



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

Agenda

Part III



13:25

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

13:35

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

Agenda

Part IV



13:45

pv magazine group

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

Networking

Presentation





Marty Rogers

VP of Global Asset Management and Support



Asset Management & Engineering Design in the Age of Climate Change

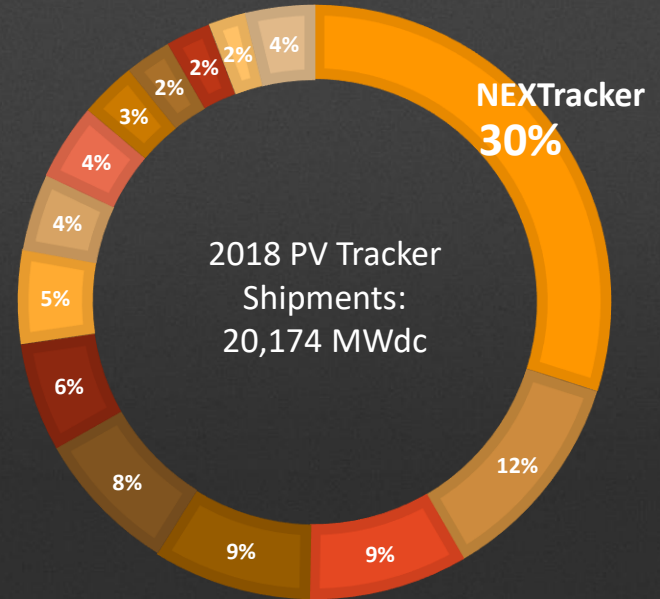
Presented at: PV Magazine Quality Roundtable @Solar Power Southeast

May 30, 2019

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

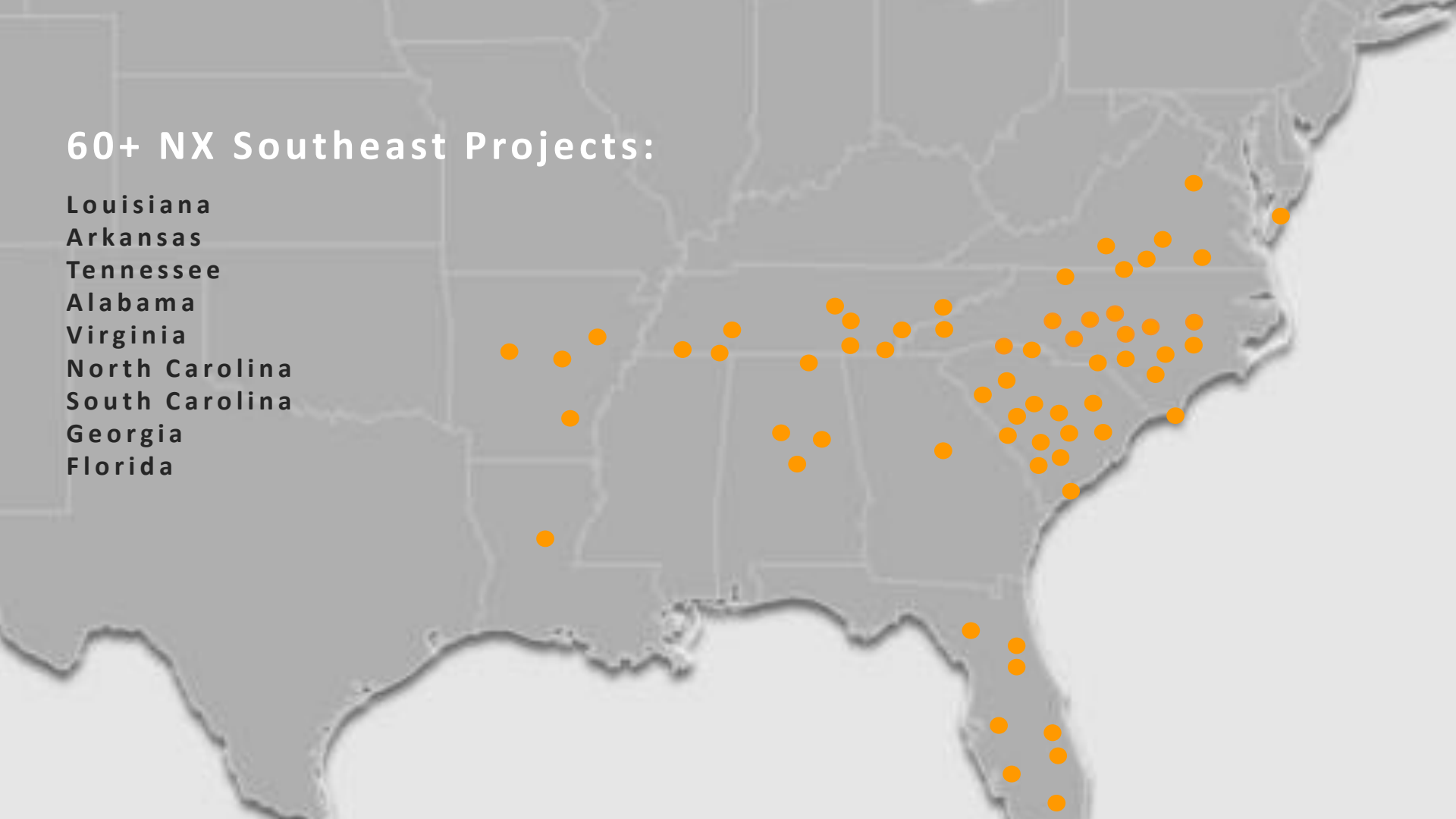


NEXTracker earns leading position in global solar tracker market, more than the three closest competitors combined

Source: Wood Mackenzie Research & IHS Markit, 2019

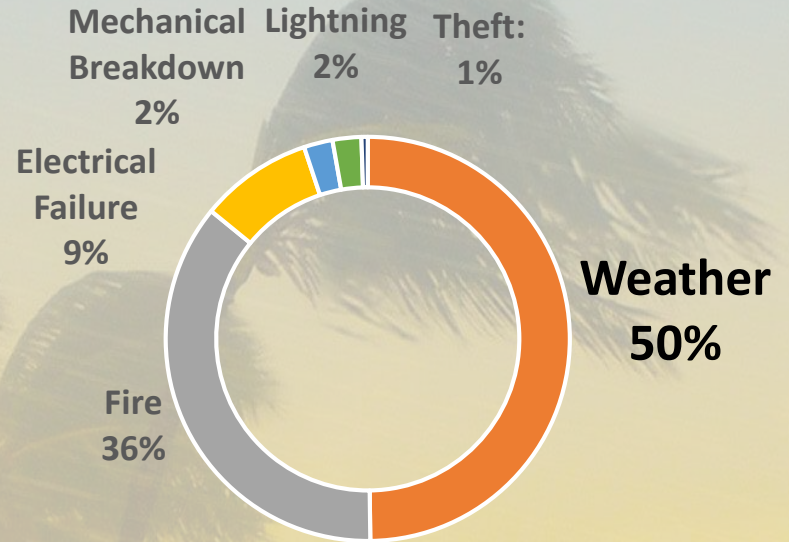
60+ NX Southeast Projects:

- Louisiana
- Arkansas
- Tennessee
- Alabama
- Virginia
- North Carolina
- South Carolina
- Georgia
- Florida



1 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

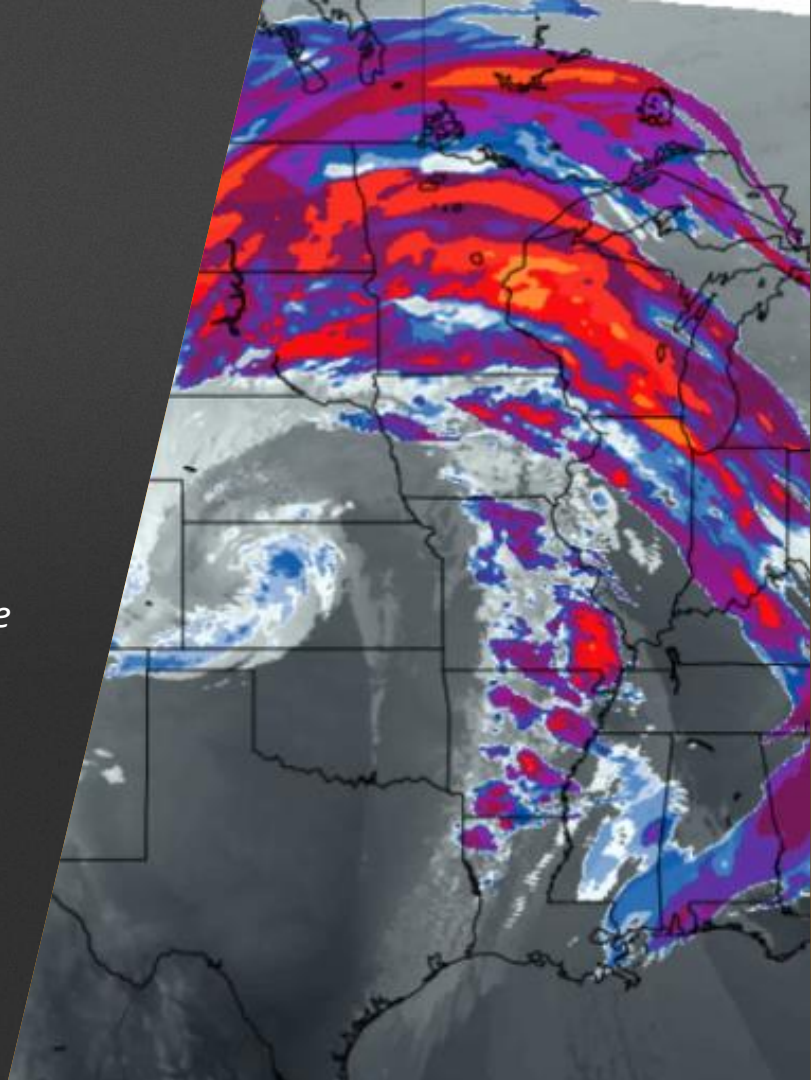
NX Report Card: 2016-18

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

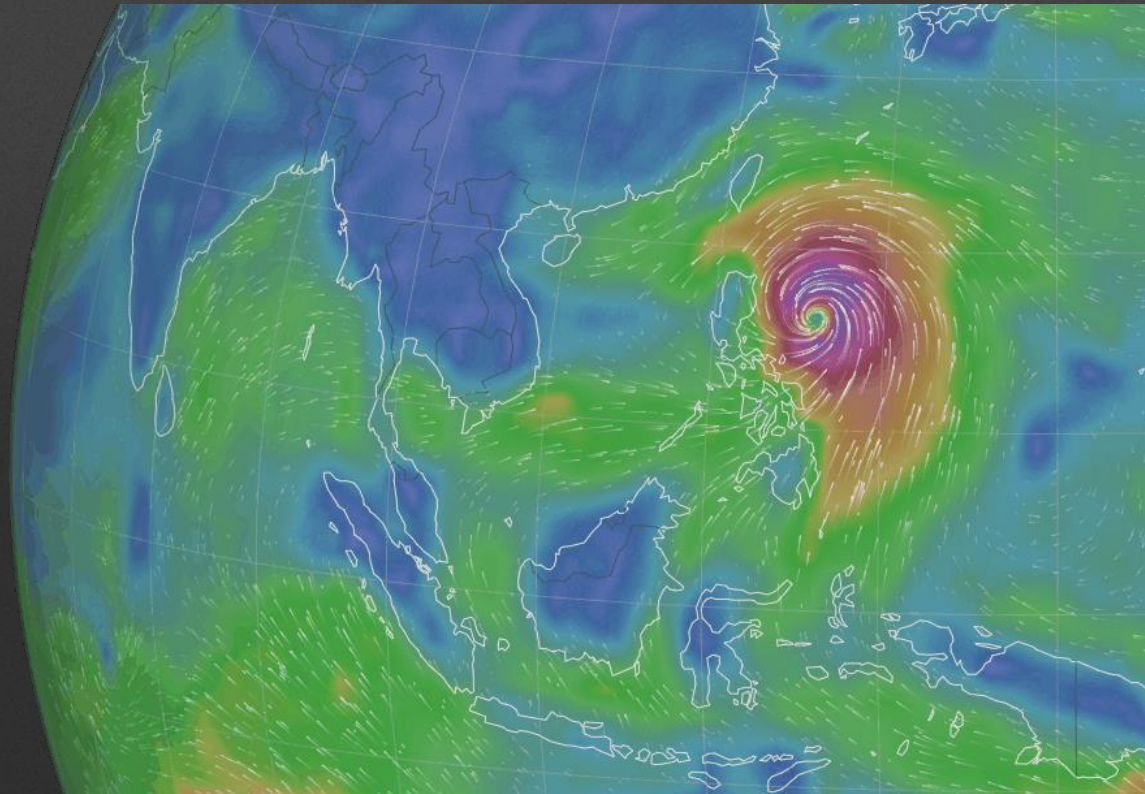
*The combined impacts of sea level rise and storm surge in the Southeast have the potential to cost up to **\$60 billion each year in 2050** and up to **\$99 billion in 2090** under a higher [carbon pollution] scenario.*

- 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)

Affected area

NEXTracker: no damage

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.



Location	300-year Design Wind Speed (mph)	Torsional Galloping Wind Potential (winds greater than 25 mph gust; 3 m height, east-west direction)		Average Annual Probability (%) of Winds >20 mph, E-W Direction	Percent Tracker Failure in 25-year Design Life	
		Average Events/Year	Average Hours/Year		Stow into Wind, Damping >15%	Stow Flat with Only Structural Damping
Central CA	120	41	188.8	71.1	1.7	7.4
Utah	105	14	23.4	6.8	2.7	14.6
Saudi Arabia	115	5	17.3	14.7	0.1	1.0

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



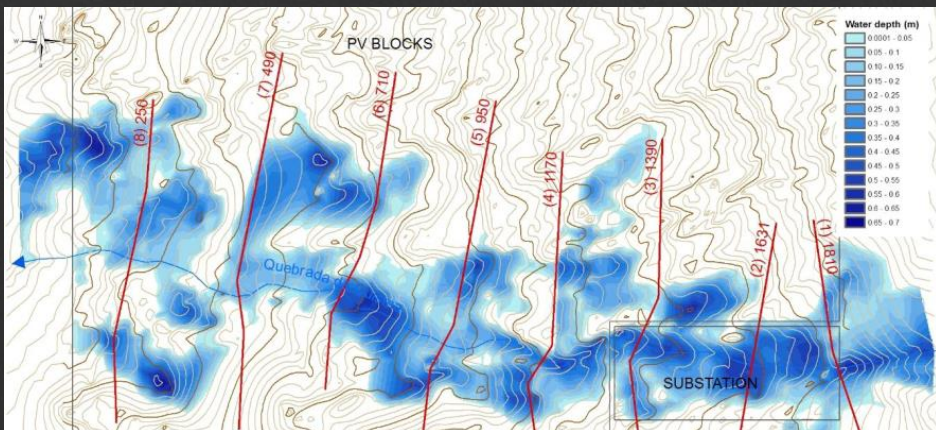
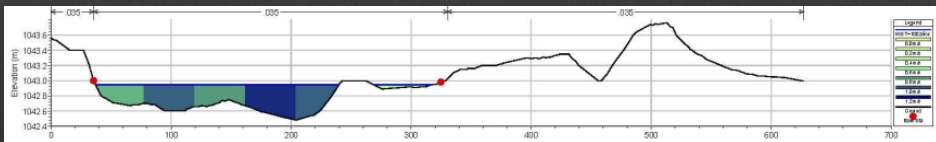
Extreme Weather Events

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



North Carolina site using NEXTracker's NX Horizon after Hurricane Matthew, 2016



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

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NEXTracker[™]
A Flex Company





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





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Quality case study #2:

Wind damage: What to do now?

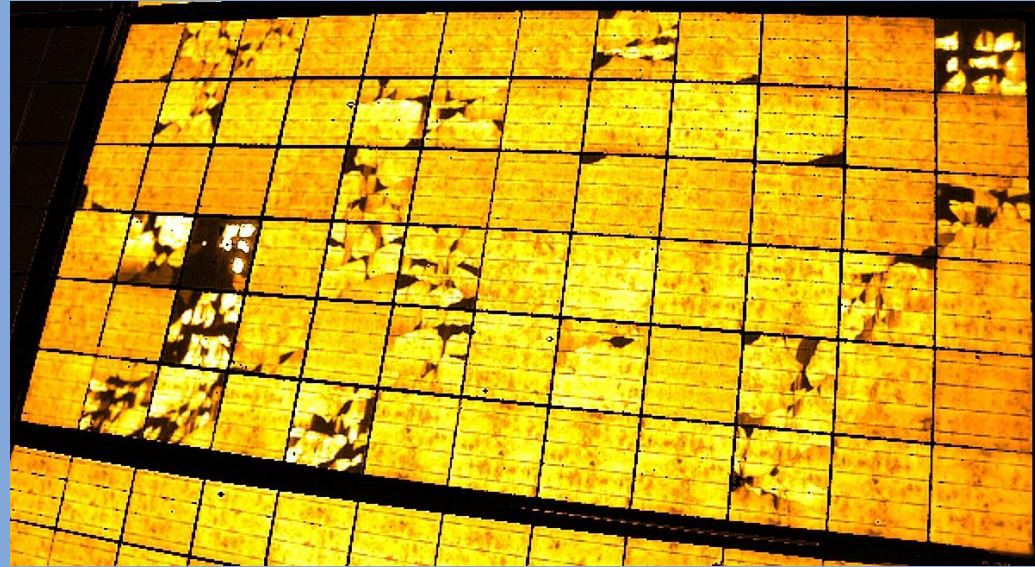
Quality case #2: Wind damage, obvious and not-so-obvious

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.



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



A large white number 6 is overlaid on a circular image. The image shows a solar farm with rows of solar panels, many of which are partially submerged in water, indicating flooding. The sky is overcast and grey.

6

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





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