



ABC solar cell - towards single-junction Efficiency limit

Redefine Solar
For Carbon-free Society

BC Workshop
2023.11



Overview

110GW+

Solar Cell Output

5bn\$+

2022 Revenue

3

Global R&D Bases

17,000+

Employees globally

20% +

R&D experts

1,000+

Patents

Production Capacity

5 Production bases

61GW

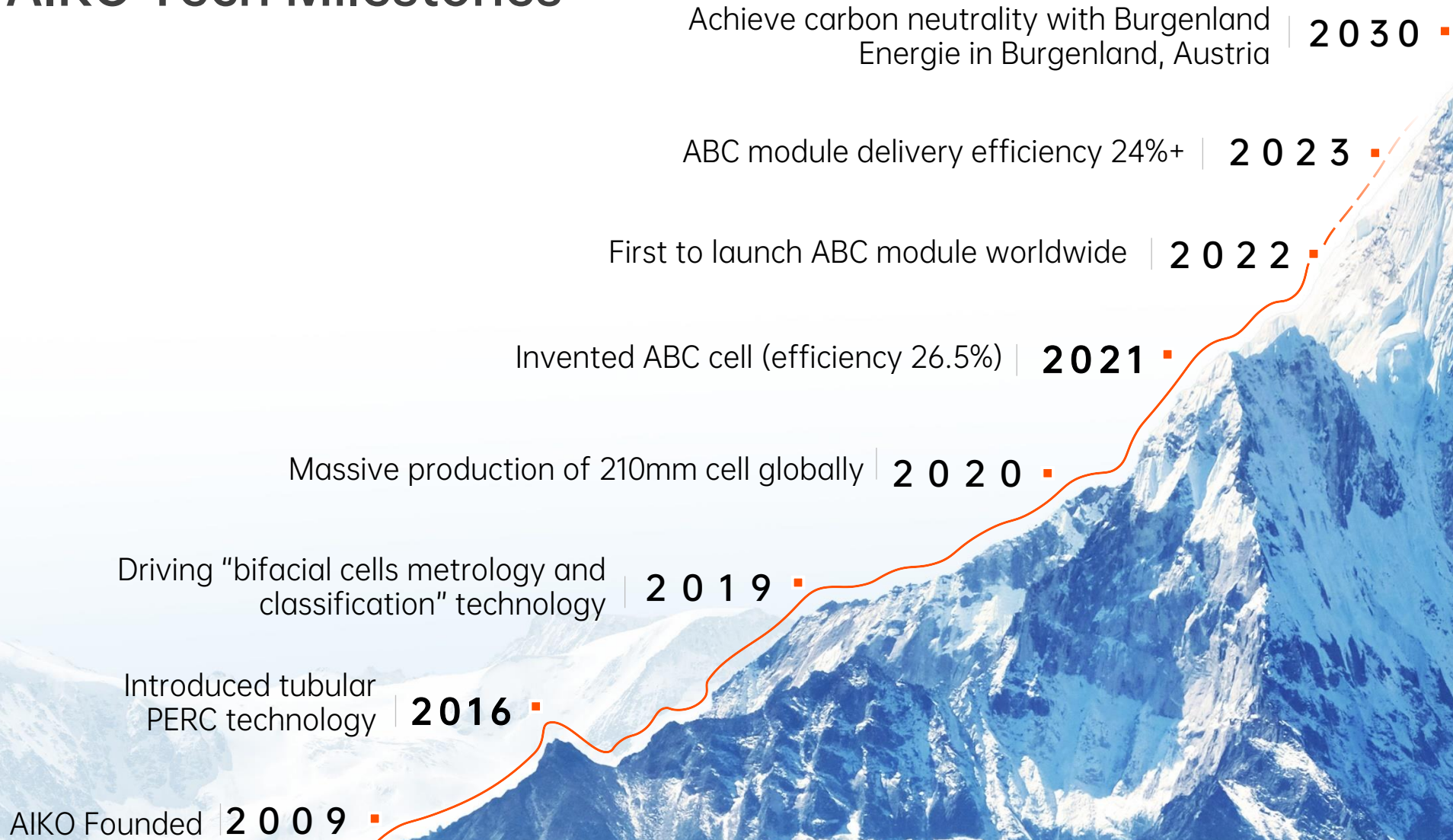
Annual Cell production capacity

25GW

ABC Module capacity



■ AIKO Tech Milestones



Global layout

Research and development investment in recent three years

350mn\$+

International research and development platform
Global Photovoltaic Joint Innovation Center
Solarlab AIKO Europe

The planned capacity of N-type cells

86GW

Five major production bases
Foshan Yiwu Tianjin Zhuhai Jinan



■ Overseas sales network

■ Production base

■ R&D platform

□ Subsidiary


In EU for EU – local team

EU local Team-more than 60 local employees



End to End Industrial Chain – quality/cost control

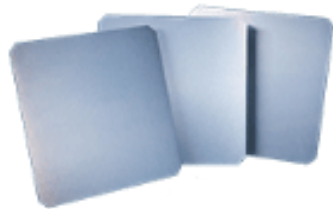
PolySilicon



丽豪半导体
LIFAO SEMICONDUCTOR

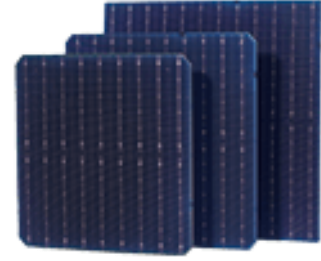
Asia Silicon

Wafer



高景太阳能
Gokin Solar

Cell



Module



One-stop Solution



AIKO ABC Product Portfolio

Residential Scenario

23.8% Delivery Efficiency
440-465W Delivery power rate



ABC Dual-Glass White Module- 54cell



ABC Dual-Glass Black Module-54cell



ABC Single-Glass White Module-54cell

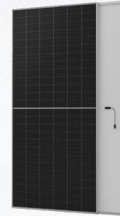


ABC Single-Glass Black Module-54cell



C&I Scenario

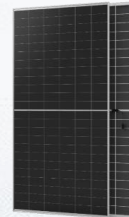
24.0% Delivery Efficiency
595-620W Delivery power rate



ABC Single-Glass White Module-72cell



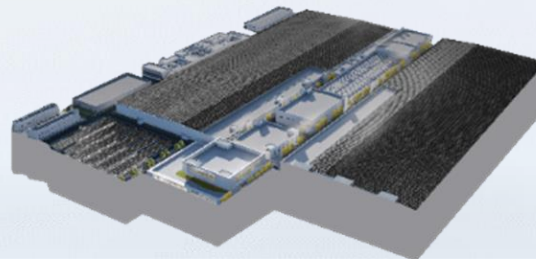
ABC Single-Glass Black Module-72cell



ABC Dual-Glass White Module-72cell

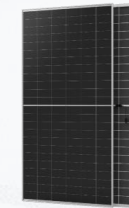


ABC Light Weight Module-54cell

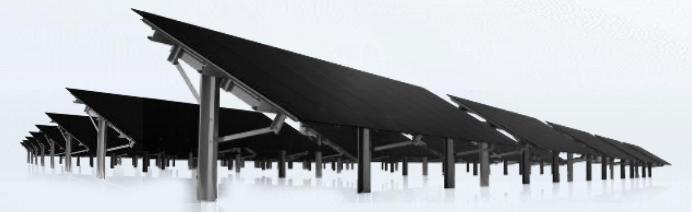


Utility Scenario

23.7% Delivery Efficiency
605-625W Delivery power rate

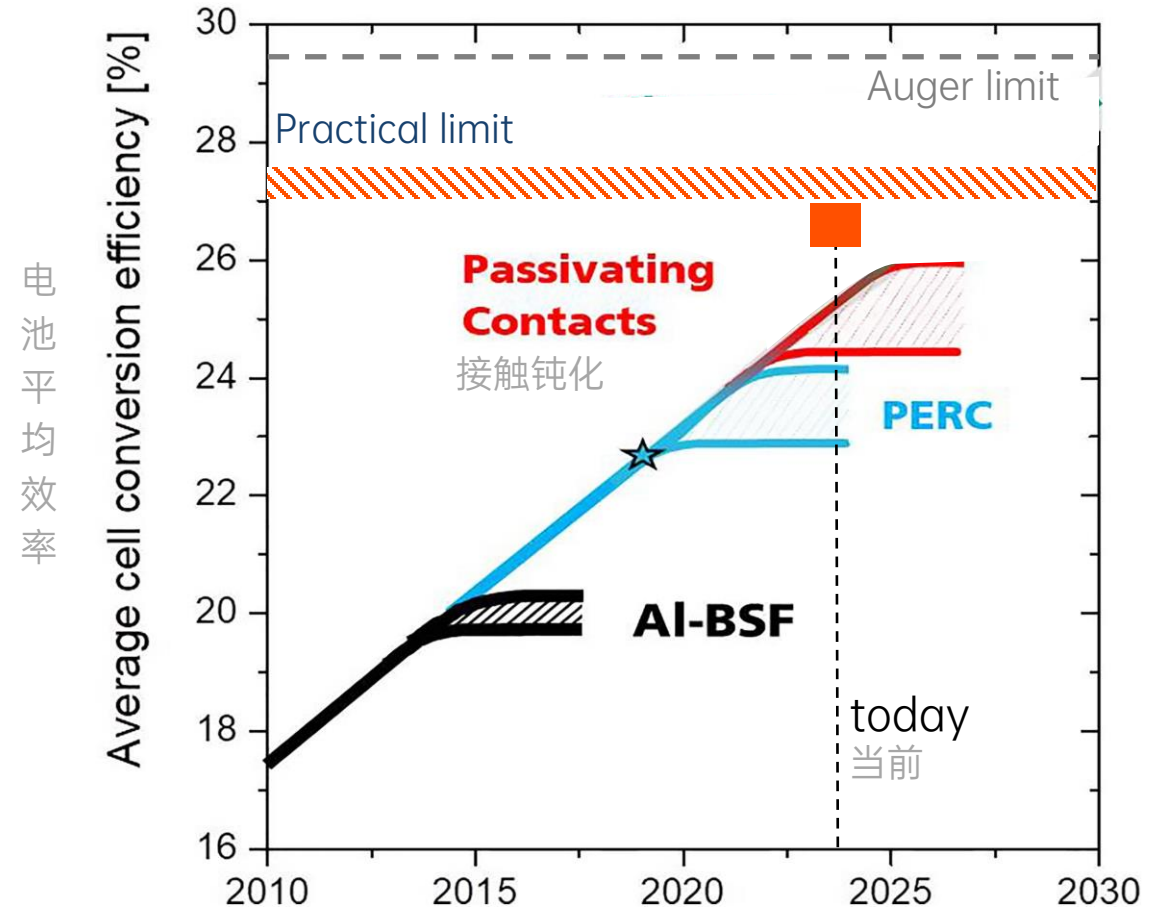


ABC Bifacial Dual-Glass White Module-72cell



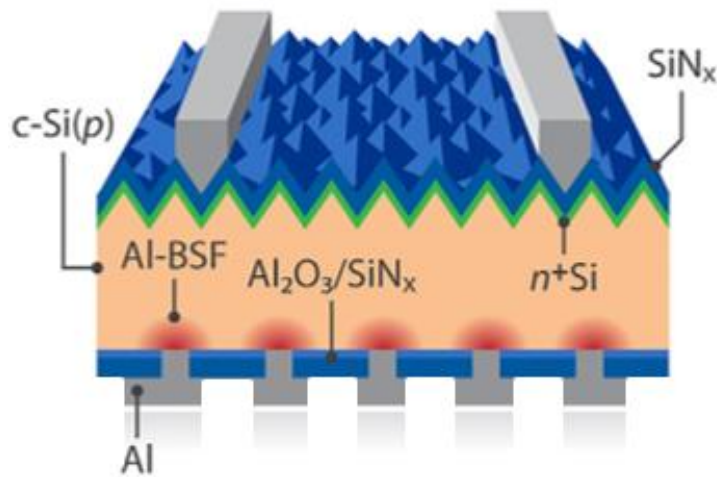
Efficiency Limits

- c-Si Solar cell technology is a single junction technology (1 p-n junction).
- theoretical efficiency limit of SJ cell:
GaAs: ~32.5 % ($E_g = 1.41$ eV)
Si: 29.4% (due to Auger recombination).
- Si world record: 26.8 % by LONGi on HJT technology (certified value)
- Aiko laboratory ABC cells 26.5% (not certified)
- very little room left for efficiency improvement in c-Si technology



M. Hermle, F. Feldmann, et al. *Appl. Phys. Rev.* (2020) DOI: 10.1063/1.5139202

PERC (Passivated Emitter and Rear Cell)

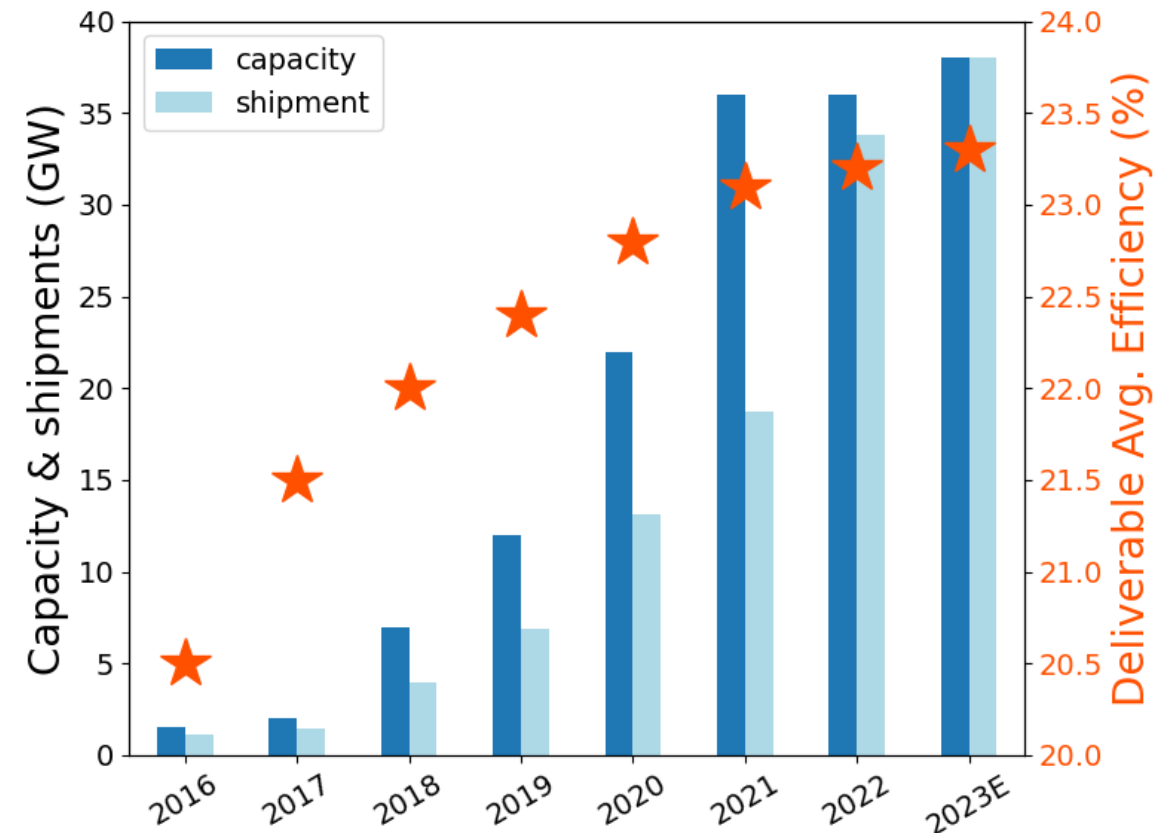


Median production:

	PERC
Eta (%)	23.60
Voc (mV)	697.47
Jsc (mA/cm ²)	41.25
FF (%)	82.01

- Eta potential: **24 %**

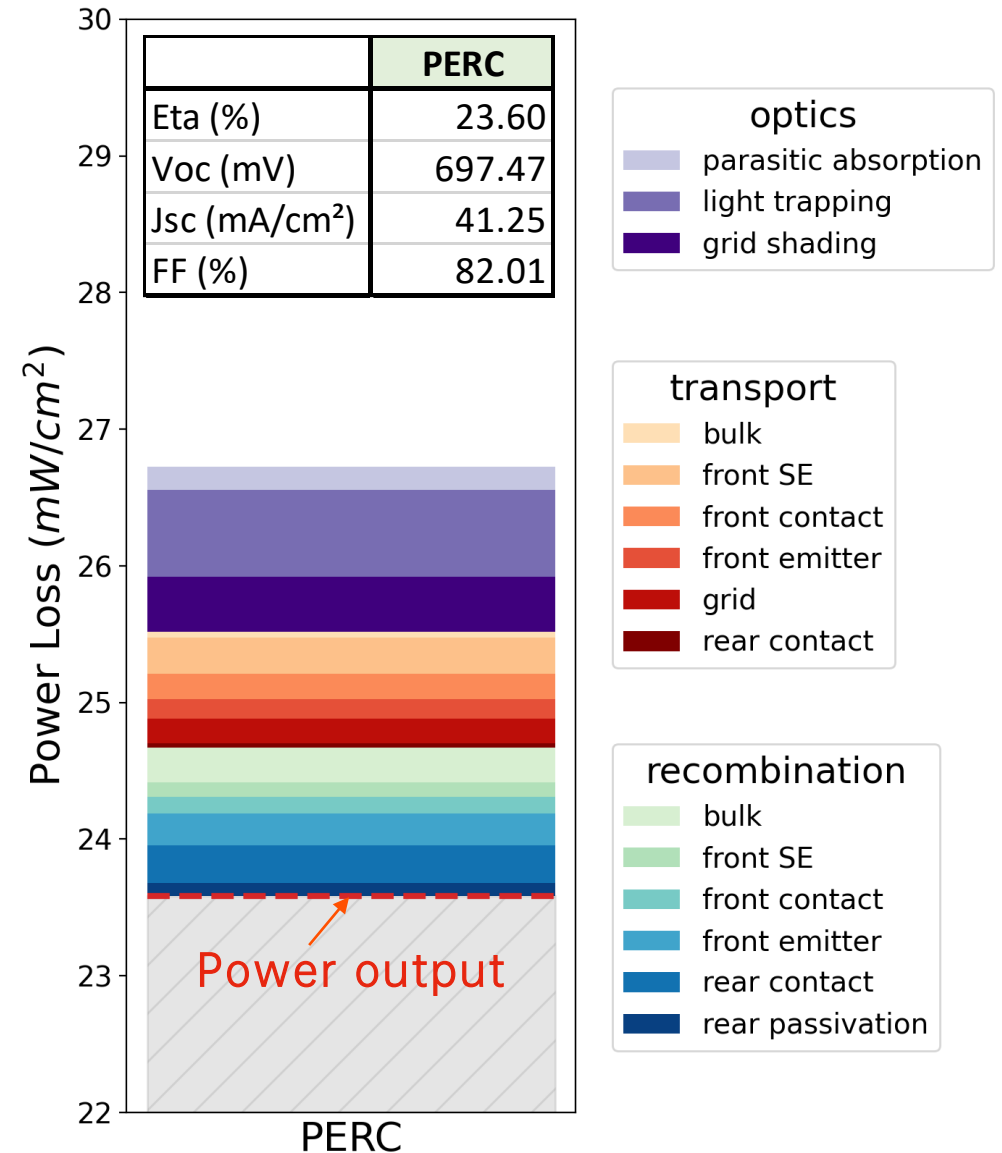
- PERC cell is the current working horse of the industry
- Aiko is a leading manufacturer of PERC solar cells



Motivation – How recombination impacts efficiency

Quokka Simulation of PERC Cell

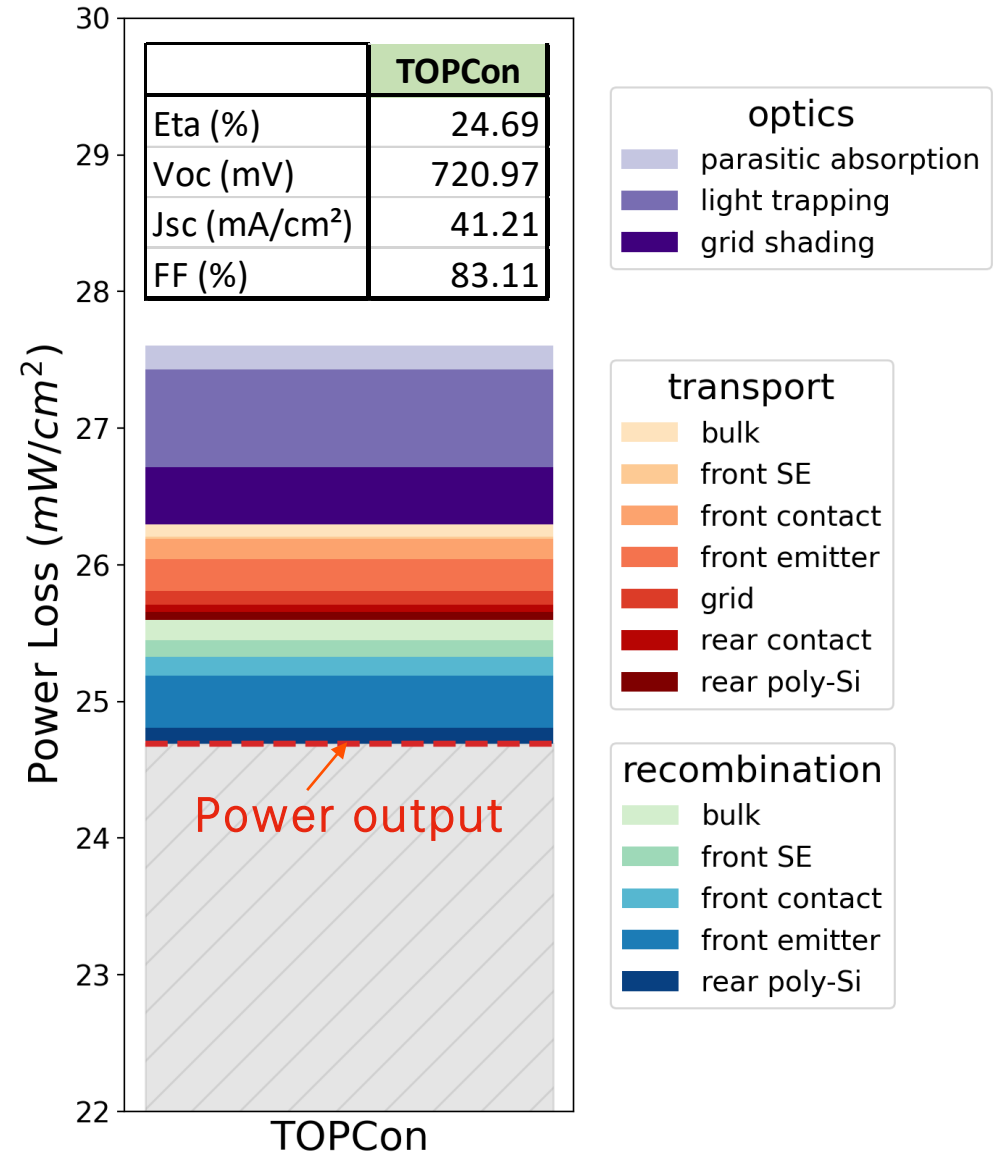
- Voc limited by recombination
 - at metal contacts
 - front emitter
 - bulk
- 3D transport in bulk affects FF
- ➔ Little room for improvement
- ➔ Switch to TOPCon



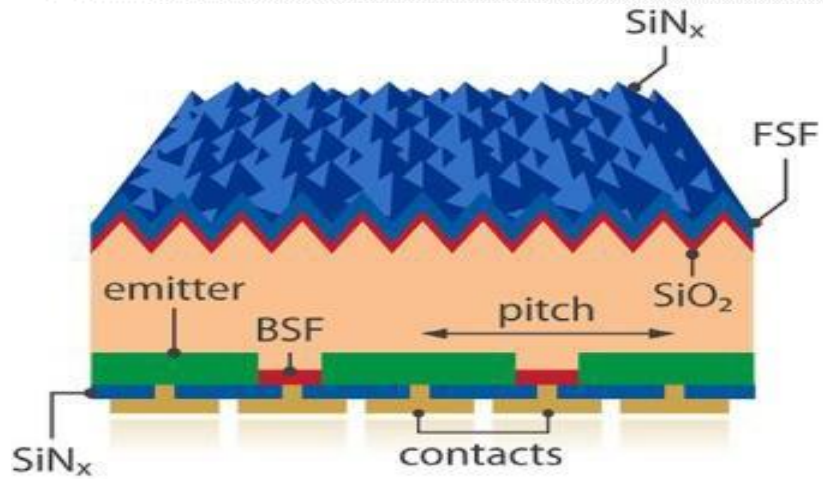
Motivation – How recombination impacts efficiency

Quokka Simulation of TOPCon Cell

- 25% efficiency possible in MP
 - Voc +20-30 mV compared to PERC
 - Efficiency significantly limited by
 - Recombination at front emitter and unpassivated front metal contact
 - Grid shading
- All back contact solar cell



ABC (Back Contact Technology)



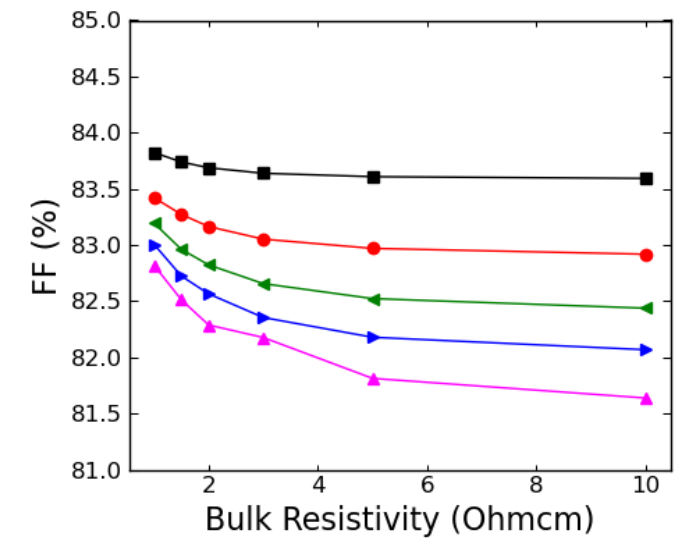
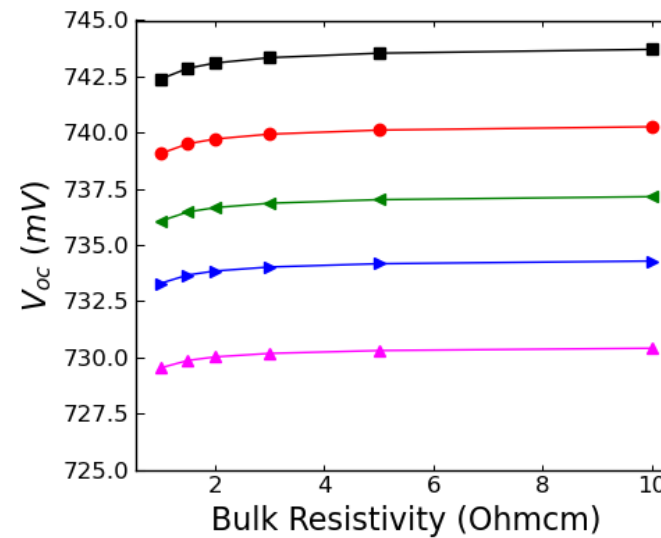
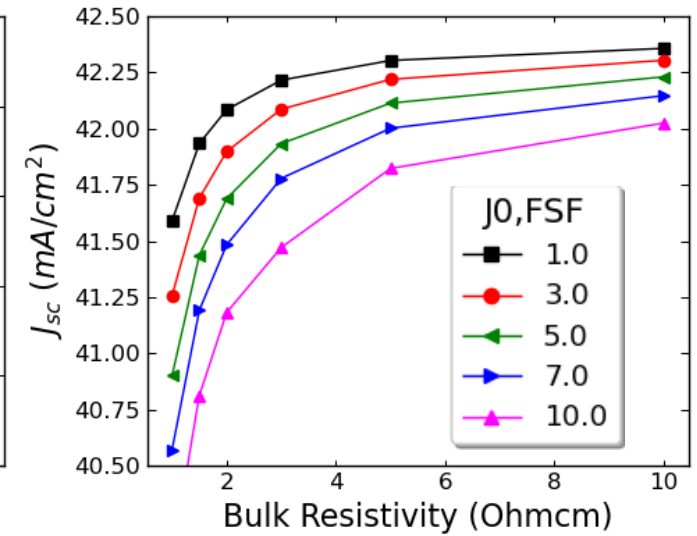
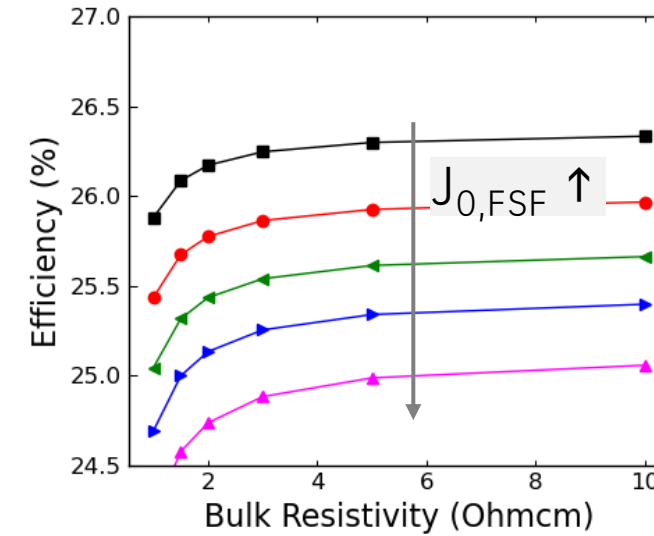
Eta potential: **26-28** %

- Metal grid on the rear
 - no shading losses → $J_{sc} \uparrow$
 - Grid can be optimized to minimize R_s losses → $FF \uparrow$
- Implementation of passivating contacts at rear
 - No trade-off between surface recombination and lateral transport losses
 - Negligible parasitic absorption losses

Design Criteria for ABC Cell

Quokka Simulation of ABC Cell

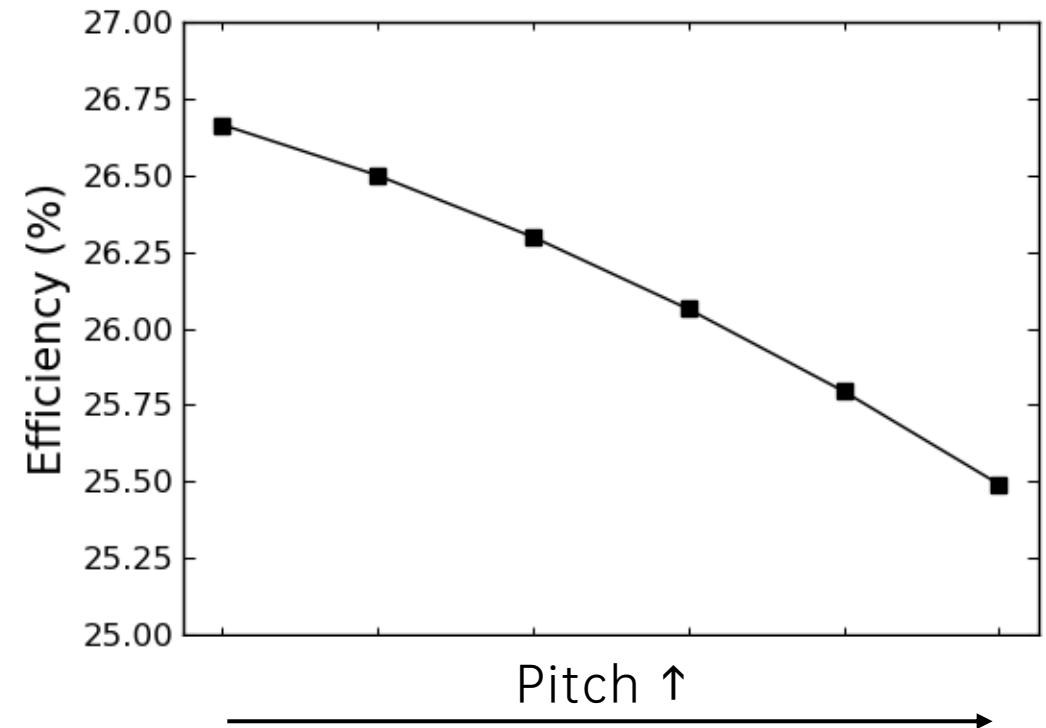
- Key design criteria:
 - Excellent front passivation
 - High bulk lifetime
 - Optimal wafer resistivity



Design Criteria for ABC Cell

Quokka Simulation of ABC Cell

- Key design criteria:
 - Excellent front passivation
 - High bulk lifetime
 - Optimal wafer resistivity
 - Narrow pitch
 - Well-passivating rear contacts

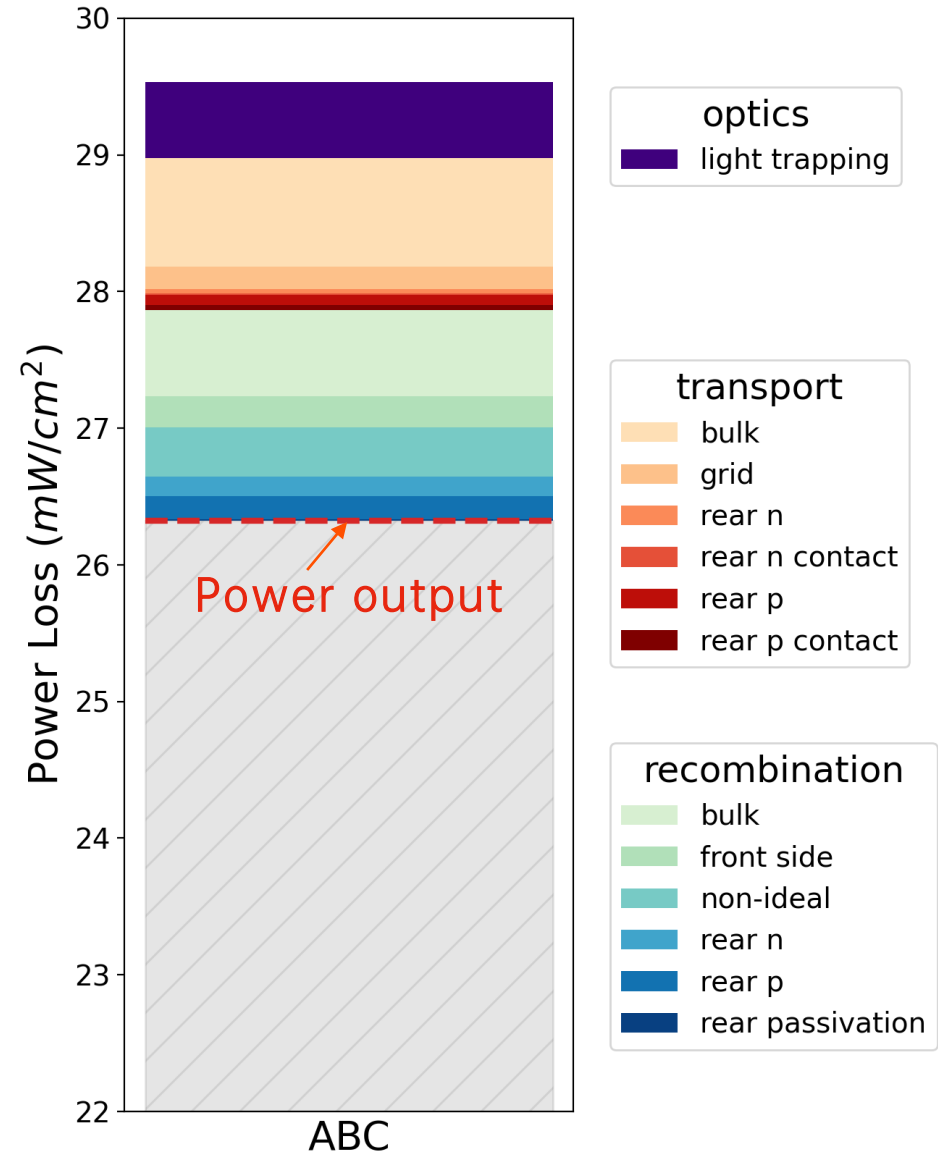


Motivation – How recombination impacts efficiency

Quokka Simulation of ABC Cell

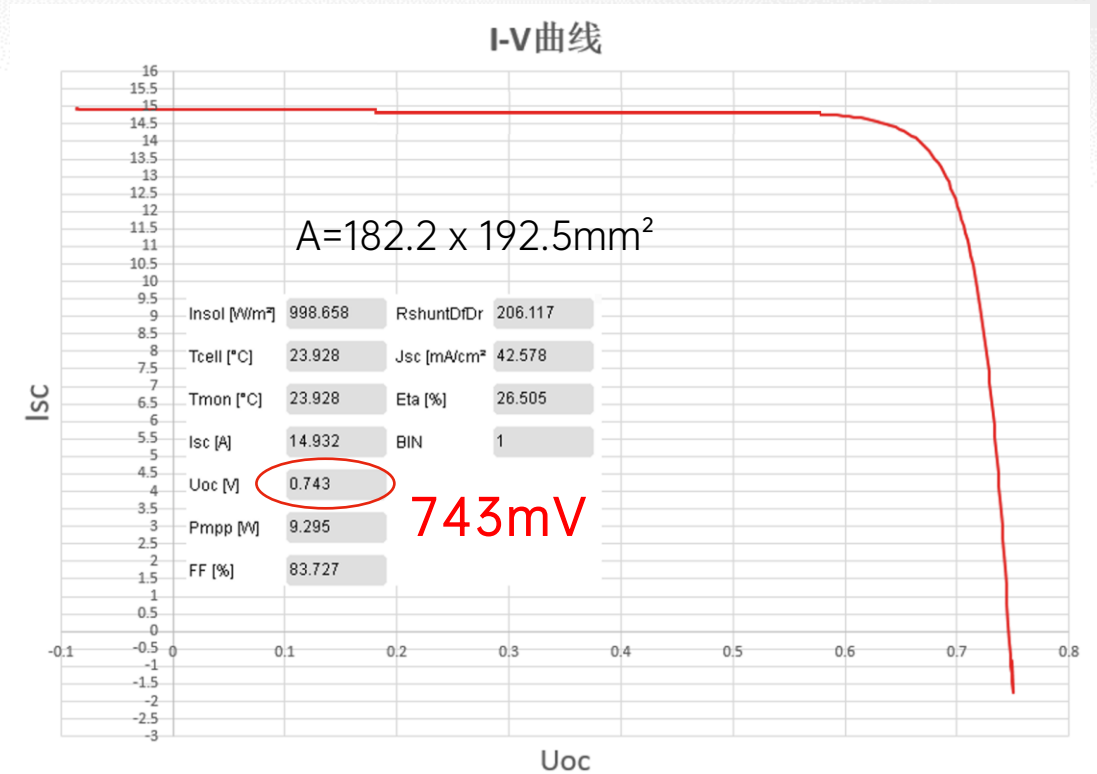
- Key design criteria:
 - Excellent front passivation
 - High bulk lifetime
 - Optimal wafer resistivity
 - Narrow pitch
 - Well-passivating rear contacts
- ➔ Eta > 26%

	PERC	TOPCon	ABC
Eta (%)	23.60	24.69	26.32
Voc (mV)	697.47	720.97	743.00
Jsc (mA/cm ²)	41.25	41.21	42.09
FF (%)	82.01	83.11	84.18



ABC (Back Contact Technology)

- AIKO mass produces ABC cell with >26% efficiency
- AIKO developed a patented **silver-free** metallization technology based on copper
- Sustainable for TW scale production levels
- Multi Busbar Interconnection Technology
- Effective reduction of R_s losses by shortening the finger length



Comparison of Solar Cell Technology

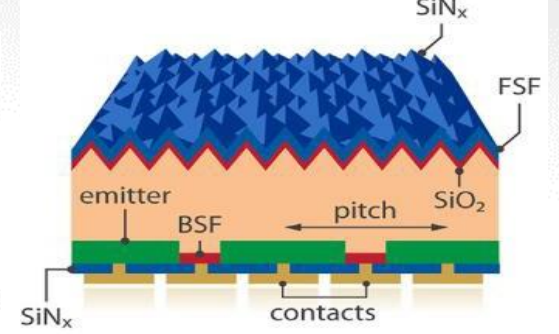
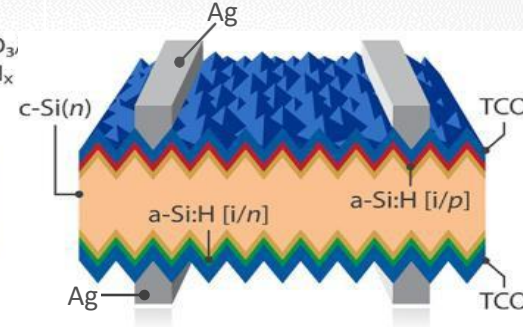
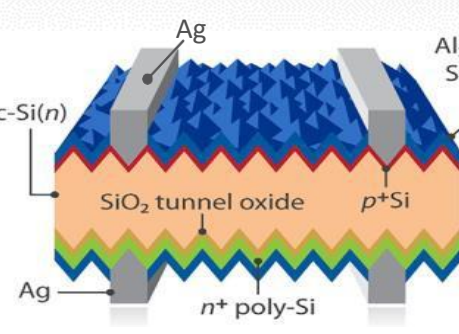
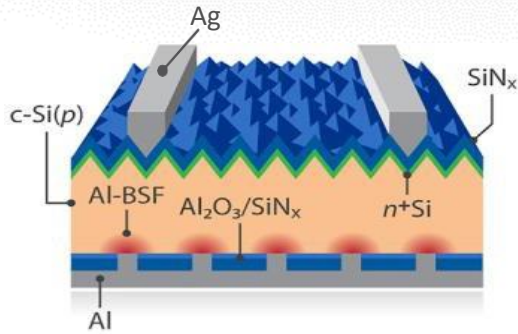
PERC

TOPCon

HJT

ABC

Cell Topology



Front Surface Shading

Yes
(3-5% Shading)

Yes
(3-5% Shading)

Yes
(3-5% Shading)

No
(0% Shading)

Ag-based Metallization

Front+Back
(~70mg)

Front + Back
(~110mg)

Front + Back
(~150mg)

No
(0mg)

Metallization Temperature

>700°C

>700°C

~200°C

>700°C

/

/

/

/

/

Voc

700mV

720mV

>740mV

>740mV

ETA Potential

24%

25-26%

25-26%

26-28%

ABC Technical Whitepaper - Core Technologies



Hotspot Protection and Module-level Optimization Technology

under development



Full cell area for light absorption and power generation



Totally passivated front side and Passivated Contacts on back side



All Back Passivated Contact Technology



Ag-free Metallization Technology



End-to-end Value Chain Innovation

from poly-Si to One-Stop Solutions

Industrial Top -0.26% Temp Coefficient

-0.26% Industrial Top Temp Coefficient
Certified by PV Magazine Test Report

+2.43% Extra Gain per Wp due to Better Temp Coefficient
Real-life Test @Quartar Doha

CEA | PV MAGAZINE PROGRAM TEST REPORT
SUPPLIER | Aiko

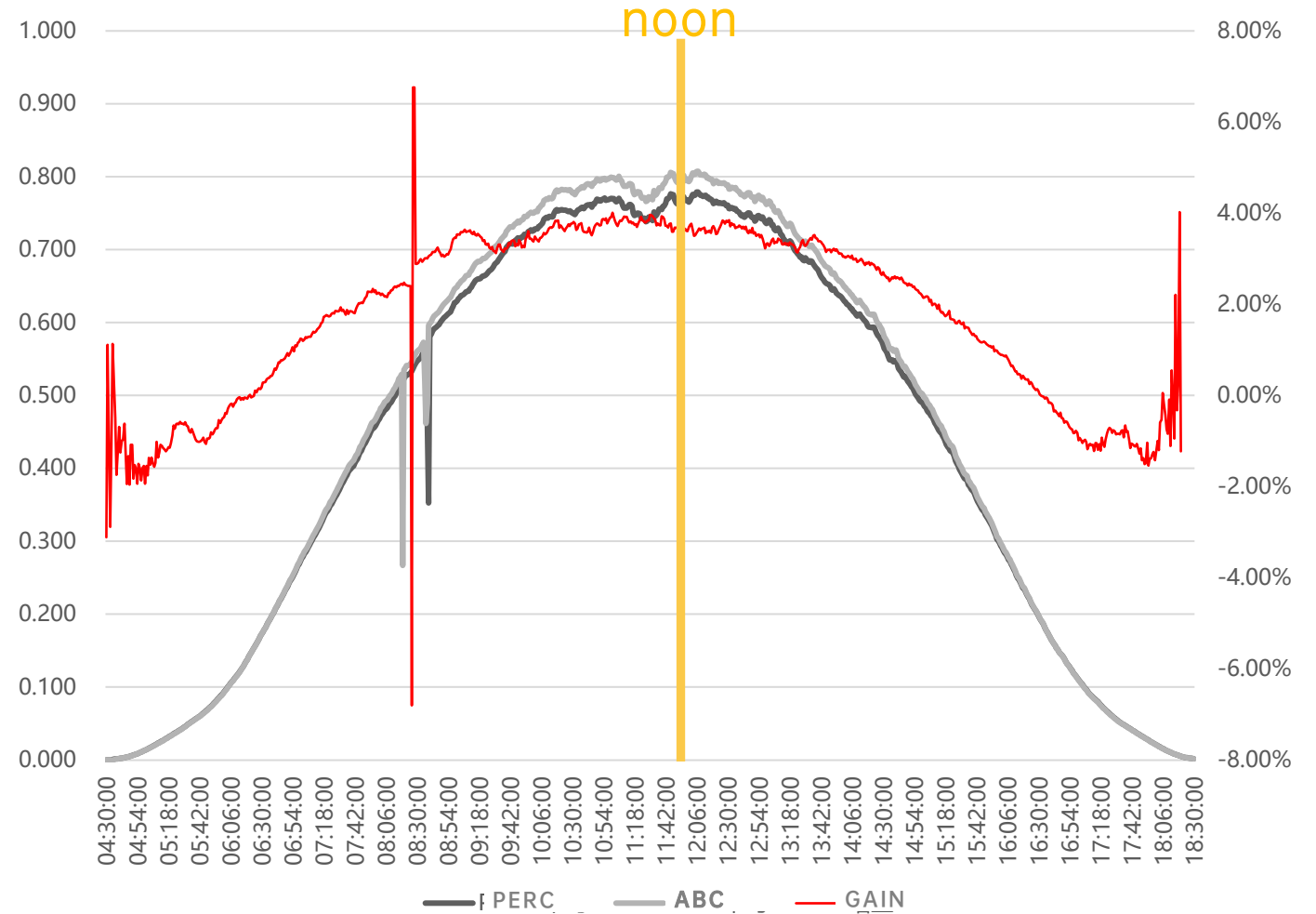
3.4. Pmax temperature coefficient test

Table 9 and Figure 5 depict the Pmax temperature coefficient test results.

Table 9 Pmax temperature coefficient test result

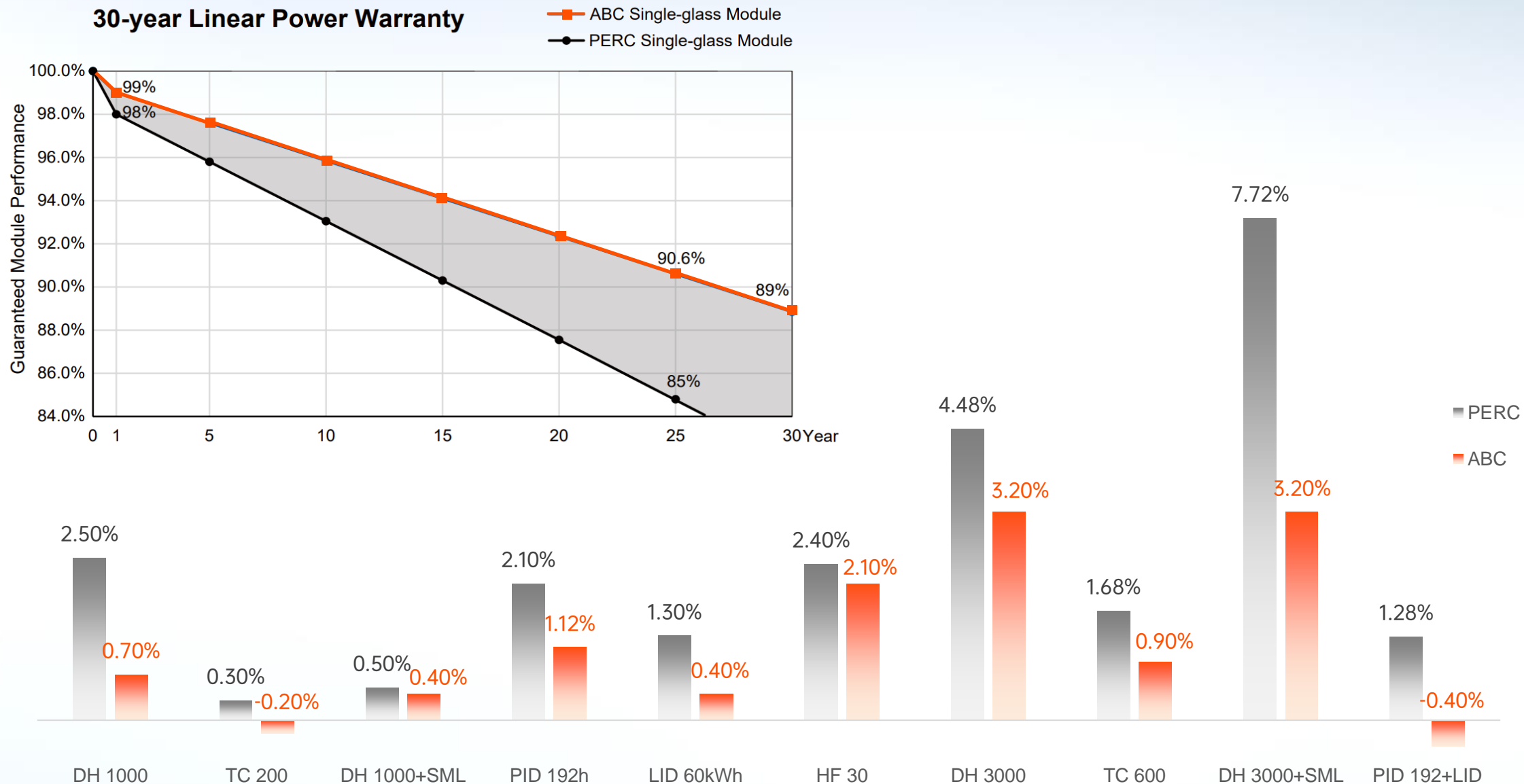
AIKO-A-MAH72MW	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Grade
Pmax Temperature coefficient (%/°C)	-0.26%					107

Figure 5 Pmax temperature coefficient test result

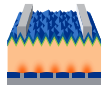


Better Quality: 89% power output after 30 years

30-year Linear Power Warranty



Key Features of ABC Module



Better Quality

Power temperature coefficient: $-0.26\%/^{\circ}\text{C}$

Longer warranty, lower degradation



Product warranty



Performance warranty



Higher Generation

15%+ higher yield, same area
Compared with PERC

Degradation
1st year $\leq 1\%$
year-by-year $\leq 0.35\%$



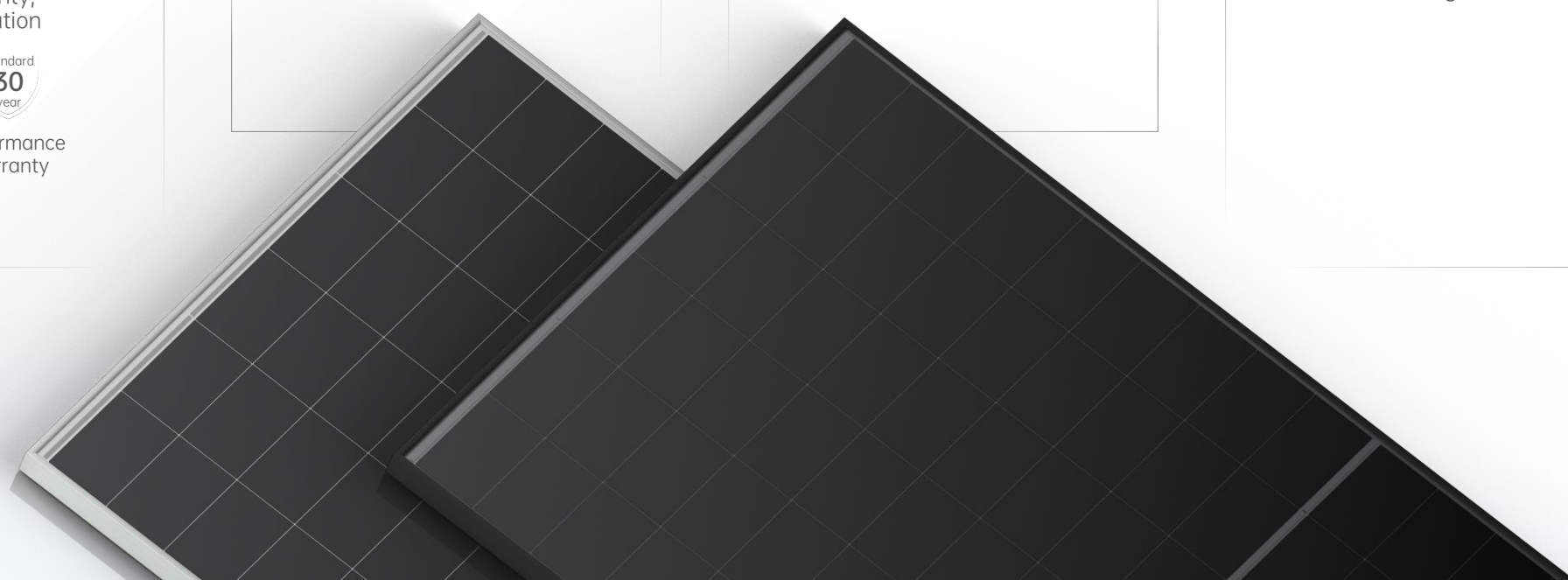
Lower BOS

7%+ BOS reduction
compared with PERC modules



Extreme Aesthetics

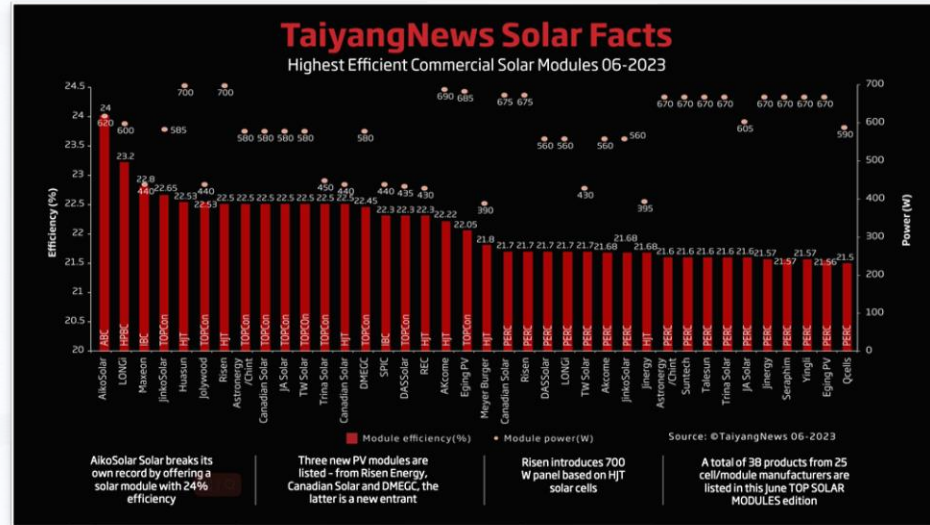
Pure-black front
without gridlines



2023 Red Dot Design Award



TaiyangNews Mass Production TOP Module List



Intersolar Award 2023





MISSION ZERO

The green-powered
vineyard



AIKO 

FIND YOUR POWER

