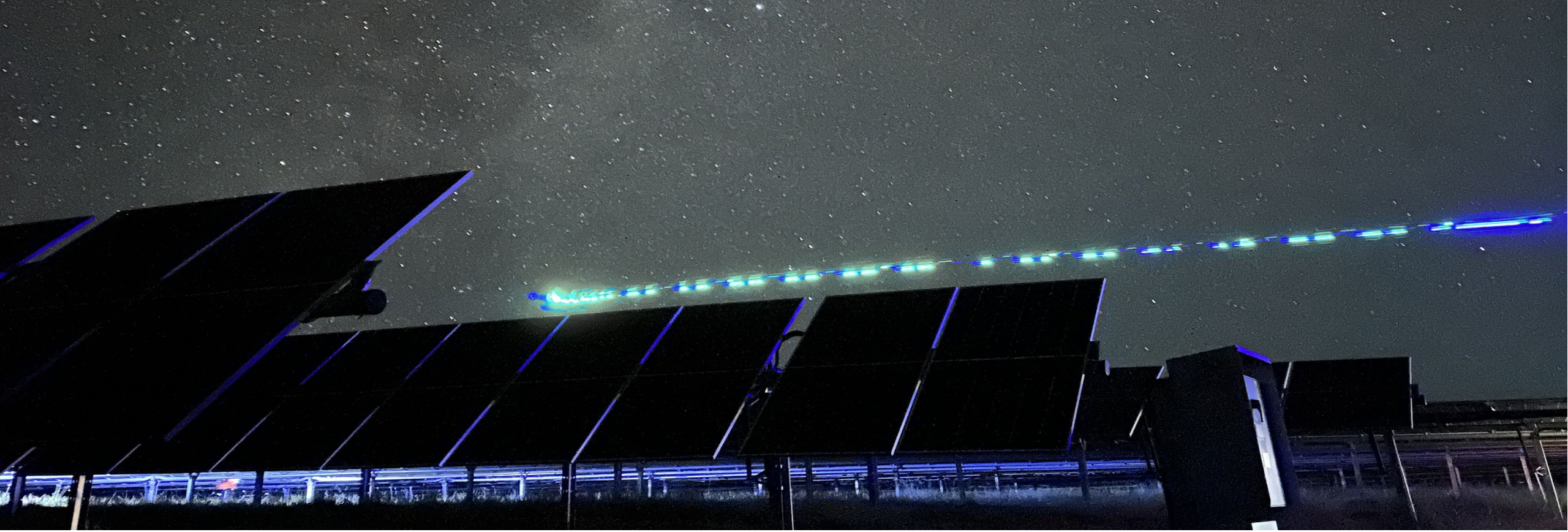

How Drone EL Transforms Warranty Claims: Lessons from TOPCon UVID Cases

Quantified Energy

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pv magazine Week Europe 2025

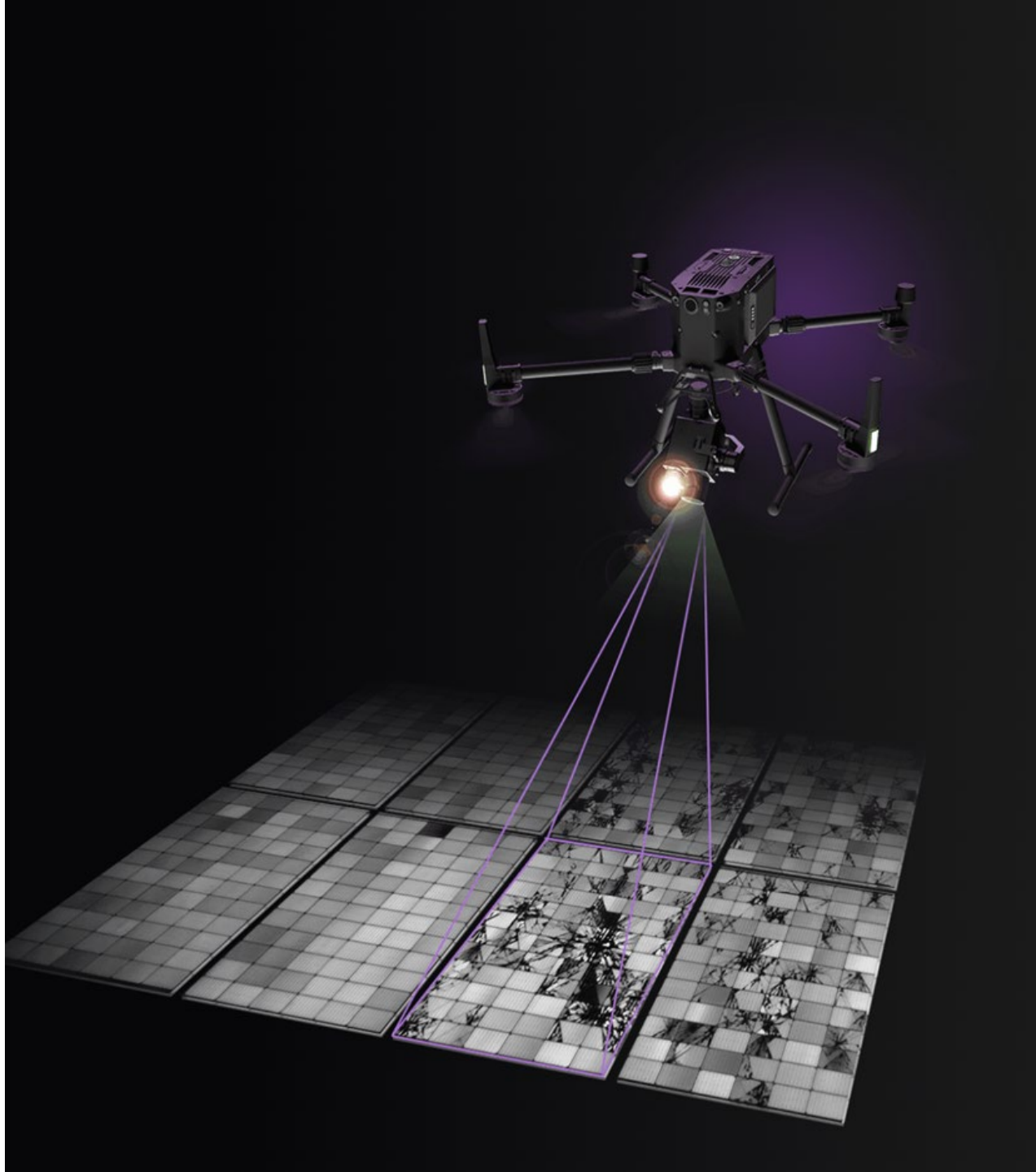
3rd December 2025

Quantified Energy (QE) is an A.I. enabled deep-tech company specializing in the solar PV industry

1. Helmed by a team of solar PV professionals from **SERIS/NUS**

2. Autonomous Drone EL Mapping & Quantitative EL Analysis

3. Covering important milestones: COD/DLP, warranty/insurance, TDD

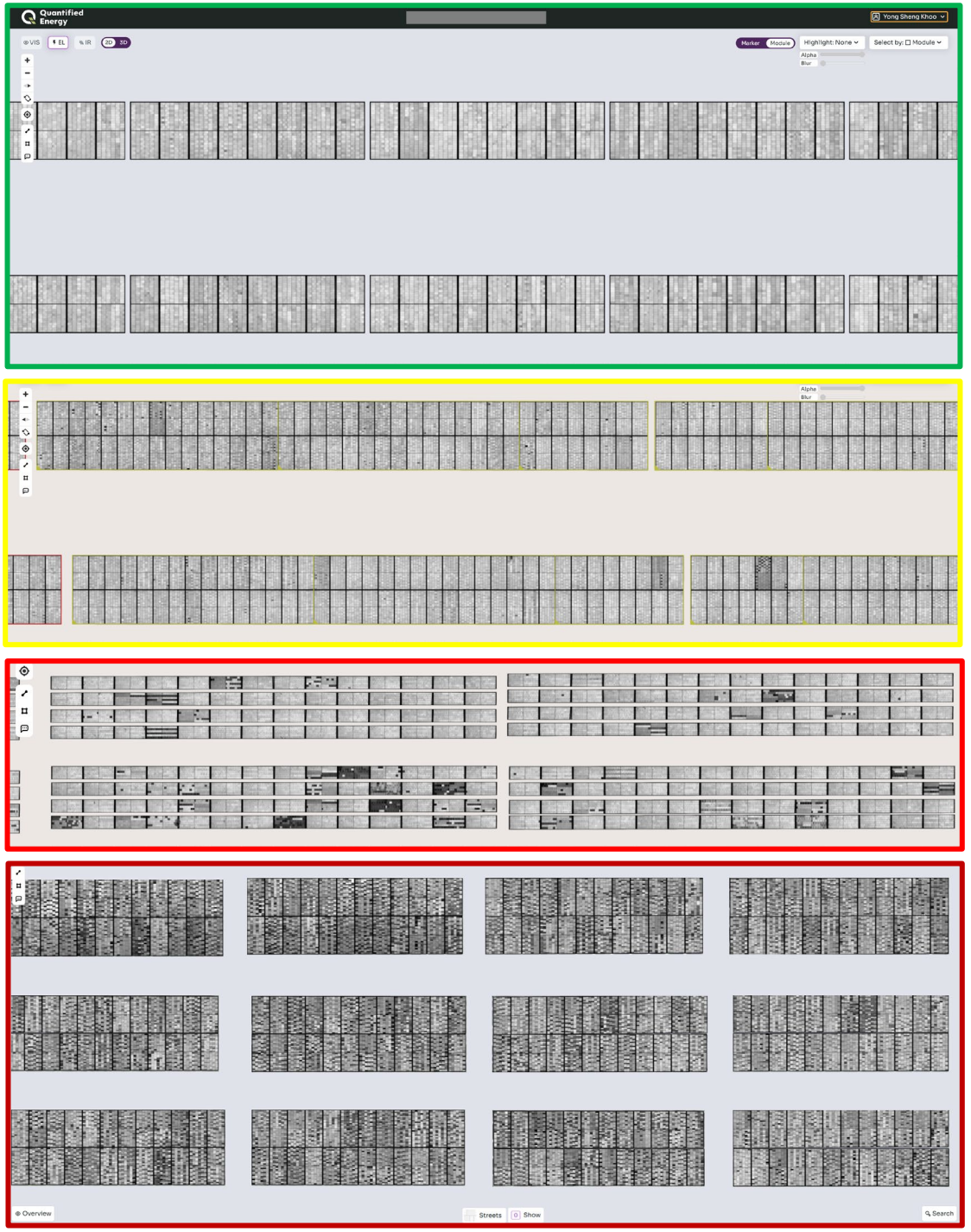


What is our observation in the field?

- ❑ QE has inspected hundreds of solar farms across multiple PV technologies:
- ❑ > 4million PV modules analyzed to date, including > 2million TOPCon modules.

- ❑ For TOPCon sites, we observed a wide range of dark-cell patterns in EL imaging:
  - ➢ Sites with no visible dark-cell patterns
  - ➢ Sites with low to moderate occurrences
  - ➢ Sites where a large majority of modules exhibited dark-cell patterns, even >90% across the site

- ❑ While EL dark-cell patterns can be any degradations, combining EL with controlled lab testing points to UVID-related degradation.



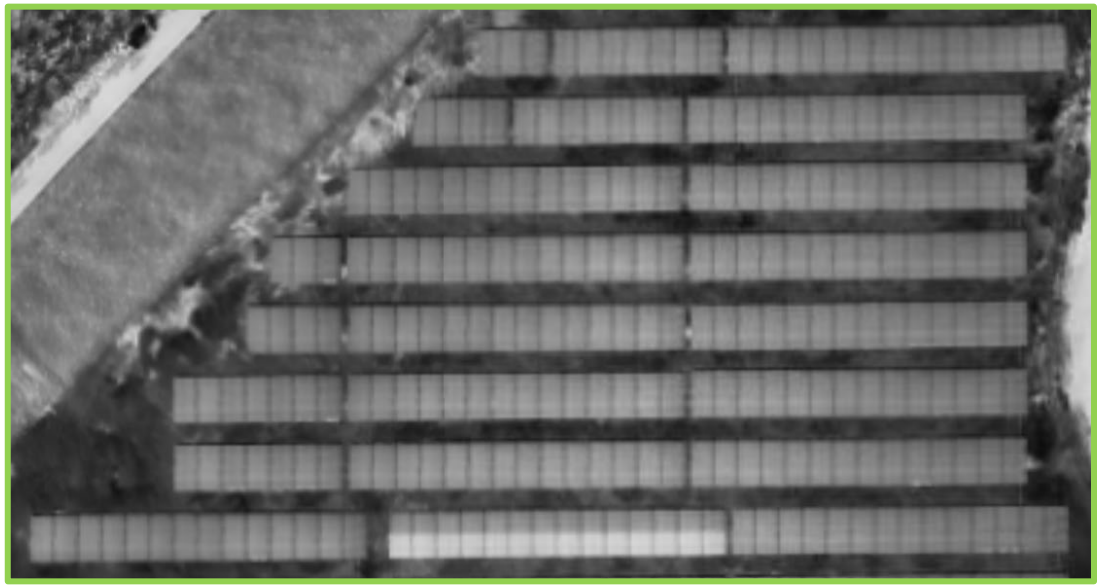
Case study – Utility Scale PV Plant with TOPCon modules

Observation of performance drop

- ❑ A utility-scale PV plant built in 2023

- ❑ After one year of operation, the plant operator observed a noticeable drop in energy yield

- ❑ A first detailed assessment by a certified third-party inspection agency found:
  - ➢ No issues with the inverter or electrical BOS
  - ➢ Drone infrared inspection showed no obvious hotspots or thermal anomalies
  - ➢ → At this stage, the root cause of the performance loss remained unclear



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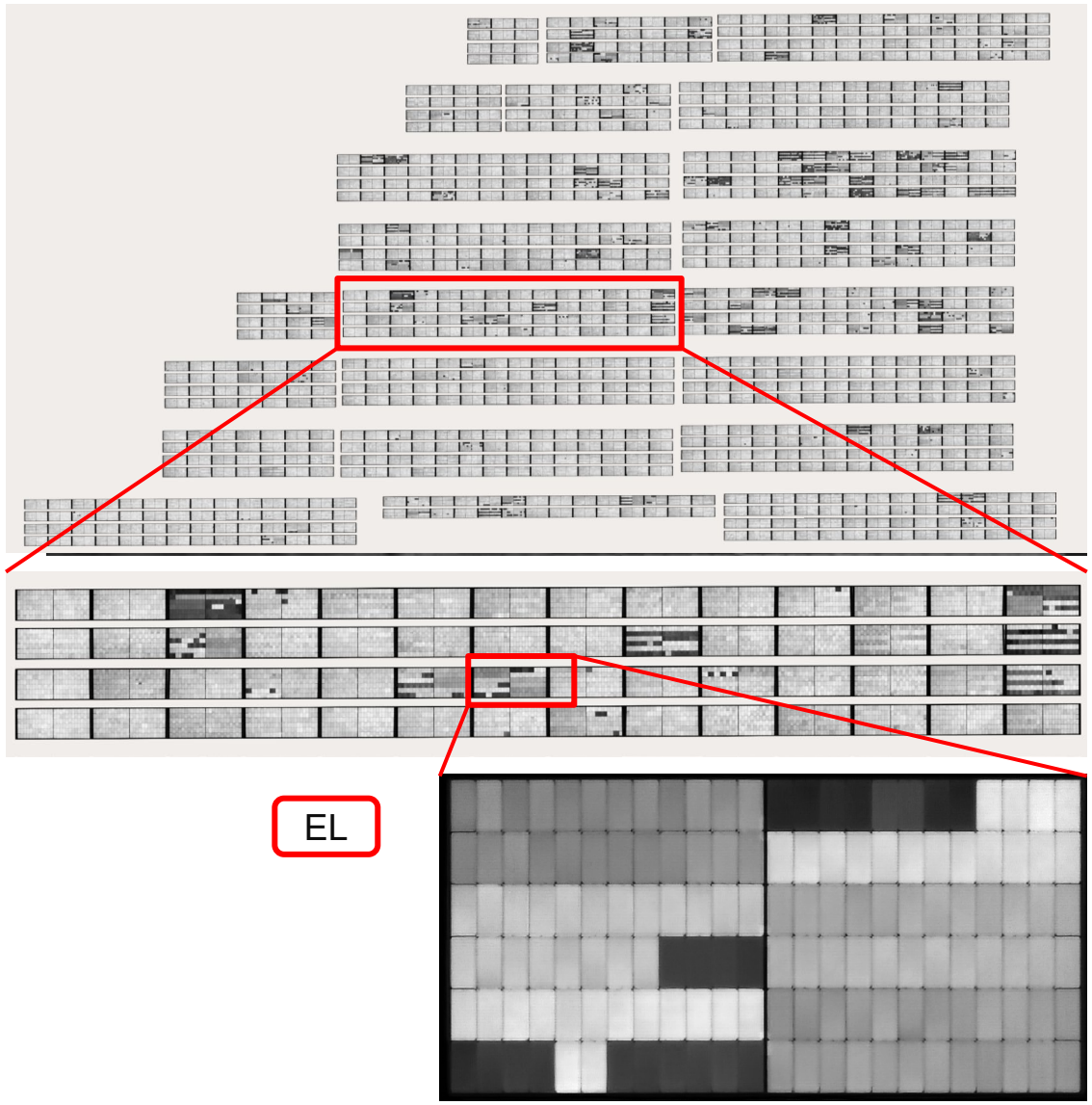
Case study – Utility Scale PV Plant with TOPCon modules

Field EL Investigation

- ❑ The owner engaged QE to perform full site drone EL inspection to find the root cause

- ❑ EL imaging revealed widespread dark/bright contrast cells
  → a signature pattern consistent with UVID-related degradation of Topcon PV modules

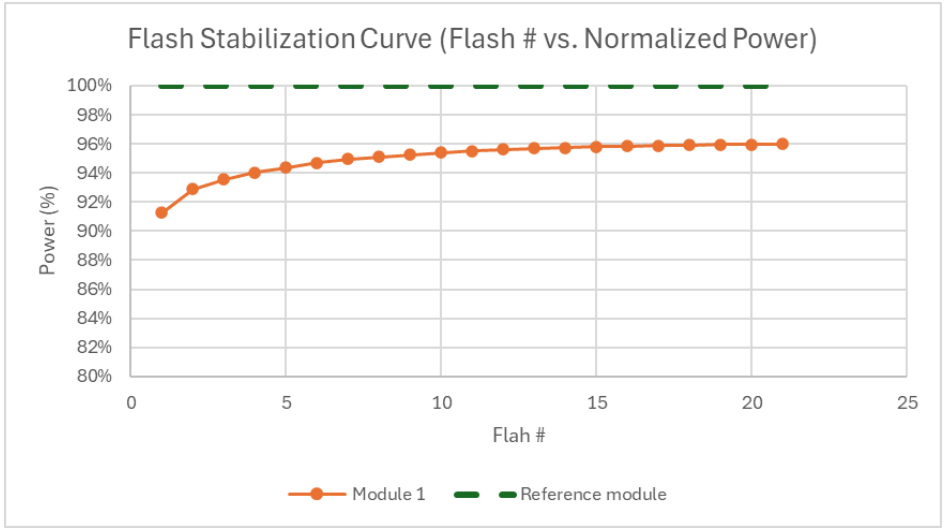
- ❑ Representative PV modules were selected and sent to an accredited laboratory for STC IV measurements

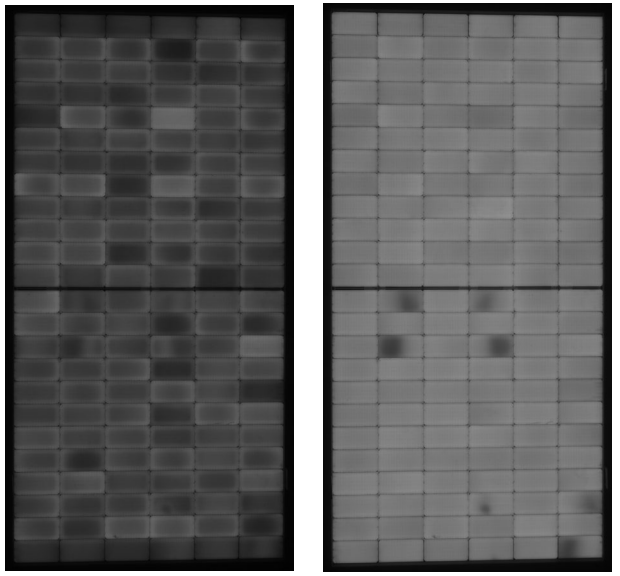


Case study – Utility Scale PV Plant with TOPCon modules

Lab testing confirming UVID

- Flash testing showed the typical UVID related metastability —power increases with each flash before stabilizing
- To eliminate metastability and dark-storage effects, all modules underwent controlled light-stabilisation prior to final measurement
- Sampling STC power tests showed average 5% power loss after full stabilization
- Warranty claim process was formally triggered → Replace the modules based on the number and severity of dark-cell patterns identified in EL
- Conclusion: EL is strong evidence for warranty





Before stabilisation

After stabilisation

Quantified Energy

THANK YOU!

Make every PV module count throughout its lifetime!

https://quantified-energy.com/

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