Trouble in the South: hurricanes, flooding and damp heat

Quality Roundtable – Solar Power Southeast 2019
Agenda

Part I

12:30
Welcome and introductions
Christian Roselund, U.S. editor, pv magazine

12:35
Presentation by Marty Rogers, NEXTracker

12:45
Quality case study #1: Humidity and module backsheets: issues to watch for and how to make sure you are using products that will last.
Christian Roselund, U.S. editor, pv magazine
Agenda

Part II

12:55
QUALITY CASE DISCUSSION
Key takeaways from the case study, lessons learnt and how you can apply these to future projects

13:05
Quality case study #2: Wind damage: What to do now?
Christian Roselund, U.S. editor, pv magazine

13:15
QUALITY CASE DISCUSSION
Key takeaways from the case study, lessons learnt and how you can apply these to future projects
Quality case study #3: Floods: Dealing with damage to systems not covered by warranties
Christian Roselund, U.S. editor, pv magazine and Timo Moeller, Commercial Director of Energy Services, First Solar

QUALITY CASE DISCUSSION Key takeaways from the case study, lessons learned and how you can apply these to future projects
PANEL DISCUSSION: Proactive prevention, mitigation and recovery from worst-case environmental circumstances including hurricanes, floods and damp heat.

• Tara Doyle, Chief Commercial Officer, PV Evolution Labs
• Marty Rogers, VP of Global Asset Management and Support, NEXTracker
• Kent Miller, Senior VP of Sales, Shoals
• Timo Moeller - Director of Commercial Energy Services, First Solar
Marty Rogers
VP of Global Asset Management and Support

NEXTracker
A Flex Company
Corporate Overview

#1 Global Market Leader in Solar Tracking Four Consecutive Years 2015-18

- 20 GW trackers contracted or delivered in six years (established: 2013)
- Wholly-owned subsidiary of investment-grade company: Flex (NASDAQ “FLEX”) $26Bn annual revenue, $14Bn balance sheet
- 350 staff worldwide, 9 global offices
- Product lines: solar trackers, energy storage, TrueCapture, Digital O&M
- Collective 200 years utility-scale expertise on Executive Leadership Team

NEXTracker earns leading position in global solar tracker market, more than the three closest competitors combined

Source: Wood Mackenzie Research & IHS Markit, 2019
60+ NX Southeast Projects:

Louisiana
Arkansas
Tennessee
Alabama
Virginia
North Carolina
South Carolina
Georgia
Florida
ROOT CAUSES OF PV FAILURE

- Weather: #1 source and 50% of PV Insurance Claims (source: GCube)
- Claims have increased over 87% over past 5 years, largely due to greater impact of weather related claims (Source: GCube)
- Climate Change is contributing to rise of extreme weather and damages to solar plants

Source: GCube, 2017
NX Report Card: 2016-18

*Harsher, more catastrophic and frequent seasonal hurricanes*

- 2016 - Hurricane Matthew: 160mph, CAT 5
- 2017 – Hurricane Maria: 155 mph, CAT 5
- 2018 - Hurricane Florence: 150 mph, CAT 5

*The combined impacts of sea level rise and storm surge in the Southeast have the potential to cost up to $60 billion each year in 2050 and up to $99 billion in 2090 under a higher [carbon pollution] scenario.*

  - National Climate Assessment Report, Nov. 2018
NEXTracker: Forging the Standard on Wind Design

- NEXTracker along with CPP Wind Engineers has changed the industry with respect to wind analysis & stow strategies
- 2015-2018: NX sustained hurricanes Matthew, Harvey, Maria, Irma, Florence and others without failures
A Tale of Two Designs: Wind Event Comparison

Wind speed caused event at 46mph

Tracker 2 (Not NEXTracker)

NEXTracker: no damage

Affected area

Directional winds during event
To Stow or Not to Stow

• More attention on LCOE at end of life, rather than simply upfront install costs is needed in the industry. Maximum uptime results in maximum revenue.

• Wind Failures cause major issues in downtime when sites or portions of become non-operational.

<table>
<thead>
<tr>
<th>Location</th>
<th>300-year Design Wind Speed (mph)</th>
<th>Torsional Galloping Wind Potential (winds greater than 25 mph gust; 3 m height, east-west direction)</th>
<th>Average Annual Probability (%) of Winds &gt;20 mph, E-W Direction</th>
<th>Percent Tracker Failure in 25-year Design Life</th>
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<tr>
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<td>Average Events/Year</td>
<td>Average Hours/Year</td>
<td>Stow into Wind, Damping &gt;15%</td>
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<td>Central CA</td>
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<td>115</td>
<td>5</td>
<td>17.3</td>
<td>14.7</td>
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</tbody>
</table>
Best Practices for High Winds

• Instabilities and failures can occur at low to moderate wind speeds (25mph - 60mph)

• Deflected shapes must be calculated to understand the twist of the tracker during wind events

• Dynamic Amplification Factors (DAFs) must be used when calculating loads

• Multiple frequency modes must be analyzed at operational wind speeds and stow wind speeds
Best Practices for Designing for Extreme Weather

*Design key equipment well above grade*

NEXTracker Design
All NX components sealed and positioned well above grade to avoid contact with water and sand

Extreme Weather Events
Actual NEXTracker site enduring harsh flood. Along with hurricanes, floods can be extremely damaging to sites
Design above flood clearance, design for extreme weather

- Submerged equipment can lead to future failures, all sensitive equipment located well above grade
- Smart flood sensors can rotate PV modules to avoid water
Southeast U.S. & Diffuse Light

How to keep production high and reap additional benefits in geographies with high diffuse horizontal irradiation
Value of Connectivity

*On trends, early detection, resolve, feedback loop*

- Upgrade firmware
- Diagnose system health: order spares if required
- Automate commissioning to accelerate project delivery
- Upgrade existing sites to increase energy yield and improve safety
Thank you

Contact:
Marty Rogers
Sr. VP Global Services
mrogers@nextracker.com
Quality Case Study #1

Humidity and module backsheets: issues to watch for and how to make sure you are using products that will last.
Quality case #1: Mysterious ground faults and module failure: humidity and module construction issues

The situation: A C&I developer and asset owner discovered the same problem at many of its sites across the United States: after it rained or humidity levels rose, PV systems reported ground faults.

- O&M technicians initially saw no obvious issues, and assumed nuisance tripping
- A more detailed inspection showed severe busbar corrosion, de-lamination and discoloration and cracking of backsheets, due to moisture ingress
- When these problems were compared to PVEL’s test results for the same module models, they showed similar issues

What was done: Due to the high level of system failure all of the affected modules had to be replaced, and the owner is currently replacing around 100 MW of product. The manufacturer was able to produce a similar sized module, but with a different power rating, resulting in design reconfigurations. The warranty only covered the modules, not the cost to replace them, nor the lost revenue.
Questions

1) At what point as an asset owner or an O&M provider do you require a more detailed inspection of mysterious issues?

2) What are the primary ways that modules fail due to high humidity?

3) What is the best way to ensure that the modules that you buy can withstand humid conditions?

4) Are similar issues experienced with thin film modules? Do these hold up to moisture better due to glass-glass construction?

5) Who should pay for the lost energy and replacement labor, and should asset owners and EPCs insist on warranties that cover these items?
Quality case discussion

Key takeaways from the case study, lessons learnt and how you can apply these to future projects
Quality case study #2:

Wind damage: What to do now?
Quality case #2: Wind damage, obvious and not-so-obvious

The situation: A hi-resolution aerial inspection of a solar project in the wake of a severe wind event revealed severe mechanical damage, including broken modules and modules ripped off of mounting systems and scattered around the site.

Widespread cell-level thermal damage was not identified in the initial scan, but in a subsequent scan two years later subtle cell-level hot-spots were identified in regions which had previously seen wind damage, and these were traced to cracks in cells which had widened over time.

This cell-level damage was induced during the wind event but evolved over time to produce both a thermal anomaly and energy impact on the project.

What was done: The owner filed an initial insurance claim after the event, however was forced to swallow the financial losses associated with the energy loss.
4 – Quality Case #2
Questions

1) Why were the thermal signals not originally visible, and what caused them to evolve over time?

2) Should those modules which only showed damage on the second scan be insurable?

3) How should insurance companies handle these issues of latent damage expression?

4) How can we differentiate between damage from specific events in the case of latent damage expression?

5) What should the next steps of the site owner be?

6) What steps can be taken to improve the process of site remediation and fault detection?
Quality case discussion

Key takeaways from the case study, lessons learnt and how you can apply these to future projects
Quality case study #3

Floods: Dealing with damage to systems not covered by warranties
Quality case: Flood damage not covered by warranties

The situation: A hurricane inflicted damage on a solar plant which featured single-axis trackers, including damage from both wind and flooding, despite not being located in a flood plain.

The details:

- 30,000 modules as well as the tracking system suffered wind damage
- More than 2’ of flooding, lasting several weeks
- Corrosion of the tracking system’s mechanical parts including actuators & bearings
- Shorts in tracker motors
- The warranty had expired for the trackers
- The company that made the tracking system was no longer making trackers and did not have replacement parts

Overall damage:

- $500,000 in lost energy production during the six-month repair period
- >$1 million in repair costs spanning parts, labor & tools/equipment
Questions

1) What is the best approach to take when your components are out of warranty, or if the component supplier is no longer in business?

2) Since warranties typically do not cover “acts of God” such as hurricanes or floods, how do asset owners protect themselves in hurricane-prone regions?

3) How could this outcome have been avoided or damages minimized through the design of plants, trackers and other components?

4) How do you design components such as trackers to withstand floods?
Quality case discussion

Key takeaways from the case study, lessons learned and how you can apply these to future projects
Panel discussion

How can inverter manufacturers address after-sales service issues, and how can this be leveraged for subsidy free PV
Tara Doyle  
Chief Commercial Officer  
PV Evolution Labs

Kent Miller  
Senior VP of Sales

Marty Rogers  
VP of Global Asset Management and Support

Timo Moeller  
Director of Commercial Energy Services
Trouble in the South: hurricanes, flooding and damp heat

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