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

Quality Roundtable – Renewable Energy India Expo 2019
## Agenda

### Part I

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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<tr>
<td>12:00</td>
<td>Welcome and introductions</td>
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</table>
| 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 |
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
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
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Subrahmanyam Pulipaka
CEO

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Panel discussion
Utility scale project development guidelines, and key considerations for ensuring quality and durability, NSEFI Quality Taskforce stakeholder discussion
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Monika Rathi
Head of Business Development, Mahindra

Jitendra Morankar
VP of Global Design Applications

Jan Mastny
Head of Global Sales, Solar & Wind

Shantanu Sirsath
Technical Head India

Olivier Haldi
Global Business Development Alternative Energies
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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Global Business Development
Alternative Energies
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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VP of Global Design Applications

Jan Mastny
Head of Global Sales, Solar & Wind

Shantanu Sirsath
Technical Head India

Olivier Haldi
Global Business Development
Alternative Energies
Learning from 2GW field data analysis:

Specifying the right PV materials to achieve maximum solar returns
Oakland Fu
Global Business Development Manager
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
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*

- No Defects (68%)
- Backsheet (14%)
- Cell / Interconnect (14%)
- Encapsulant (5%)
- Other (<1%)

- 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 (e.g., cell cracking evidenced by subsequent EL or PID test)
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
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
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

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

Cracks extend the length of the module across busbars
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
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 observed in roof-mounted modules
•  Roughly 5% of 2MW cracked, 100kW
•  Areas could not be accessed, 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

<table>
<thead>
<tr>
<th>Initial year of operation</th>
<th>2013</th>
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<tbody>
<tr>
<td>Service Time</td>
<td>5 years</td>
</tr>
<tr>
<td>Backsheet:</td>
<td>FEVE</td>
</tr>
<tr>
<td>Climatic conditions</td>
<td>Hot, Dry and Arid</td>
</tr>
<tr>
<td>Mounting configuration</td>
<td>Ground mounted</td>
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### 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](image1)

![Backsheet inner layer cracks are visible when viewed from the front (Illuminate back side)](image2)
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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.
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Senior Manager and Business Development Head India, TÜV Rheinland

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Researcher in Photovoltaic Reliability, PV Reliability Group, NCPRE, IIT Bombay
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Networking session
Best practice guidelines for high quality utility scale project development and module manufacturing

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