE
SolarPower Europe

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Panel discussion

Utility scale project development guidelines, and key considerations for ensuring quality and durability, NSEFI Quality Taskforce stakeholder discussion

Monika Rathi

Head of Business Development, Mahindra

Jitendra Morankar

VP of Global Design Applications

NEXTracker
A Flex Company

Jan Mastny

Head of Global Sales, Solar & Wind

LEONI

Shantanu Sirsath

Technical Head India

Growatt
powering tomorrow

Olivier Haldi

Global Business Development
Alternative Energies

STÄUBLI

Quality case I

Walmart vs. Tesla

> “*On information and belief, Tesla’s predecessor-in-interest-SolarCity-had adopted an ill-considered business model that required it to install solar panel systems haphazardly and as quickly as possible in order to turn a profit, and the contractors and subcontractors who performed the original installation work had not been properly hired, trained, and supervised.*

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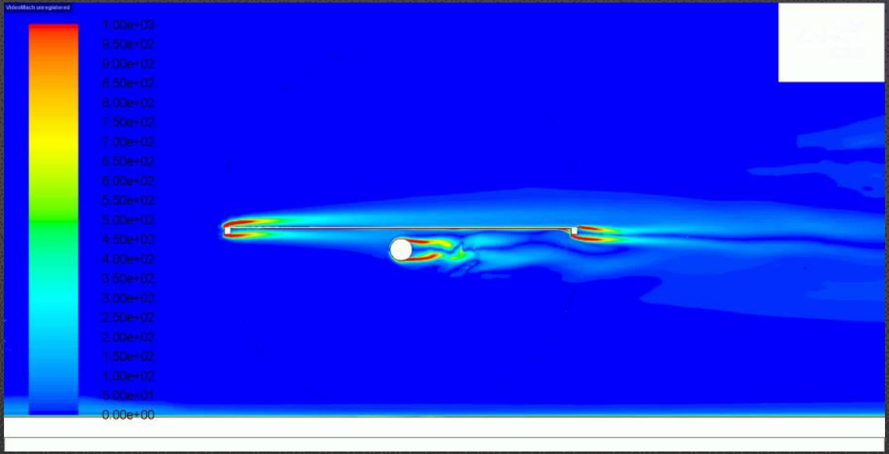
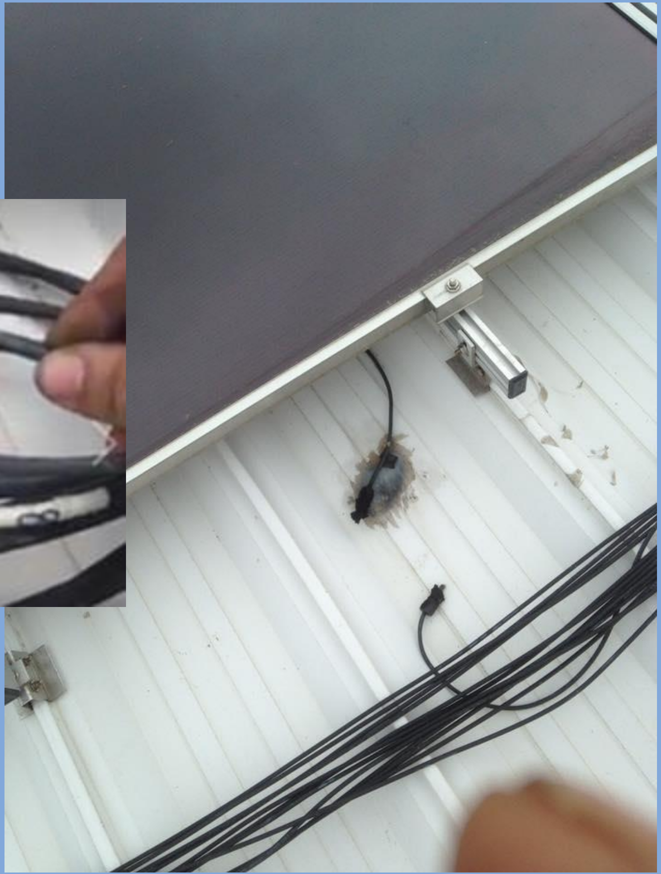
Dynamic Analysis

- Scaled PV Trackers are placed in a wind tunnel to observe dynamic effects
- Aeroelastic Instability was observed where tracker did not stay in 0 degree position
- Vortex Shedding of wind leads to Torsional Galloping where wind loads will cause an unbalanced system, leading to the tracker rotating out of 0 degrees
- Sustained Torsional Galloping will lead to Vortex Lock-In, where the tracker rotates in an excited back and forth state
- Torsional Galloping or Vortex Lock-In can result in huge damages to a PV System





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Learning from 2GW field data analysis:

Specifying the right PV materials to achieve maximum solar returns

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Oakland Fu

Global Business Development Manager

DUPONT

Learning from 2GW Field Data

Specifying the right PV materials to achieve maximum solar returns

Oakland Fu

DuPont Photovoltaic and Advanced Materials

18 Sept, 2019

DuPont global field reliability program

- Quantitative analysis: components, materials, age, failure mode
- Post-inspection analytical characterization
- Collaborative: field partners, developers, government labs, universities

Improved accelerated tests and informed materials selection

6.5 M
modules

355
Installations

1.8 GW
modules

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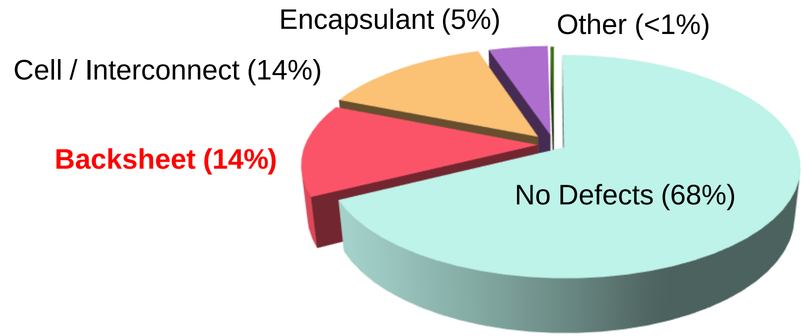
2019 Global field data analysis summary

- Nearly **2 GW** of fields inspected
  - Total module defects observed: 34%
  - Total backsheet defects observed: 14%
- Backsheet defects increased by 47% from 2018 analysis
- Cracking constitutes 66% of all backsheet defects

Module Defect Trends*



Backsheet: outer layer (air side) and inner layer (cell side) cracking, delamination, yellowing

Cell / Interconnect: corrosion, hot spot, snail trails, broken interconnect, cracks, burn marks

Encapsulant: discoloration, browning, delamination

Other: glass defects, loss of AR coating, junction box

* Actual module defects can be higher due to defects not picked up by initial inspection protocol (eg. cell cracking evidenced by subsequent EL or PID test)

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PVDF Field Cracking– Arizona, US
Case 1   3 MW

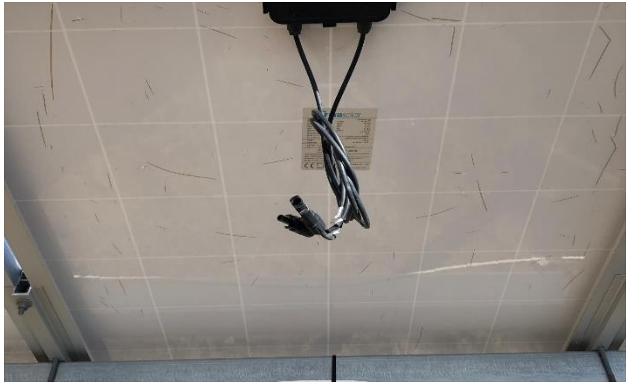
Initial year of operation   2011

- Service Time   7 years
- Backsheet   PVDF
- Climatic conditions   Dry, hot and cold
- Mounting configuration   Ground mounted

Inspection Summary

- PVDF-based backsheets **100% cracked**
- 3 MW of modules had cracked PVDF and were replaced
- Tedlar® PVF backsheets- no defects in the same installation

New replacement modules



widespread cracking of backsheet outer layer

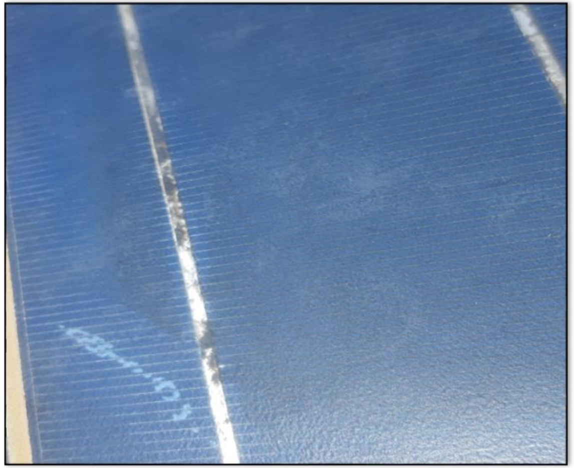
DUPONT™

PVDF Field Cracking- Northwest India
Case 2   480 kW

Initial year of operation	Nov 2011
• Service Time	7.5 years
• Backsheet	PVDF
• Climatic conditions	Hot & Arid
• Mounting configuration	Ground mounted

Inspection Summary

- Outer layer cracking & delamination of 15% of PVDF modules, 480kW affected
- Modules experiencing ground faults and inverter tripping with power loss.
- No issues with modules using Tedlar® PVF-based backsheets



Cracks in PVDF extend across busbars, along cell edges and over multiple cells, ribbon corrosion observed.

PA Field Cracking- Arizona, US
Case 3   12 MW

Initial year of operation: 2011

- Service Time: 7 years
- Backsheet: PA
- Climatic conditions: Dry, hot and cold
- Mounting configuration Ground mounted

Inspection Summary

- 100% PA backsheets cracked along busbar ribbons and/or between cells- 12 MW total
- Cracks facilitate interconnect corrosion and present an electrical safety risk
- Ground faults cause interruptions leading to power loss
- Overheating and burning seen.

Significant large scale cracking

Overheating at cracks

Overheating leading to burning

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PA Field Cracking – Northwest India
Case 4 1.2 MW

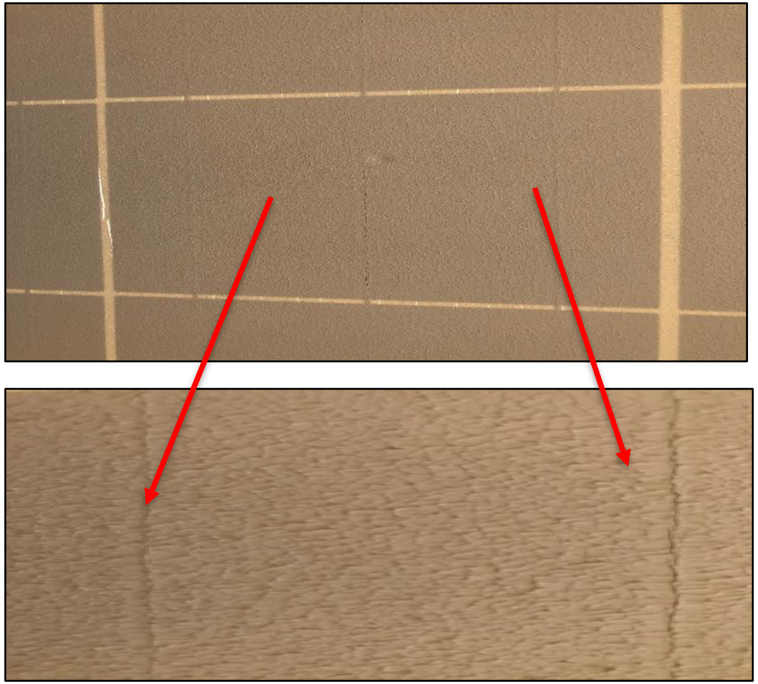
Initial year of operation Nov 2011

- Service Time 7.5 years
- Backsheet Polyamide
- Climatic conditions Hot & Arid
- Mounting configuration Ground mounted

Cracks extend the length of the module across busbars

Inspection Summary

- Cracking of PA backsheets (100% of 1.2MW)
- Ground faults, inverter tripping
- ~4200 modules replaced between 2015 and 2016



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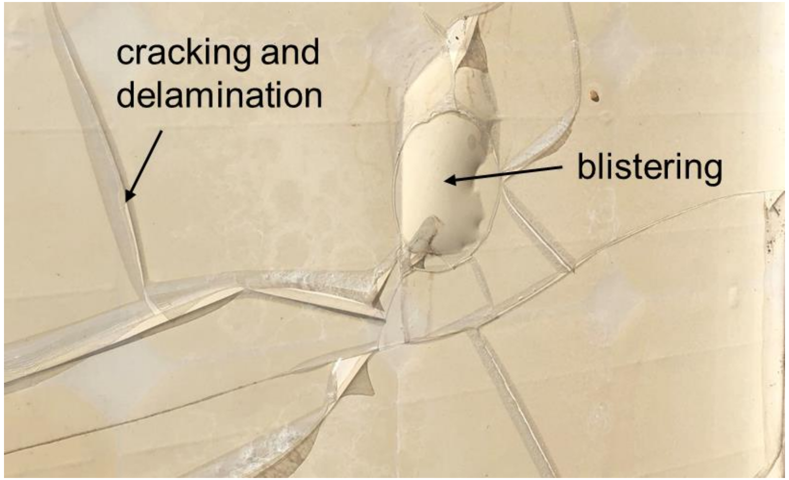
PET Field Cracking- Arizona, US
Case 5   1.8 MW

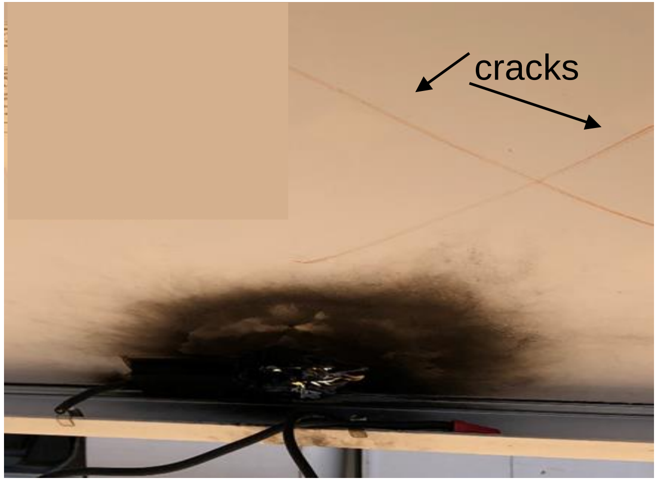
Initial year of operation   2003

- Service Time   16 years
- Backsheet: PET
- Climatic conditions   Seasonal cold/hot and arid
- Mounting configuration   Ground mounted

Inspection Summary

- 100% of PET-based modules exhibited backsheet degradation: yellowing, cracking, delamination, or all
- 10% of modules exhibited burn marks at busbar solder bonds near the junction box, with some instances of glass shatter and severe charring





Crack over busbar leading to overheating

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FEVE Backsheet Inner Layer Cracking and Corrosion, Arizona, US
Case 6   100 kW

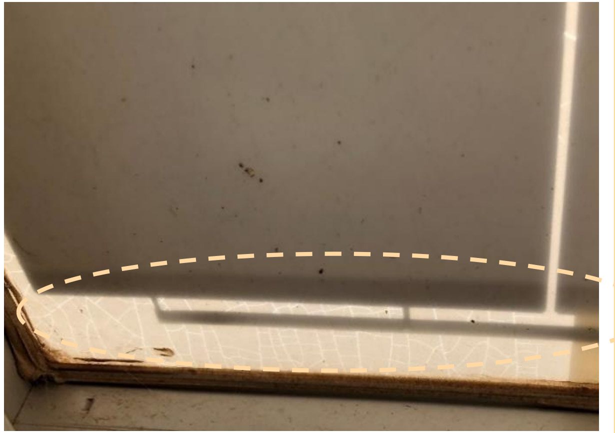
Initial year of operation 2011

- Service Time 8 years
- Backsheet: FEVE
- Climatic conditions Hot and Arid
- Mounting configuration Roof mounted

Inspection Summary

- Inner layer cracks observer in roof-mounted modules
- Roughly 5% of 2MW cracked, 100kW
- Areas could not be accesses, cracking percentage may be higher
- Crack observed leading into areas of corrosion

Roof mounting



Cracked inner layer

Cracking leading to corrosion

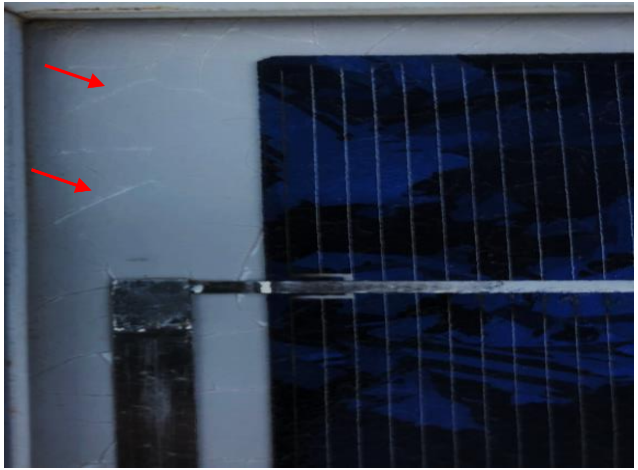
FEVE backsheet Inner Layer Cracking- India
Case 7 14 MW

Initial year of operation **2013**

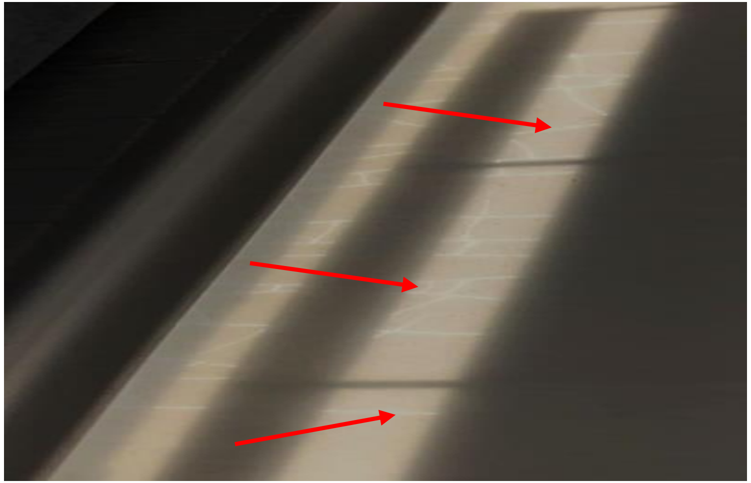
- Service Time 5 years
- Backsheet: FEVE
- Climatic conditions Hot, Dry and Arid
- Mounting configuration Ground mounted

Inspection Summary

- Cracking of FEVE coated backsheet : ~70% of the inspected modules with FEVE backsheet show inner layer cracking
- inner layer cracked all over module in spaces between cells
- Ground faults and inverter tripping occurred during winter mornings and rains



Backsheet inner layer cracking viewed from front side



Backsheet inner layer cracks are visible when viewed from the front (Illuminate back side)

Panel discussion

Made in India modules: setting up manufacturing locally. Practical guidance to ensure quality standards and supply international markets, and addressing opportunities and challenges under current policy frameworks, tariff structures and subsidies

Mohamed Hidayathulla

Senior Manager and Business Development Head India, TÜV Rheinland

Rajaram Pai

Business Leader and Marketing Manager

DUPONT

George Touloupas

Technology and Quality Director

CEA Clean Energy Associates

Narendra Shiradkar

Researcher in Photovoltaic Reliability, PV Reliability Group, NCPRE, IIT Bombay kw to kwh MOVING FROM KILOWATT TO KILOWATT HOURS

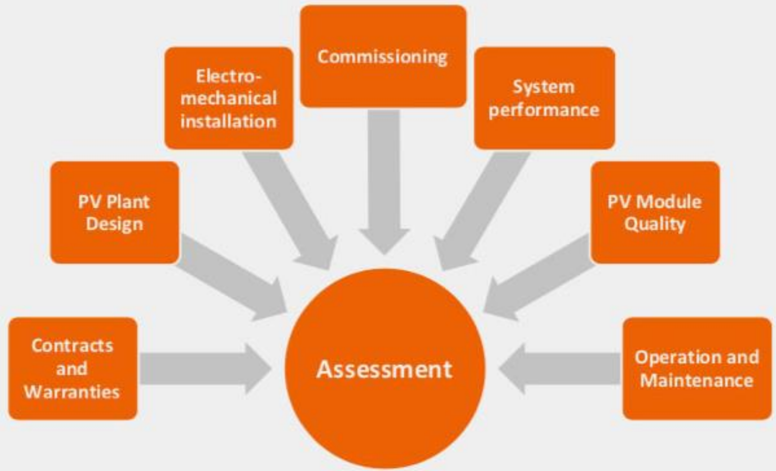
IN COOPERATION WITH:

GOVERNMENT OF INDIA MINISTRY OF NEW AND RENEWABLE ENERGY

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

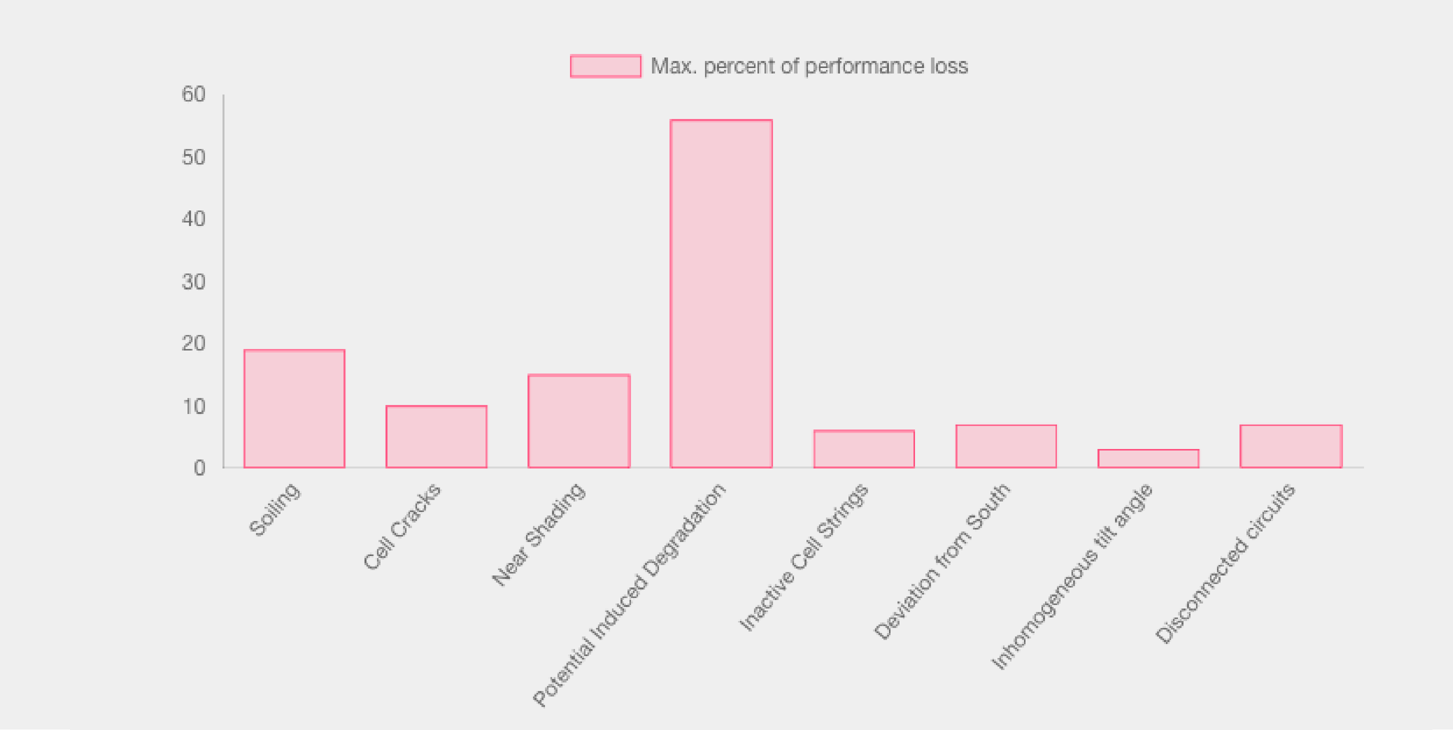
german cooperation

PI Photovoltaik Institut Berlin



MOVING FROM KILOWATT TO KILOWATT HOURS

IN COOPERATION WITH: MINISTRY OF NEW AND RENEWABLE ENERGY, giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, german cooperation, PI Photovoltaik Institut Berlin



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4

Networking session

Best practice guidelines for high quality utility scale project development and module manufacturing

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