
ENERPARC

# UVID prevention in TOPCon modules

## Insights and strategies from an asset owner's perspective

# ENERPARC AG

## Experienced Solar Photovoltaic Specialist

### Experience

- Team of more than 600 professionals, comprising 150 engineers vastly experienced in PV and with diverse cultural backgrounds

### Focus

- Founded in 2008, we have focused on planning, engineering, execution and operation of utility scale PV power plants

### Track Record

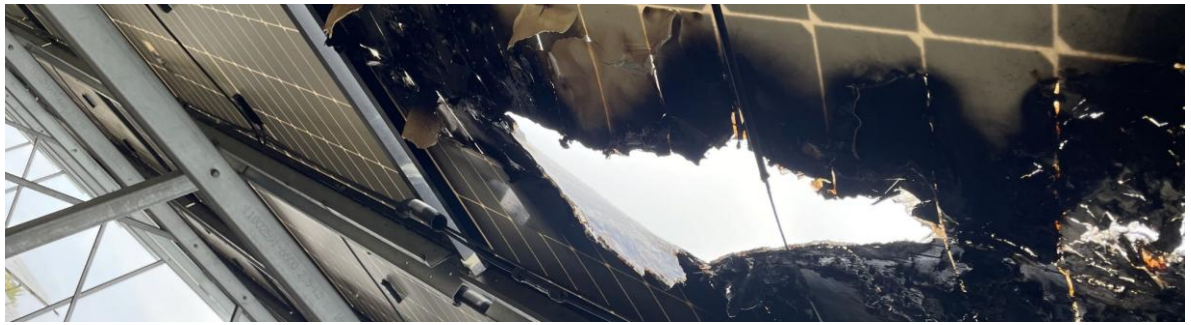
- More than 5GW solar assets build in Europe, India, USA, Australia and Asia

### Market Access

- Leading renewable energy producer (IPP) with an own portfolio of 4GW solar power plants

# RECENT MILESTONES IN MODULE DEVELOPMENT

**Driven by performance increase and cost reduction**

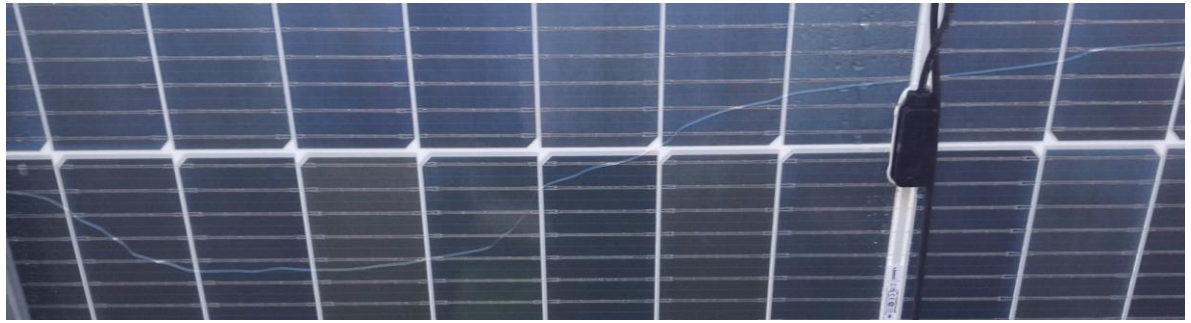


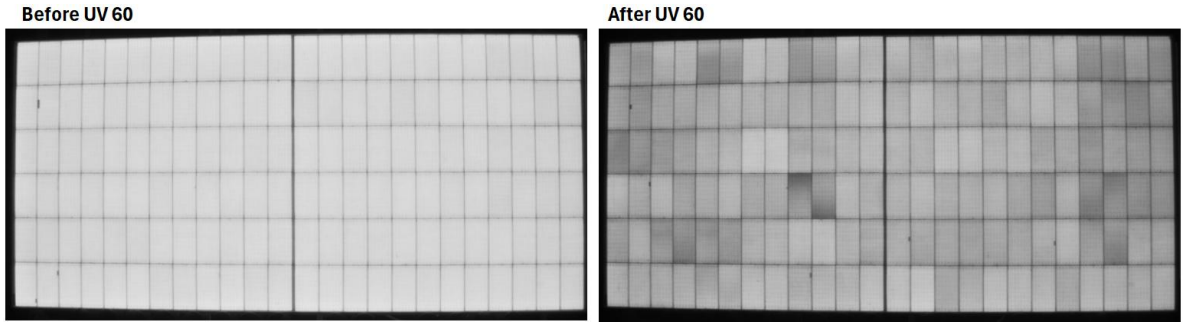
## Change from full cell design to half cut cell design

- Weak soldering of junction boxes is resulting in burned modules (Lost bypass diodes/LBPD)

## Polymer back sheets are replaced by glass, glass-glass modules for bifacial use, thinner front glass

- Back glass that is not good enough or not matching the "normal" use needs, shows increased breakage rates





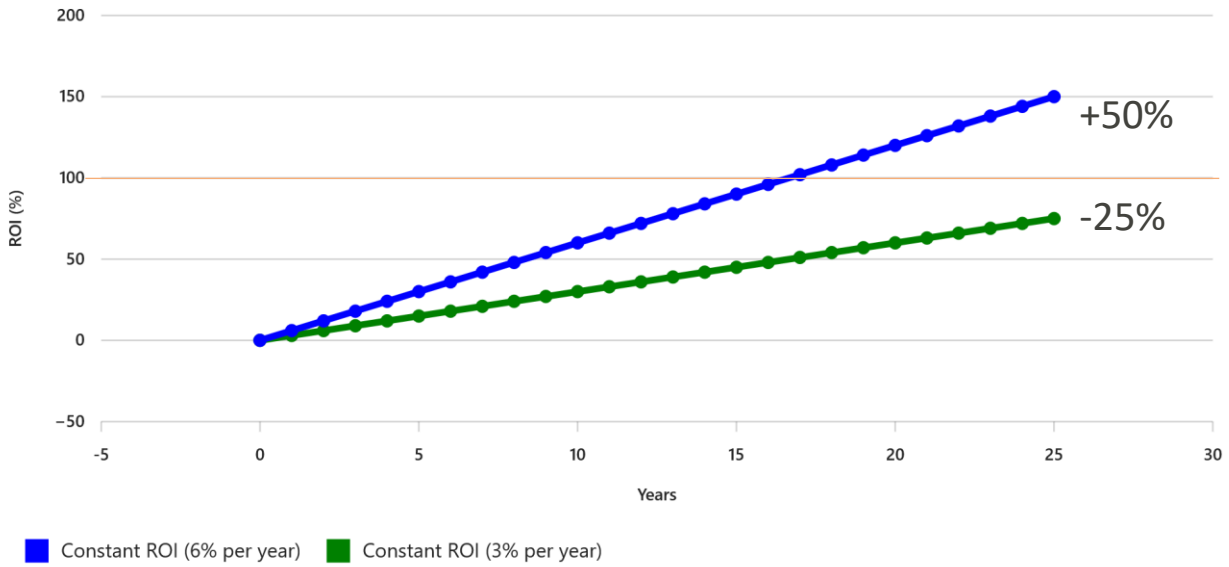

## Cell technologies as N-type TopCon have taken the lead

- Increased levels of UV induced degradation with TopCon based cells was found – metastability is becoming the new “buzz word”

# ASSET OWNERS PERFORMANCE EXPECTATIONS

**Acceptable nominal starting power and expected yearly degradation**

- Asset owners need a reliable forecast of energy yield for a functioning business model
- Standard PV business models have a single digit ROI per year
- An unexpected additional underperformance can make the business model unprofitable (like low initial STC + UVID)
- Such an underperformance can shrink the margin easily by 50%, which makes the project ineffective




- Good performing assets have an average module power degradation of << 0,5% per year with modules slightly better than nominal power at installation

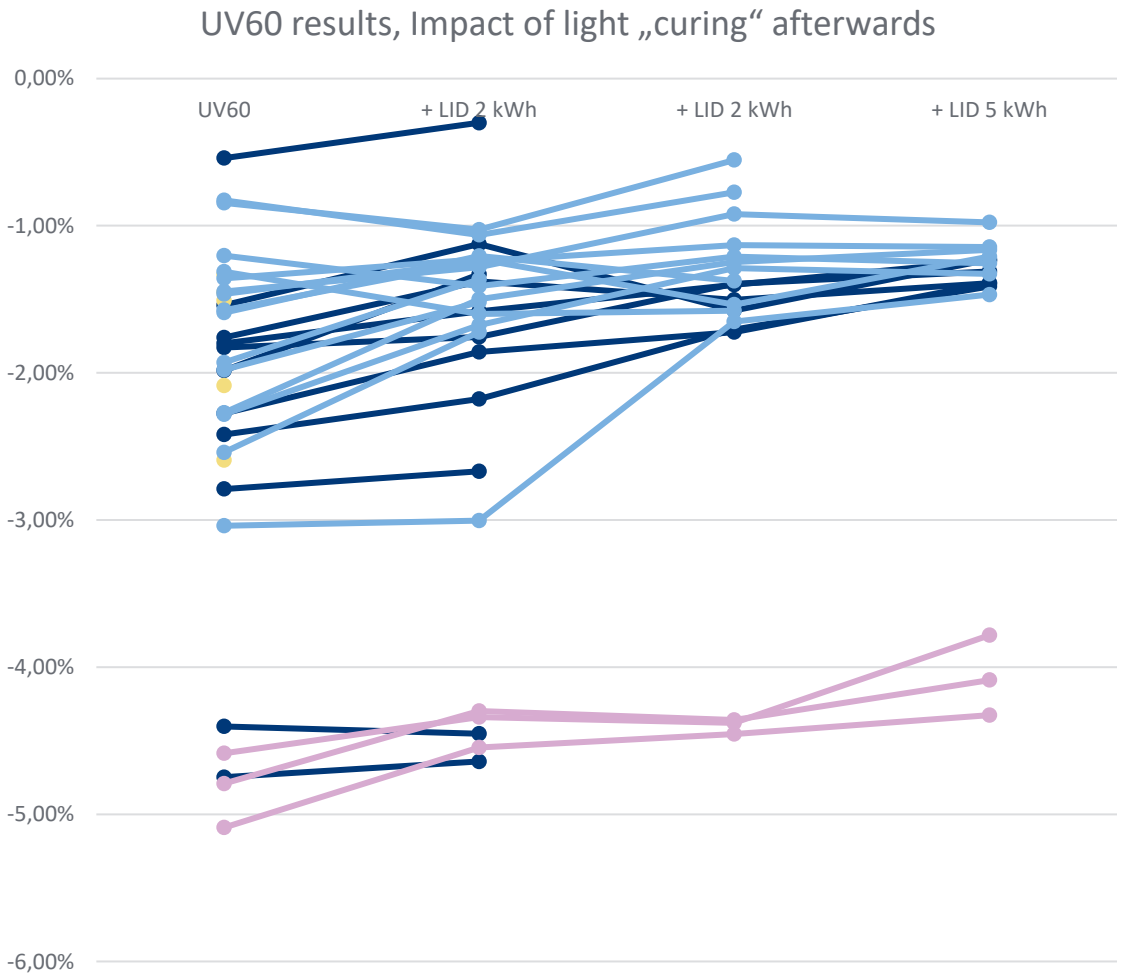
**Todays challenges:**

- **UVID limited to 1,5% (!?) - but was seen with >> 5% at sample tests (UV60)**
- **We see a trend to lower initial starting power of modules, metastability makes tests more challenging**

# MODULE QA/QC SAMPLE TEST RESULTS UV60

**Module qualification and pre shipment inspection sample testing results**

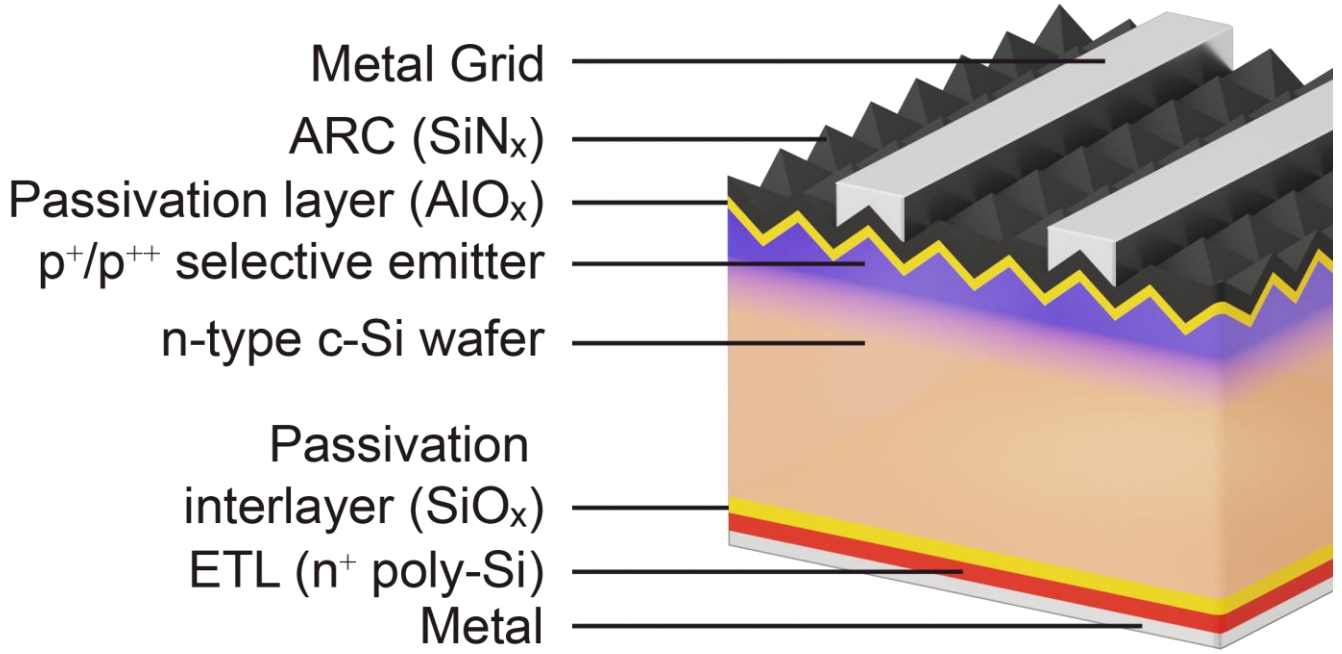
- Since 2024 we have included UV60 in our standard test scope of PSI (Pre Shipment Inspection)
- UVID testing was then also added to prequalification of new suppliers, as part of deep dive audits
- Since 2025 we have included a rejection threshold for UV60 test results in our contracts
- Together with our suppliers we established best practice light stabilization processes, to have reliable and repeatable test results after UV60 (“curing”)
- We are expecting UV60 values to be below 1,5% after light stabilization
- We have just started a research project together with Fraunhofer ISE, to understand the real-world impact in correlation to the UV60 test results



# UVID – SOLUTIONS TO PREVENT ROOT CAUSES

**Solutions on cell level for TopCON N-type:**

- AlOx: Increasing thickness and homogeneity
  - ALD-process optimization (homogeneity)
  - Adjusting ALD-Cycles (30 – 40)
  - Optimizing of layer thickness (4-6 nm)
- SiNx: Increased layer thickness and optimization of the refractive index
  - PECVD process optimization




**Solutions on module level:**

- UV-blocking EVA ➔ reducing cell efficiency and so power
- UV-shifting EVA ➔ long-term stability not proven, aging is likely

**Requirements towards the supplier:**

- <1,5% degradation after UV60 (after light soaking) by cell improvements only, ideally UV “stable” => no increased UVID

# UVID PSI – HOW TO PREVENT SURPRISES

**UVID sample testing as part of contractual module pre shipment inspection for batch approval**

## Clear definition of requirements in the purchase contract

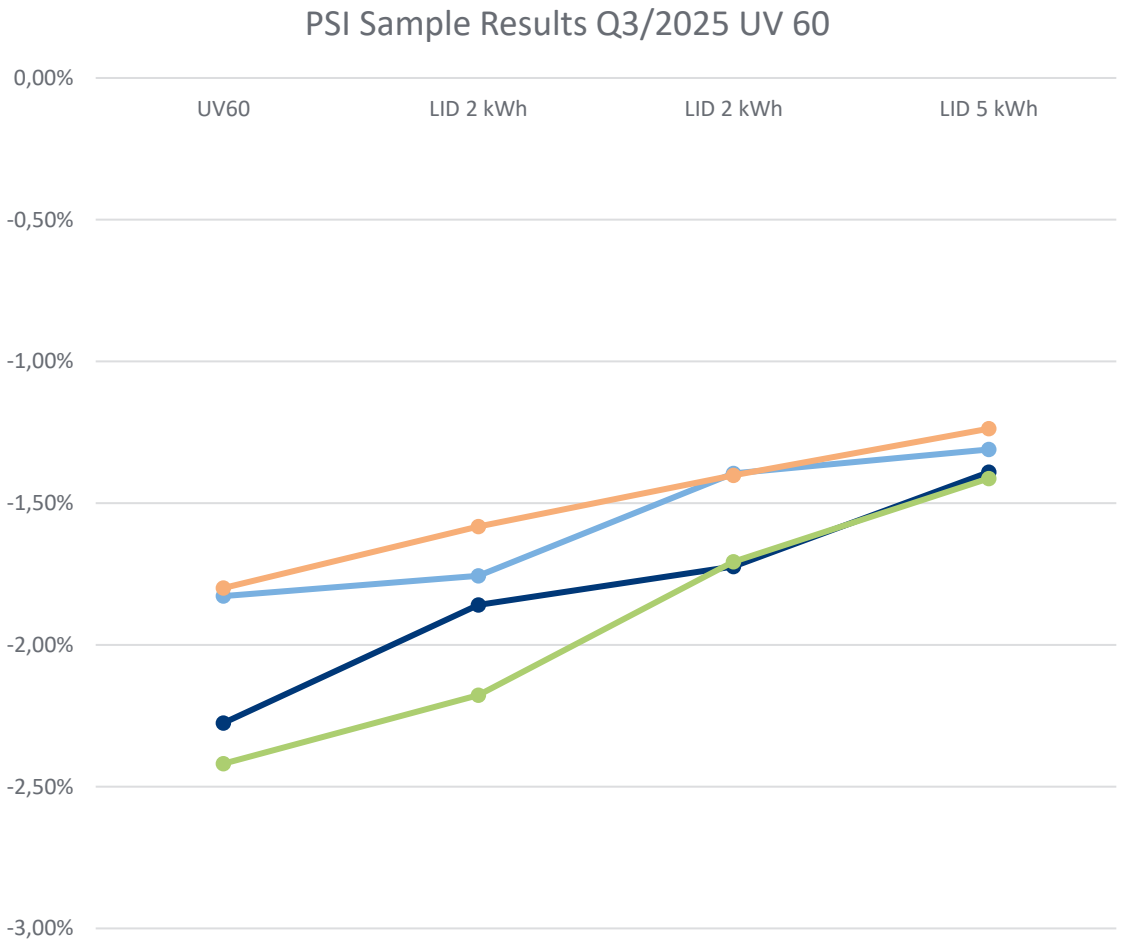
- As UVID after UV60  test cycle < 1,5% / + UV120 thresholds?

## Defining detailed test criteria:

- UVB-portion of the light source for UV testing
- Testing at shortcut, open connector or at MPP?
- Temperature range of module
- Is there a light stabilization after the UV test? How long?

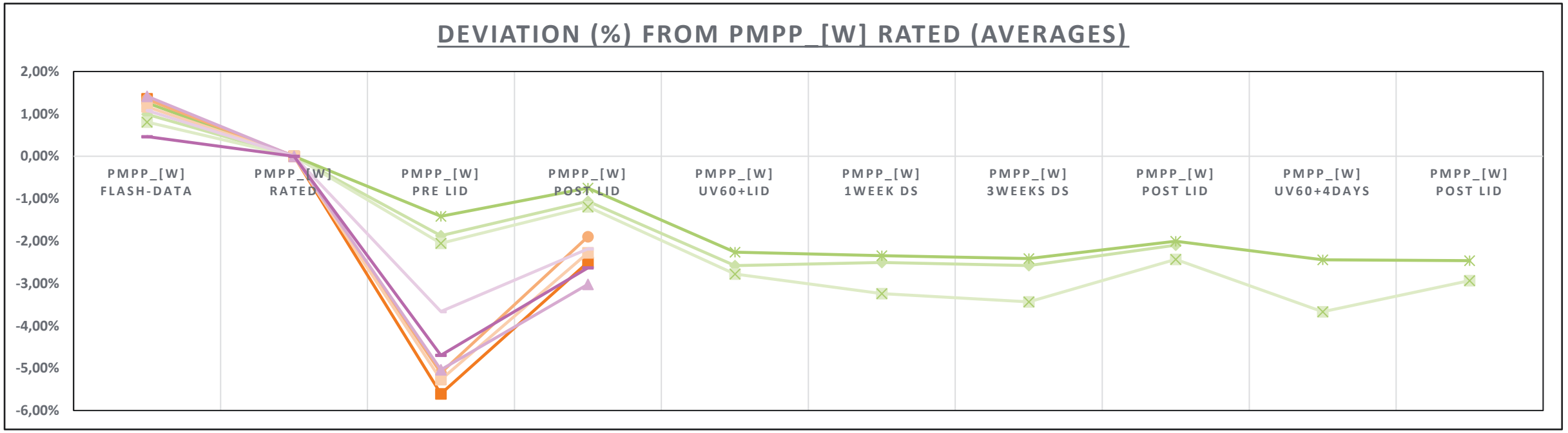
## Sample testing and agreement on consequences:

- How many samples per batch/MW/volume?
- What happens if one sample “fails”?
- Testing more samples? Reject?



# METASTABILITY OF NEW CELL TECHNOLOGIES

- **In 2022 ENERPARC installed some MW n-Type TopCON.**
  **PSI UVID-Testing was at this time not part of the usual scope**
- **2025 we collected samples to be tested, for STC power first, also to understand metastability of these early n-Types, then adding UVID characterization for warehouse modules:**
  - Sample Set 1: Modules from our warehouse (boxed, dark storage) – **Green**
  - Sample Set 2: Modules from a site in Spain after nearly 2 years operation - **Purple**
  - Sample Set 2: Modules from a site in northern Germany (2 years) - **Orange**



# METASTABILITY OF NEW CELL TECHNOLOGIES

**Impact on module procurement**

- Verification of Nominal Power was usually done in the past „out of the box“
- This was necessary in order to verify as good as possible the nameplate power, to not take first-years light induced degradation offset into account.
- All new cell technologies will come together with **Metastability!**
- Light stabilization upfront to any STC power measurement is needed, coming together with adding an LID markup
- Also for reference modules the metastability is challenging
- Updates on contractual power verification processes must be considered

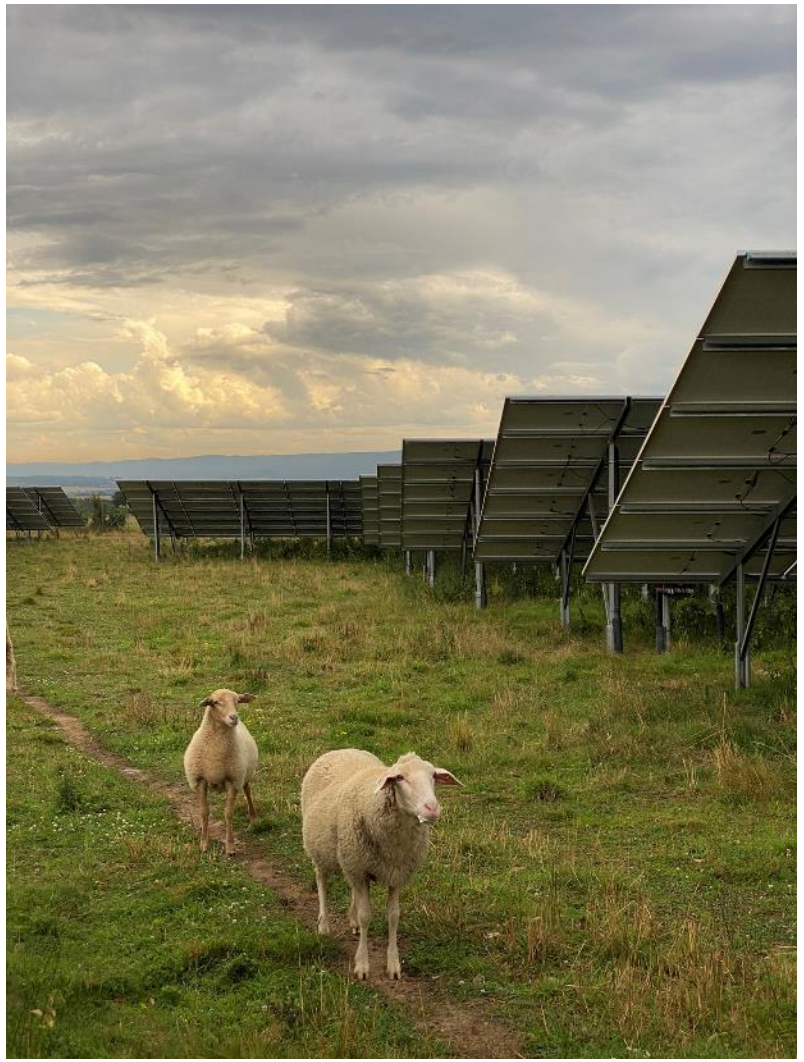
# SOLAR MODULE QUALITY STANDARD - VDE SPEC 90038

- VDE working group of solar experts have updated the guidance document for specifying quality in the solar module purchasing process to version 1.1.: https://dialog.vde.com/en/vde-dialog-editions/2025-03-vde-weltweit/2025-03-sicherheit-standardissierung



# SUMMARY AND CONCLUSION

- UVID sample tests are a must have for module QA/QC
- Contractual agreed UV60 thresholds in guidance with the VDE Spec 90038 or upcoming IEC TS are strongly recommended
- Solving the UVID issues on cell level by improving the cell design is the must have solution, modules shall be as stable as possible
- Further data and evaluations are needed to understand the relationship between accelerated laboratory testing and actual field performance – also to make accelerated testing better
- We need process updates to evaluate the contractual vs. the delivered performance of “metastable” cell designs



# THANK YOU.

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**Special thanks to:**
**Jan Zornikau, Team Lead Quality Management ENERPARC**