Safeguarding Solar PV Revenues

The Role of Bill of Materials in PV Module Degradation and Failure

Learn how to avoid the high cost of module degradation & failure modes from a Bill of Materials (BOM) perspective

Insights from

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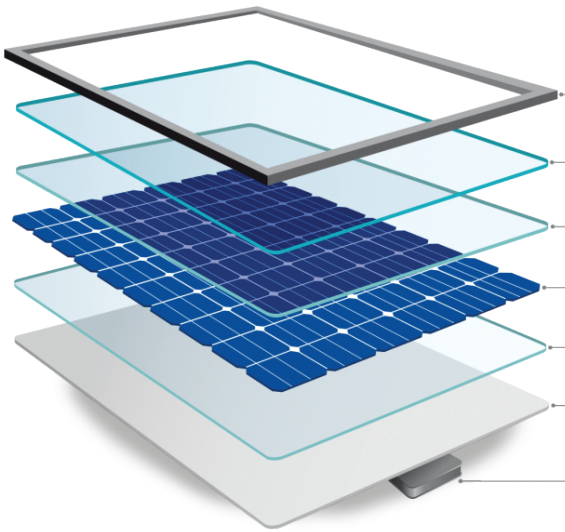
Bright solar PV future



Frame: mechanical strenght & protection against salt mist corrosion

Glass: weathering protection of inner layers

Encapsulant: electrical isolation and weathering protection

Solar Cells: combat LID/LeTID & PID shunting

Encapsulant: electrical isolation and weathering protection

Backsheet: optimized layer sequence for longer life of modules

Junction Box: prevents moisture from reaching the terminals and protects against hotspots

PV Module Materials are Optimized for Reliability

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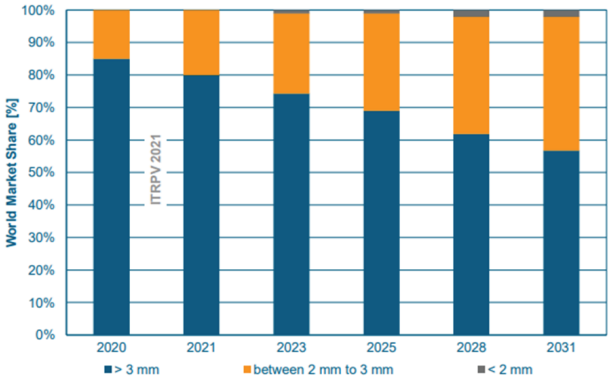
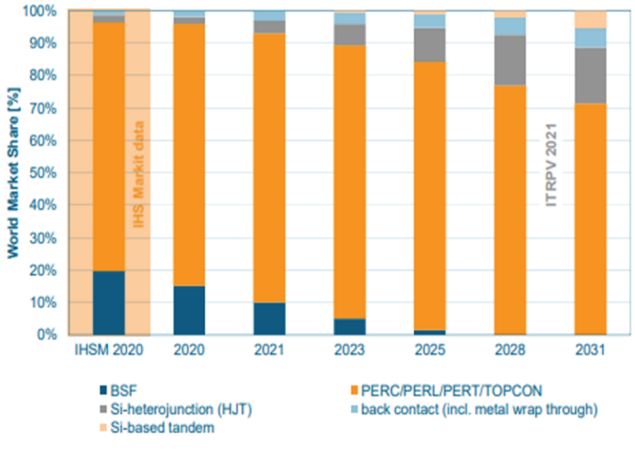
Growing market share for thinner glass



Adoption of advanced cell types



Innovation Drives Trends in Materials

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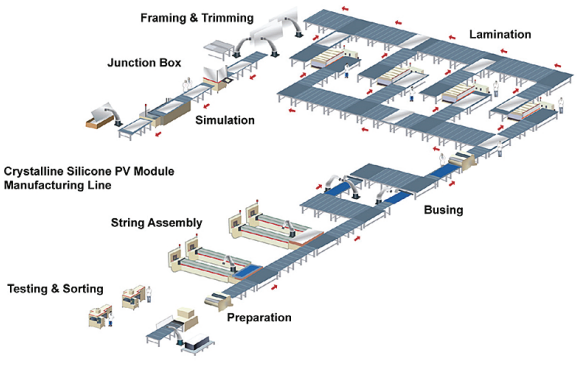
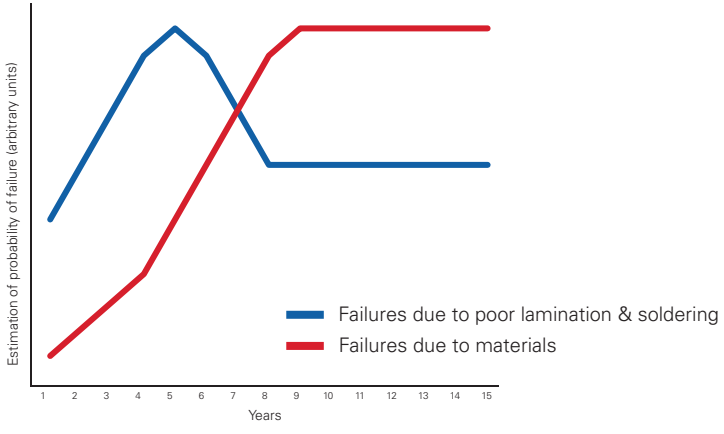
To profit you must mitigate technical risks

5% of PV plant failures observed are due to the modules, with complex root-cause analysis

for more insights see poster #2 and #3 on failure modes & degradation





Equipment, materials, procedures and operator errors impact module quality

Lamination and soldering cause most of the failures in the first 5 years. Material selection is the main cause of failures from years 5 to 15.

The reliability of materials depends on their storage, curing, composition and production quality, as well as raw material variation and material combination and interaction

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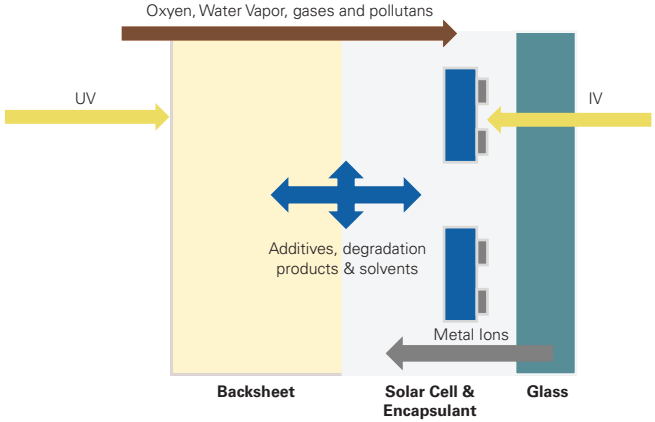
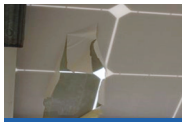
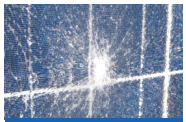


Internal & external interactions lead to unexpected degradation and failure modes



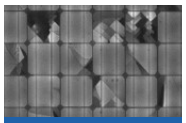
Backsheet: Yellowing, delamination

Encapsulant: Browning, delamination

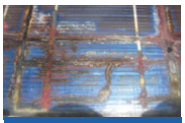


Glass: Shattinger, anti-reflection coating loss

Junction Box: Diode or connector failure, delamination

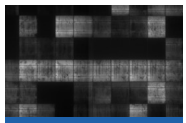


Cell: PID shunting, LID, LeTID, mictocracks, hotspots



Busbar: Corrosion, Peeling, Snapping

Frame: Loosen or bent



Module: PID

Typical failure modes and/or degradation caused by materials

The effects of new materials on failure modes & degradation rates are as yet unknown

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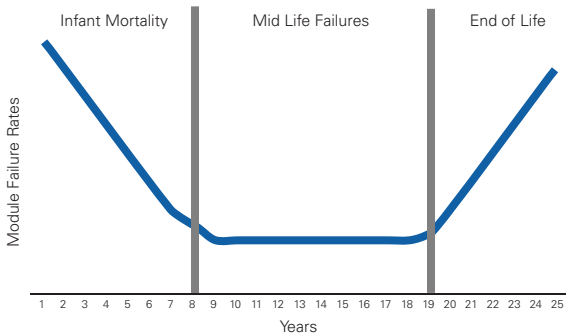
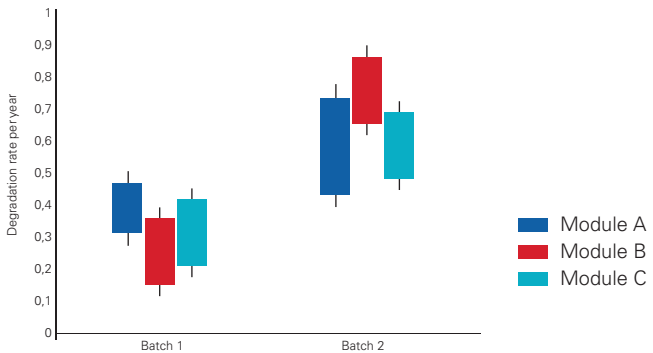


6% of IEC-certified commercial PV modules fail to meet IEC requirements in randomized thermal cycling retests; results indicate that premature failure and/or degradation is likely in the field.



Material variation causes modules from the same batch to degrade at different rates. More so from different batches.

*field modules are not representative of IEC61215 certified "golden" module because of variations in the production processes, swapping of materials, change in lamination procedure and/or production at OEM sites not listed in the IEC certification

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As it may result in extensive losses

No mitigation measures means risking default; *giving the lender right to call the debt or take corrective actions!*

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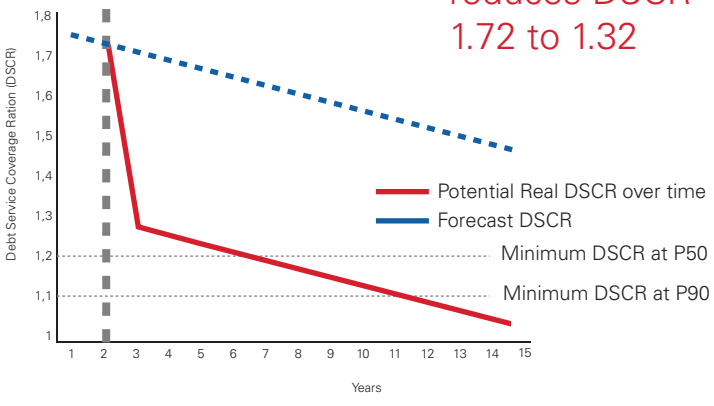
Example: module failure leads to 23% less yield & in turn revenue

23% loss in yield reduces DSCR 1.72 to 1.32



Replacing 5% of the modules of a 10MWp project would cost 125kEur (0,25 EUR/Wp), plus additional OPEX & labor costs.

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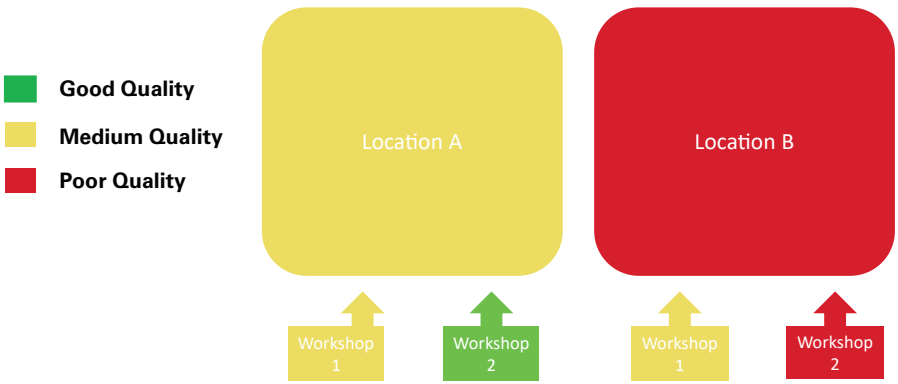
Case study

TIER 1 does not guarantee product quality nor reliability; it only suggests bankability



Factors:

- Operator Turnover & Training
- Different Machines & Process
- Cost Reductions
- Age of workshop
- Level of maintenance of equipment
- Storage of materials
- Material swapping
- Material/supplier fluctuations
- Level of automization
- Quality procedures
- Learning curve

TIER 1 module manufacturers have multiple factory locations to meet demand and quality varies for different workshops and/or OEM partners

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Mitigate these risks by:

- Third Party In-line inspection
- Factory Audits
- Batch and Site Testing
- BOM Specification & Supply Chain Management
- Product Qualification Programs
- Technology Review
- Accelerated Lifetime Testing
- O&M & Monitoring Select

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Added value of mitigating risks

Up to

3.2

EUR/kWp/year

SAVED

Typical loss for a 0.10 EUR/kWh project without mitigation strategies equates to a total loss of 5.4 EUR/kWp/year. Implementing previously stated risk strategies reduces those total losses to 2.2 EUR/kWp/year.

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Find out how Kiwa can be your partner in progress for safeguarding long term solar investments

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Kiwa field experience and data analytics
PVEL data analytics & testing
STS data analytics & inspections

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