DuPont Photovoltaic Solutions

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DuPont 2018 Field Analysis

PV Reliability

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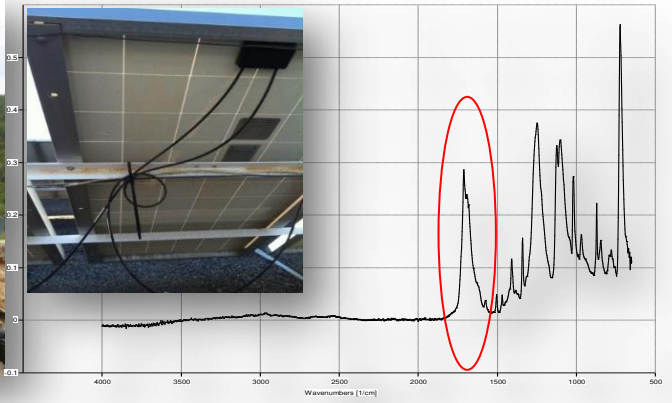
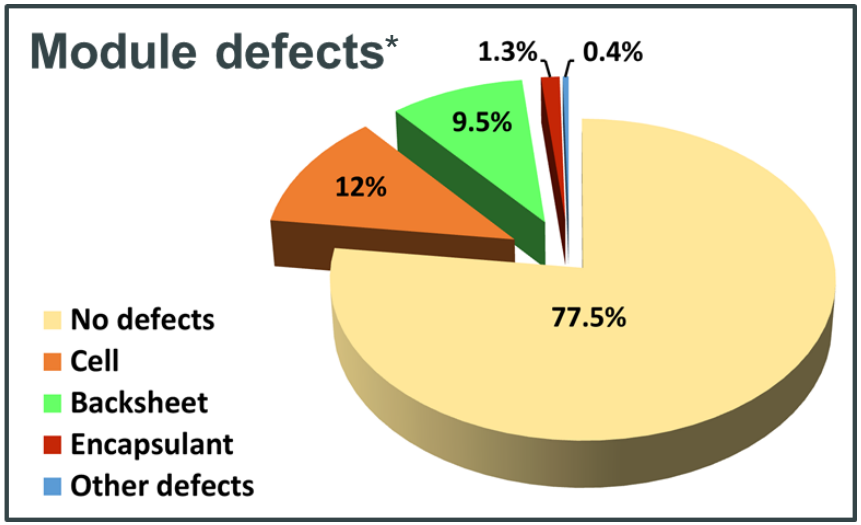


Field Program run since 2011 to inspect, assess, gather data and understand the performance and material degradation of fielded PV modules of different ages, having a variety of modules and Bill Of Materials, from different geographies and climates over North America, Europe, Asia Pacific and Middle East

- One of the most comprehensive surveys of module and component degradation
- Multi-step inspection protocol
- Statistical analysis of data by climate, component, material, mounting, age
- Case studies on different materials, module types, mounting, etc.
- Modules selected for extensive post-inspection analytical characterization
- Collaboration with field partners, customers, downstream developers

2018 Global Field Data Analysis Summary

Highlights	2018
North America, Europe, Middle East, Asia/Pacific	
Installations	275
# of panels	4,234,324
# of module makers	92
Average age (years)	3.3
GW	1.047



- Over 1 GW of fields inspected
- Total module defects 22.3%; backsheet defects 9.5%
- Backsheet defects increased by 27%
- Polymer defects: hot > tropical > temperate
- Work highlighted and cited in 2018 DNVGL PV Module Reliability Scorecard

Defect types

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

Backsheet: cracking, delamination, yellowing, inner layer crack

Encapsulant: discoloration, browning, delamination

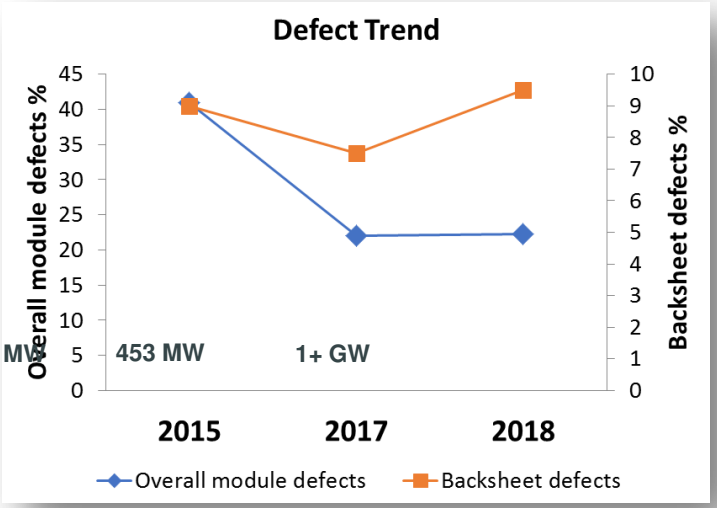
Others: glass defects, loss of AR coating, junction box

- Actual module defects can be higher due to defects not picked up by inspection protocol (eg. cell cracking evidenced by EL, PID)

Highlights

2018 Analysis vs previous 2017 analysis

- Increases # of fields from 197 to 275
- Increase # panels from 1.9 MM to 4.2 MM (453 MW to 1.04 GW)



Defect Rates

- Module defect rates unchanged from 2017
- Backsheet defects increased 27% from 7.5% to 9.5%

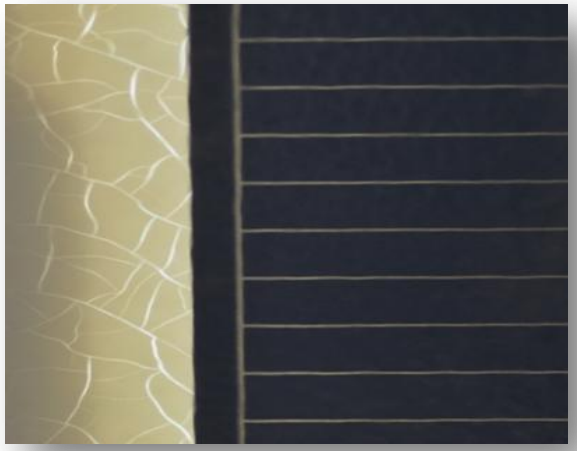
Learnings

- Several significant field failures in 4- 6 years of deployment
- Backsheet defects and failures strongly affected by materials
- UV and Temperature are important factors
- Defects showing up in Glass / Glass modules and systems

Importance of the Data

- One of largest and most comprehensive set global field data and analysis
- Guide accelerated test development
- Used to understand field performance, minimize risk, and module selection

2 Case Studies of Major Backsheet Failures



Inner Layer Cracking of PET Backsheet

- Backsheet inner layer cracked all over modules in spaces between cells and edges
- 30% power loss in 5 years, 6% loss per year
- Similar defects showing up in two continents

Outer Layer Cracking of Polyamide Backsheet

- Global failure estimated at >10 Gw
- 3-4 years service
- Safety issue and power loss due to inverter tripping

Key Learnings

- Unproven materials can increase risk and lead to large failures
- Existing tests were / are not adequate to predict and prevent these failures