TCL | SUNPOWER

Solar Performance Data for Next Generation Improvements

Francois Le Ny
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TCL SunPower Global

TCL IS THE DIVERSIFIED GLOBAL SOLAR PLAYER

TCL
奥林匹克全球合作伙伴

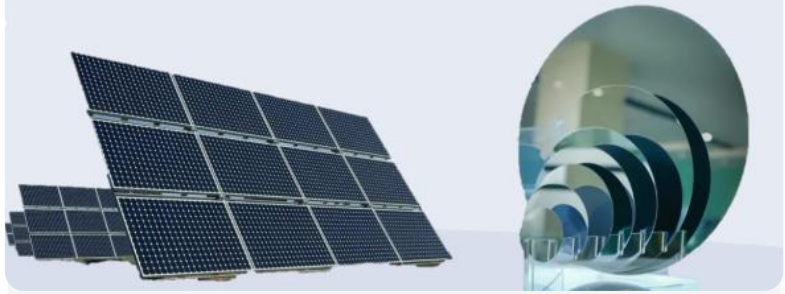
TCL

TCL CSOT (Display)

The Semiconductor Display

- **#2 TV**
- #1 Game & Automotive Display
- #1 8K, 120Hz

TCL Zhonghuan (Solar) Stock#002129.PRC



The Advanced Energy

- **#1 Wafer 200 GW capacity**
- N-Type G12 leader
- Integrated from Silicon to Module
- Industry 4.0

TCL Electronics Stock#01070.HK

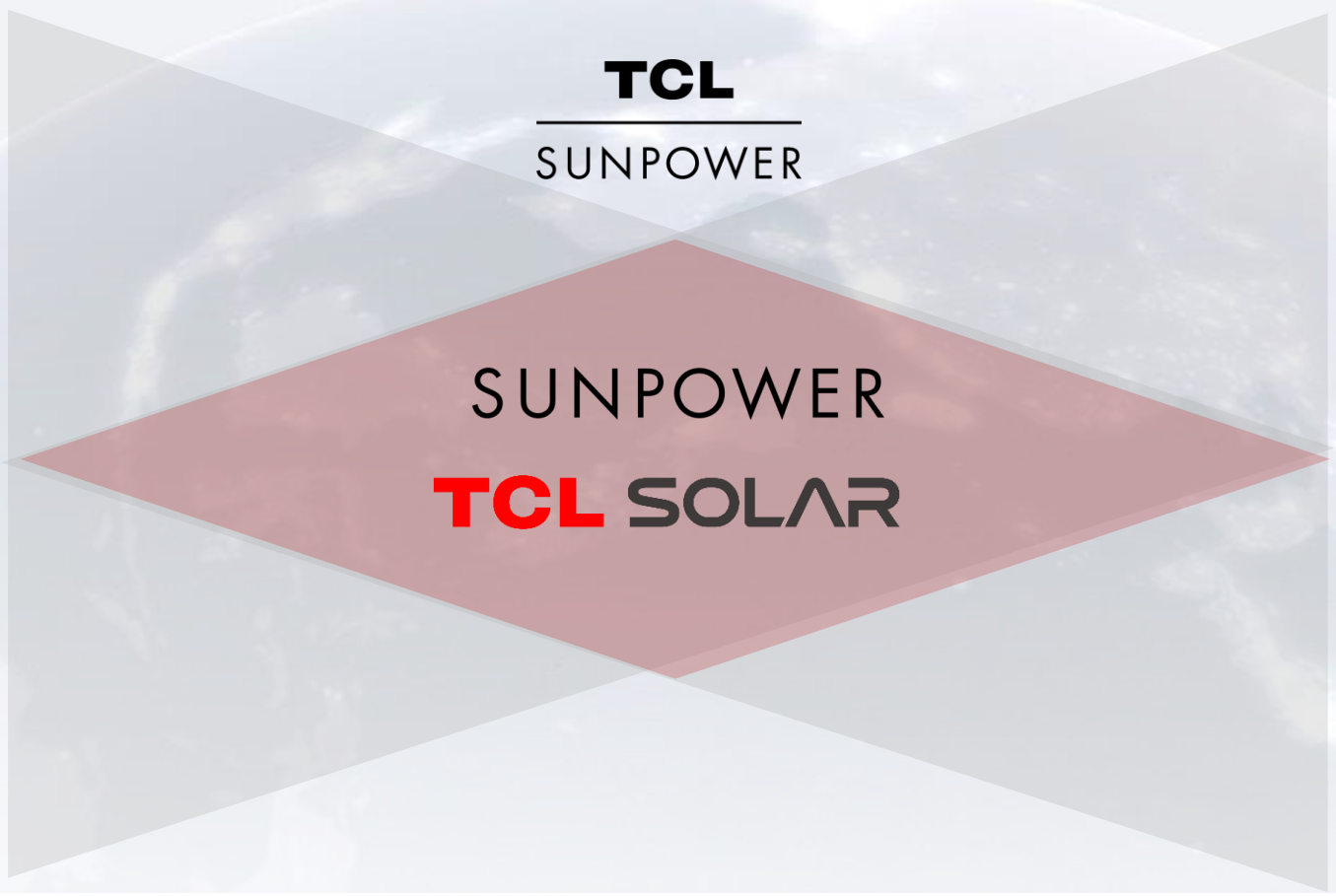
The Smart Devices

- **ALL CATEGORIES** of smart consumer electronics products and services: Smartphones, Smart Tablets, Home Appliances, Smart Vehicle Solutions, XR, Smart Home Energy Solutions.
- Over 160 countries

TCL INDUSTRY 4.0 AND SUNPOWER TECHNOLOGY

TCL

- Financial Power $42B
- Top 10 Global Solar panel Manufacturer vertically integrated
- 40+ years of Solar Silicon wafers
- Growing Brand Recognition



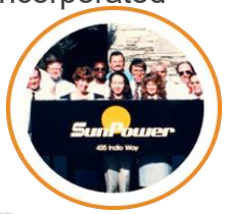
SUNPOWER

- Invented Back Contact technology. 40+ years of real field experience
- 1900+ PV patents
- A unique direct-to-installer model with +1,000 Partners in EU
- Since 2007 in Europe: a stable local team

MORE THAN 40 YEARS OF PIONEER TECHNOLOGY

1981
Earliest PV company in China

1985
SunPower incorporated



2004
SunPower's **first utility-scale power plant** in Bavaria 10MW with trackers

2007
SunPower n-type cell, reaching record-breaking 22+% efficiency

2009
World's first industrialized application of the diamond wire slicing process

2010
E SERIES
TotalEnergies Strategic cooperation

2015
X22 SERIES
TCL Sunpower JV to build high-efficiency shingled solar modules

2016
Global No.1 thinnest photovoltaic monocrystalline silicon wafer

2019
World debut of G12 Wafer

2020
TCL Technology acquisition & Cooperate with TotalEnergies

2021
High efficiency solar ultra-thin monocrystal wafer intelligent factory (30GW)

2022
Gemini Nevada (US) 1 GW

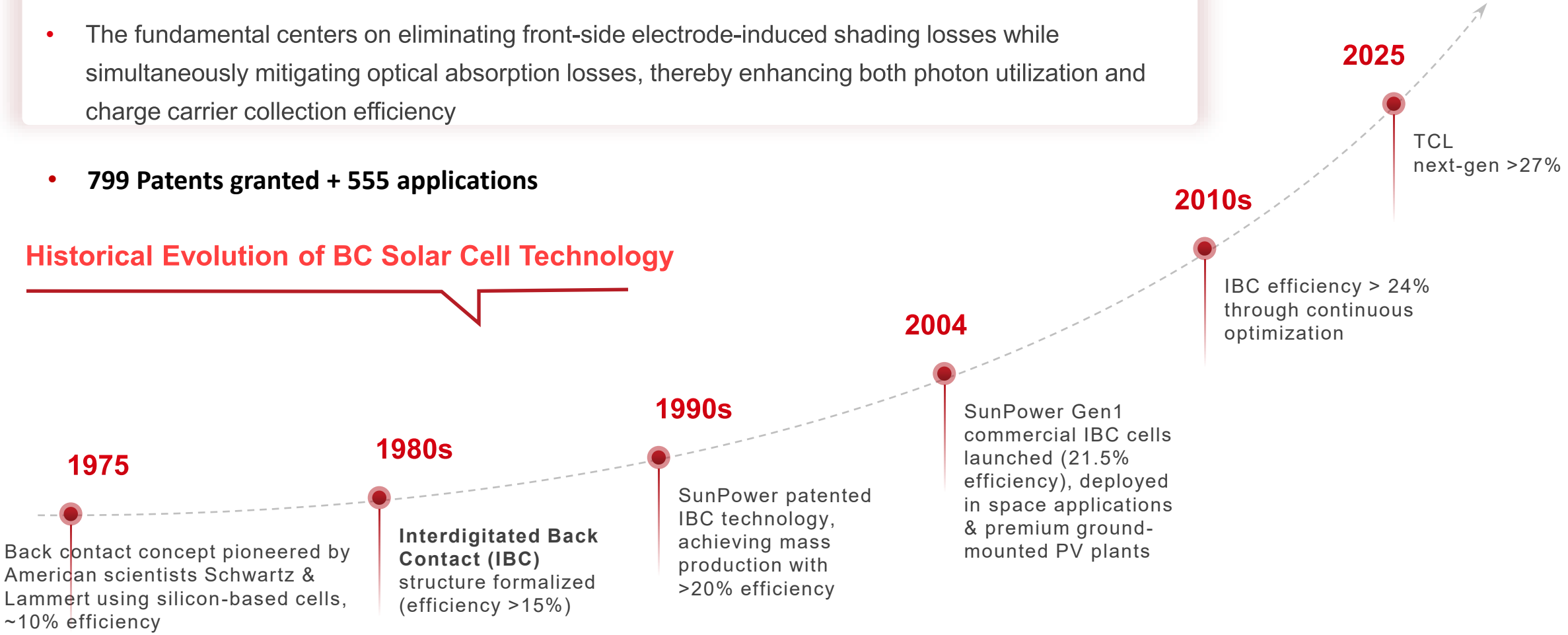
2023
N-Type TOPCON High-efficiency solar cell Industry 4.0 smart factory (12.5GW)

2025
TCL
Acquisition
TCL
SUNPOWER

BACK CONTACT (BC) 50 YEARS' HISTORY

- BC technology improves solar cell efficiency through full integration of metal electrodes on the rear surface.
- The fundamental centers on eliminating front-side electrode-induced shading losses while simultaneously mitigating optical absorption losses, thereby enhancing both photon utilization and charge carrier collection efficiency
- **799 Patents granted + 555 applications**

Historical Evolution of BC Solar Cell Technology



BC CELLS TECHNOLOGY ENABLES CUSTOMER INNOVATION

Aptera

700Watts 65km/day

SolarStratos

9521m in August 2025

Stratospheric altitude is at 11km in Swizerland

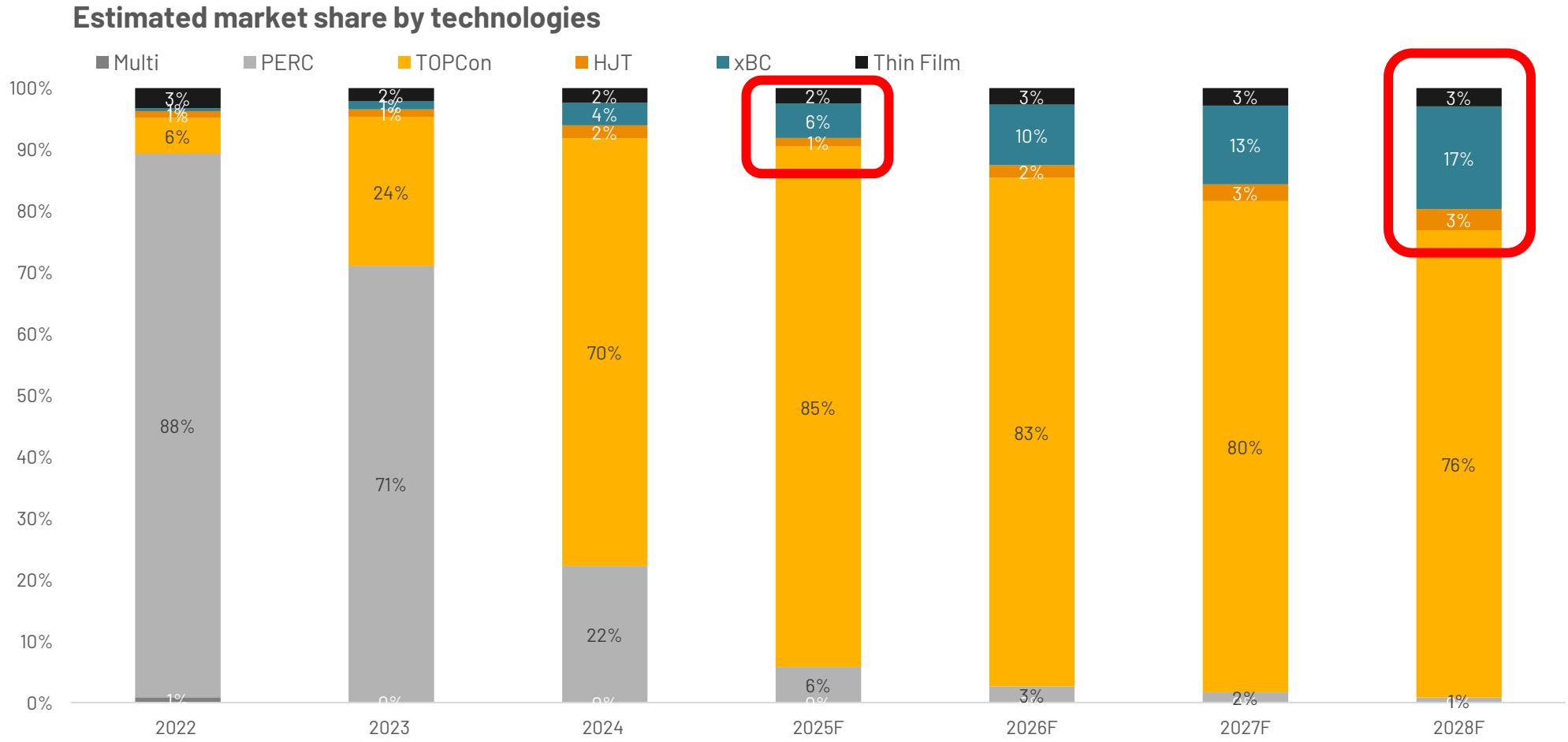
Oceans Lab

Vital cleantech through ocean racing

NASA Grover

GPS-guided, solar -operated robot examined the layers of Greenland's ice sheet

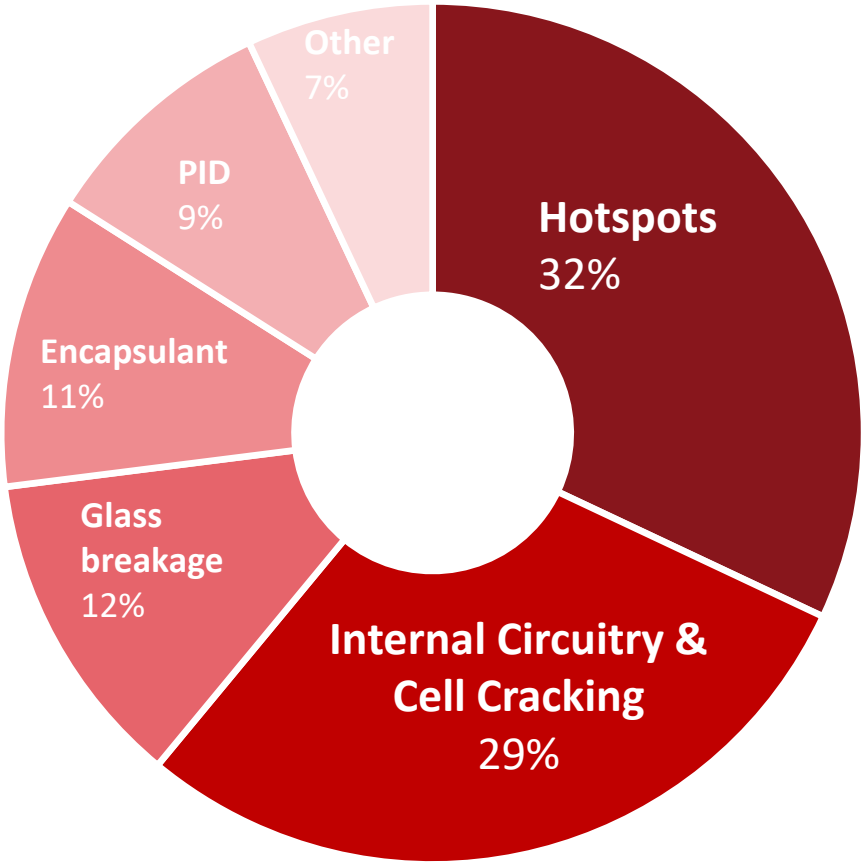
BC SHARE WILL TRIPLE WITHIN THE NEXT 3 YEARS



Source: Infolink, New Technology Market Report - August 2025

HOTSPOTS AND INTERNAL CIRCUITY ARE THE MAIN ISSUES

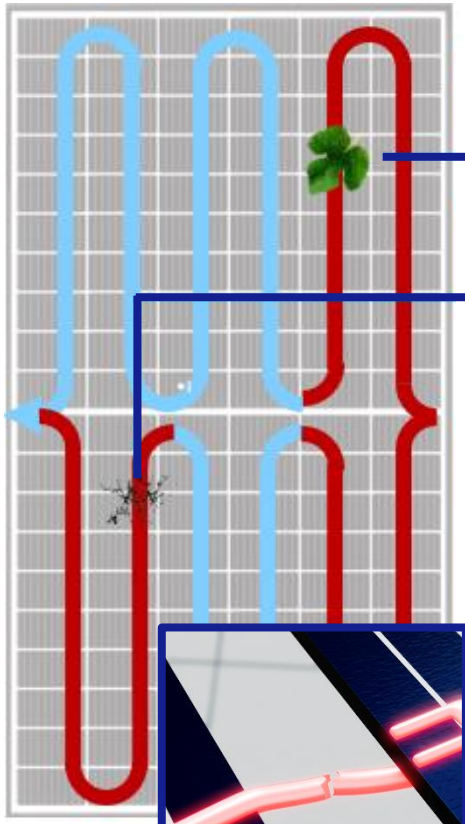
Up to 30% of modules have issues within 10 years[1]



- **The results can be significant, including energy yield losses, inverter uptime issues, and even outright panel failure.**

1. DuPont global PV reliability study (2020). Inspection observations based on 3GW in field. DuPont Global-Field-Reliability-Report-2020.pdf
2. Chart source information: Jordan, D. C., Silverman, T. J., Wohlgemuth, J. H., Kurtz, S. R., and VanSant, K. T. (2017) Photovoltaic failure and degradation modes. *Prog. Photovolt: Res. Appl.*, 25: 318– 326. doi: 10.1002/pip.2866.

TOP 6 REASONS FOR FAILURES



1. Power flow is blocked by shade or soiling

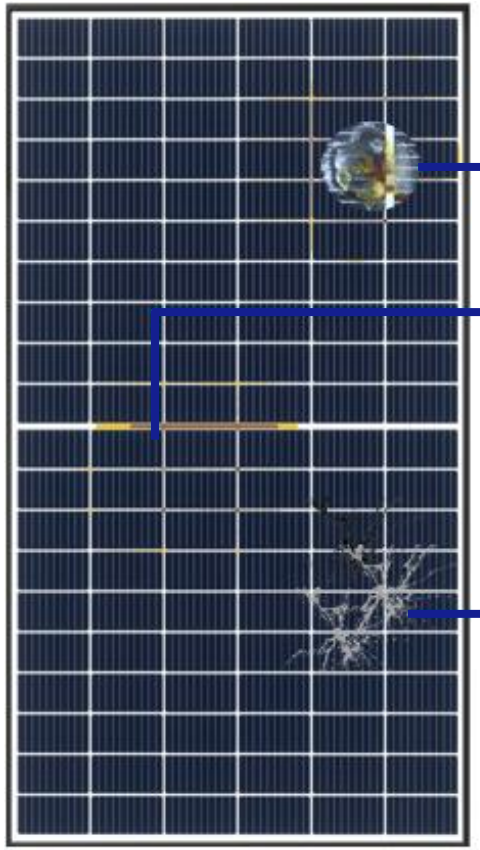
2. Cells crack from manufacturing quality, installation and transport, snow or wind loads

3. Ribbon soldering corrodes or fails from, temperature swings, humidity, snow or wind loads

Cell goes into reverse bias

Diode activates to isolate section of panel with the affected cell

Over time, this diode wears out and affected cells run in reverse bias



4. Hotspots

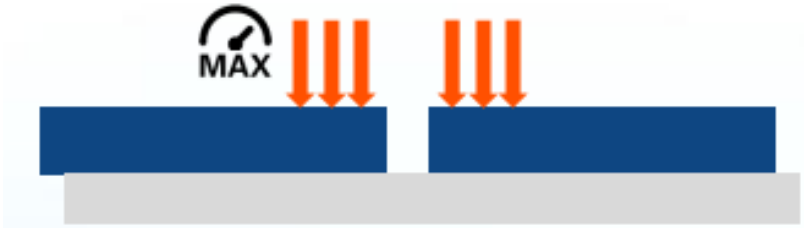
5. Burned backsheet and discoloration

6. Glass breakage

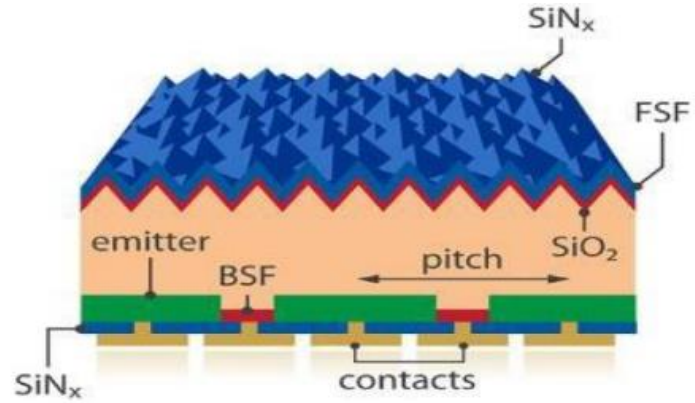
ANTI-CRACKING “HORIZON” LINE SOLDERING

BC modules adopt a less stressful single-sided welding process and “—"-shaped continuous welding technology, enhancing the product's resistance to cracks.

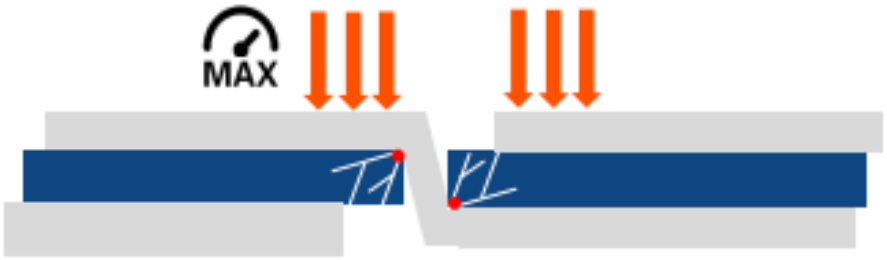
1. Horizon “—"-shaped continuous



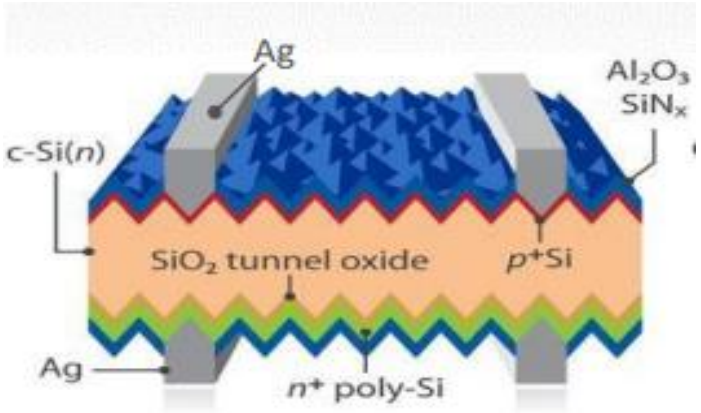
Edge Stress of BC Cell: 26 MPa



2. Conventional "Z"-Shaped



Edge Stress of TOPCon Cell: 50MPa

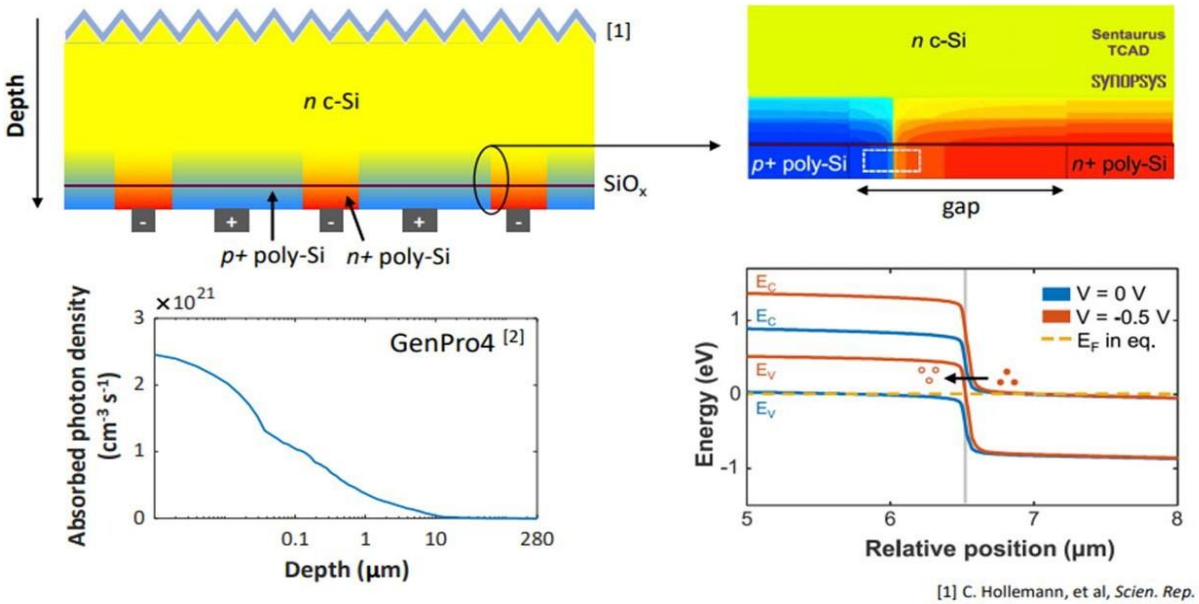


HIGHER PROTECTION FROM SHADE & HOTSPOTS

Due to their unique back-contact structure, the module can maintain a higher power output under light-blocking conditions. When the module is shaded, the unshaded area still functions.

- Cells can operate in reverse voltage (bias) when shaded
- Conventional cells reach dangerously high temperature when bypass diodes fail
- Hotspots can cause DC arcs and ignite encapsulant
- BC cell technology controls breakdown voltage and hotspot temperature to enable inherently safer modules

Low breakdown BC solar cells

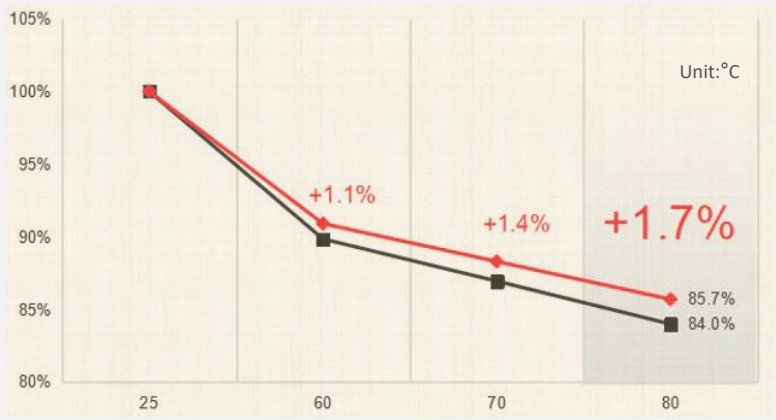


[1] C. Hollemann, et al, *Scien. Rep.* **10**, 1-15 (2020)
[2] R. Santbergen, et al, *IEEE JPV* **7**, 919-926 (2017)

BC MORE POWER GENERATION

Lower Temperature Coefficient

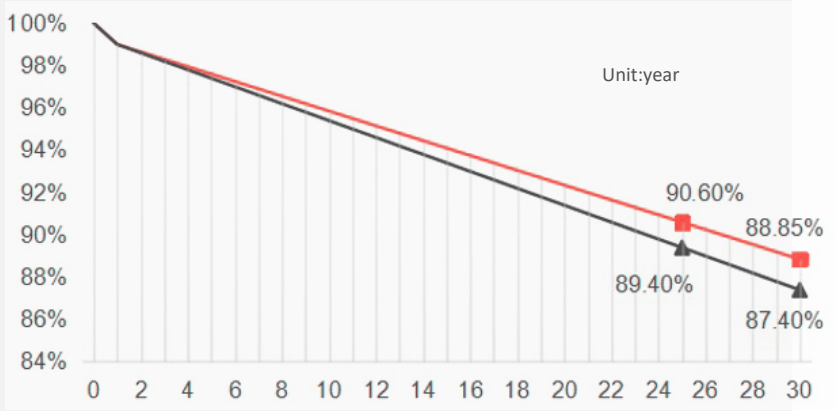
-0.26%/°C VS -0.29%/°C



For every 1°C increase, BC output power is 1KW higher than TOPCon +1.1% more energy at 60°C

Lower Power Degradation

BC ≤1%-0.35%/year TOPCon ≤1%-0.40%/year



The power retention after 30 years is 88.9%,

1.5% higher than TOPCon.

Source: available main data sheets in the market

18 YEARS BC FIELD DATA COLLECTION SHOWS <0.2% DEG.

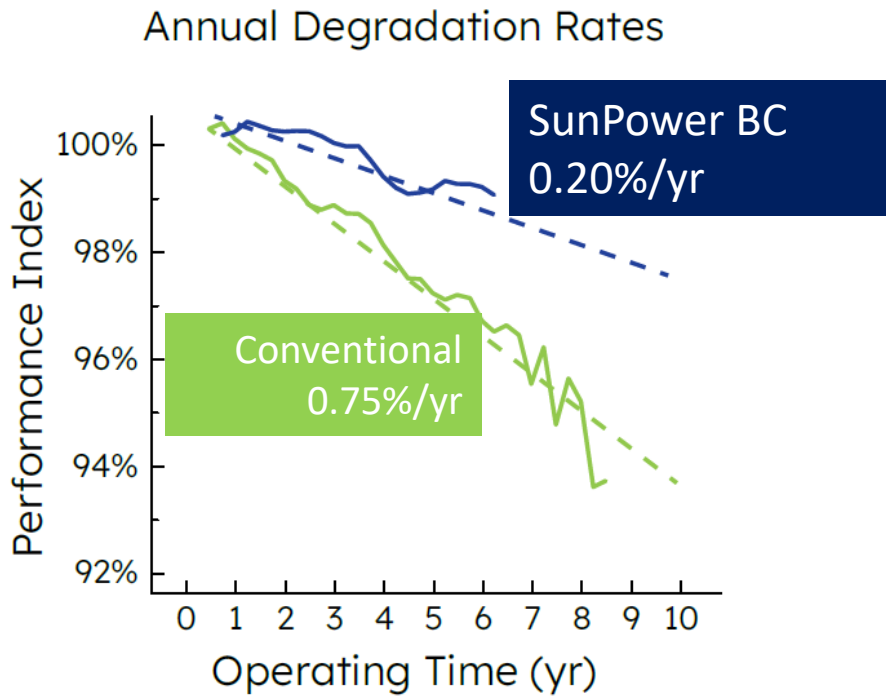
Lab results @ NREL since May 2007

System A: SPR-220-WHT (AR Coating)	
Median annual Degradation	**-0.10%**
Notes	• System continues to show no degradation within statistical uncertainty • Slight AR coating damage noted in 2020

System B: SPR-210-WHT (No AR Coating)	
Median annual Degradation	**-0.04%**
Notes	• System continues to show minimal degradation within statistical uncertainty • A few cracked cells identified in November 2018 have had no impact on production

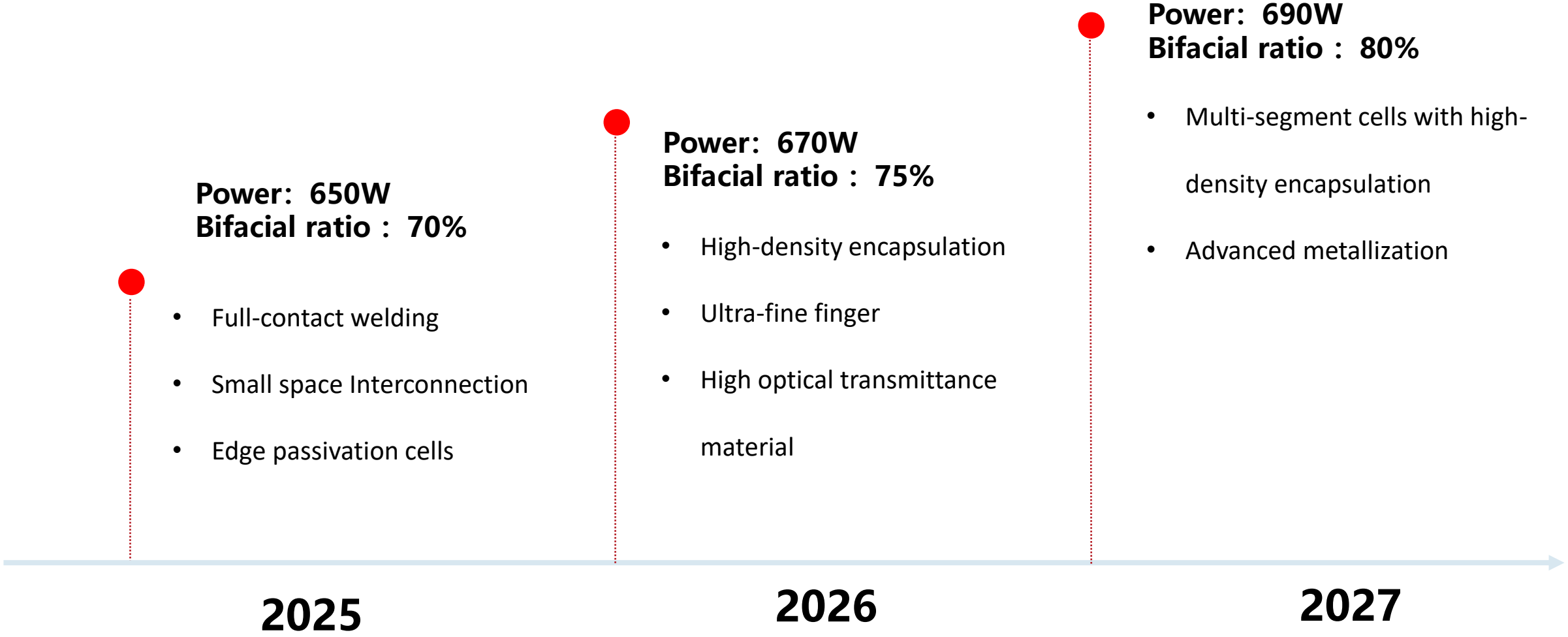
149 sites since 2009

- Study of 230MW, over 800,000 panels, Sunpower panels degrade at roughly 0.20% per year
- Conventional panels, including multi, mono and heterojunction technologies, demonstrated a combined degradation of ~0.75% per year[1].



1 Based on PVSYST simulations in typical climates; PAN files are third-party verified; compared to leading mono PERC panel. Chart Source: Jordan, D. et. al. "Robust PV Degradation Methodology and Application." PVSC 2019

UTILITY-SCALE BC TECHNOLOGY ROADMAP



BC EMERGING AS THE NEXT-GEN FOR UTILITY-SCALE PROJECTS

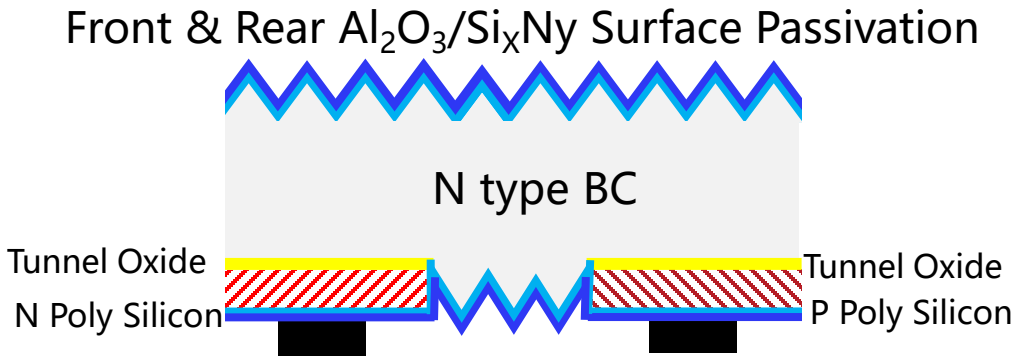
1. Recent technology improvements
   - Simplified metallization and laser patterning
   - Better yield rates and automation

2. Cost down through scale
   - Large Solar manufacturers invest heavily in BC lines
   - Mass production drives cost close to TOPCon

3. Streamlined processes
   - Integration of cells and modules assembly steps
   - Materials optimization

4. Access to Competitive Supply Chain

5. Vertical integration
   - Reduce depedency on third parties



Historically considered premium, recent developments are driving rapid cost reductions and making them viable for mainstream adoption and suited for large scale applications.

→ BC reduces BOS costs, helps with lower degradation and Temperature coefficient to improve LCOE for utility-scale projects and enable higher adoption lately.

SOLAR STAR
California, USA

- 747 MWp
- SunPower IBC
- 2015 completion

MONTALTO DI CASTRO Italy

- 85 MWp
- SunPower IBC
- 2011 completion

THANK YOU!