Technology Innovation and Risk Mitigation of Solar Assets

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Over 50% of panels installed in the field since 1975 contain DuPont materials
Evolution of the Backsheet Defects

- Backsheet defects have increased from 7.5% based on 450MW (2016) to 9.5% based on 1GW of field data (2018).
- But serious backsheet defects (cracking & delamination) have increased from 14% of the total backsheet defects to 58%.
Material Sensitivity in the Field

PA = Polyamide
PVDF = Polyvinylidene Difluoride
PVF = Polyvinyl Fluoride
PET = Polyethylene Terephthalate
FEVE = Fluoroethylene Vinylether

PA DEFECTS

- 56% 4+ years in service
- 45.7% All service years

GLASS DEFECTS

- 35%

PVDF DEFECTS

- 30.3%

PET DEFECTS

- 22.6%

FEVE DEFECTS

- 3.4% 3.1% 2.4% 0.05%
Accelerated Sequential Dynamic Mechanical Load Test

**Mechanism:**

Dynamic mechanical loading combined with UV, thermal cycling and humidity freeze lead to delamination of G/G modules at edges.

G/G structures are not breathable, moisture ingress from edges and acid from degraded EVA encapsulant are trapped in the module.

The sequential test simulates outdoor delamination of G/G modules.
Why a Clear Backsheet vs Glass?

- Conventional packaging technology, field proven
- High transparency, thinner
- Compatible with incumbent production assembly
- Breathable substrate / EVA vs POE (polyolefin)
- Improved heat dissipation
- Lighter weight by 25-35%
- Framed panels bring mechanical stiffness (especially with 72 cell designs)
- Lower surface tension vs glass – ease of cleaning / back
Designing a Durable Clear Backsheet

Xenon Arc Lamp, boro/boro filter
0.8 W/m²-nm @ 340 nm, 90 °C BPT, 65 °C CHT
Adequate Testing to de-risk Innovation

Field failures

Dynamic Mechanical Load test for Glass/Glass structures

Lab test failures

Material Accelerated Sequential testing for Glass/Backsheet structures
LCOE Sensitivity

<table>
<thead>
<tr>
<th>LCOE Variation</th>
<th>Efficiency (18%)</th>
<th>Power Output (1800kWh/kWp)</th>
<th>Lifetime (25 years)</th>
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<tbody>
<tr>
<td>20%</td>
<td>22%</td>
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- PERC
- n-type
- HJT,...
- Irradiation
- Bifacial
- Trackers
- O&M

- System design
- BoS Components
- BoM/panels
- O&M

Efficiency: 18%
Power Output: 1800 kWh/kWp
Lifetime: 25 years

2.3 USD cents/kWh
Tedlar® PVF-based Backsheets in the Field

Low power loss and no degradation

- SUPSI Switzerland 1982: 0.4% annual power loss
- Nara, Japan, 1983: 0.2% annual power loss
- SMUD USA 1984: 0.9% annual power loss
- SYSU China 1985: 0.4% annual power loss
- Mont Soleil, Switz. 1992: 0.3% annual power loss
- Beijing 1999: 0.7% annual power loss