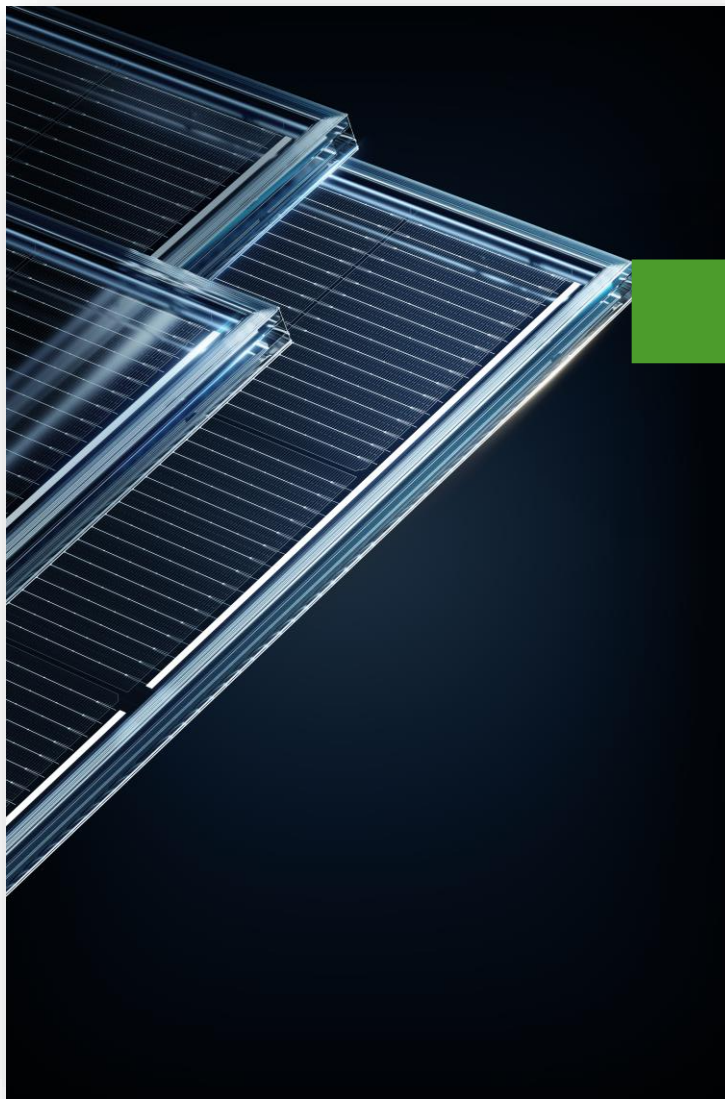




N-type TOPCon Technology Leadership

- Carlos Magistris
- Senior Technical Service Manager EU

Table of Contents



01 JinkoSolar Introduction

02 Tiger Neo Series

03 Technical Roadmap

04 Strategies for Success

05 Conclusions

Jinko Performance: Global Leader

210GW

Delivered

* 2023 Q4

No.1

2016-2019
Module Shipments

25

World Records

110GW

Total Module
Capacity

* 2023 Q4

55GW

N-type TOPCon
Module Capacity

* 2023 Q4

15%

Market Share

**Data as of 2023 Q2

Global Leader in Technological Innovation



2000+

Granted
Patents



2278

R&D
Team



409

Patents
applications



6.9Billion

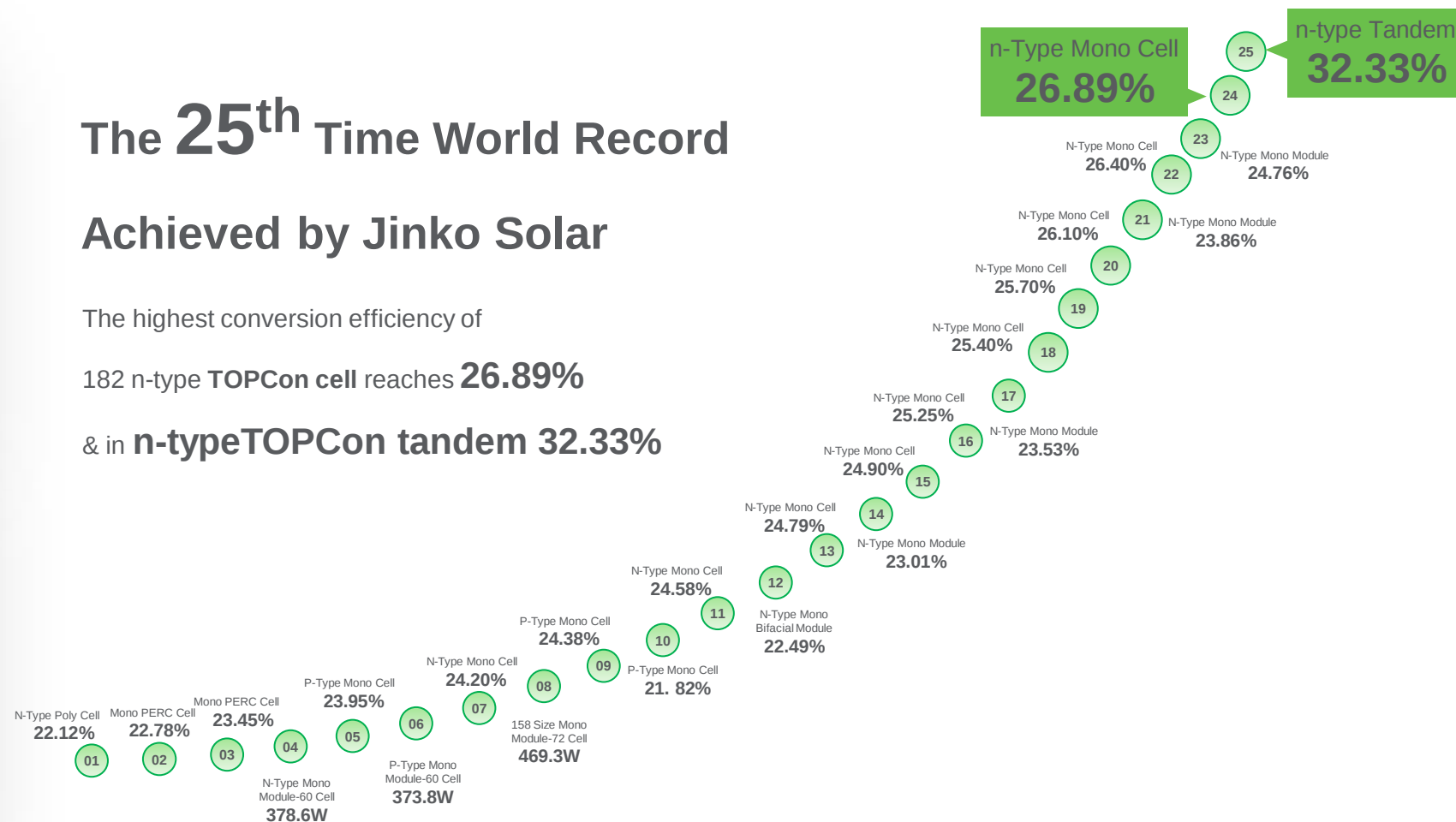
(CNY)
R&D
Investments

The 25th Time World Record Achieved by Jinko Solar

The highest conversion efficiency of

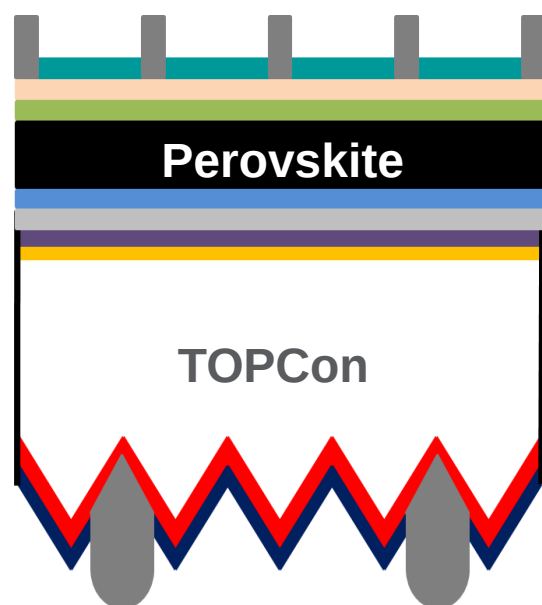
182 n-type TOPCon cell reaches **26.89%**

& in **n-type TOPCon tandem 32.33%**

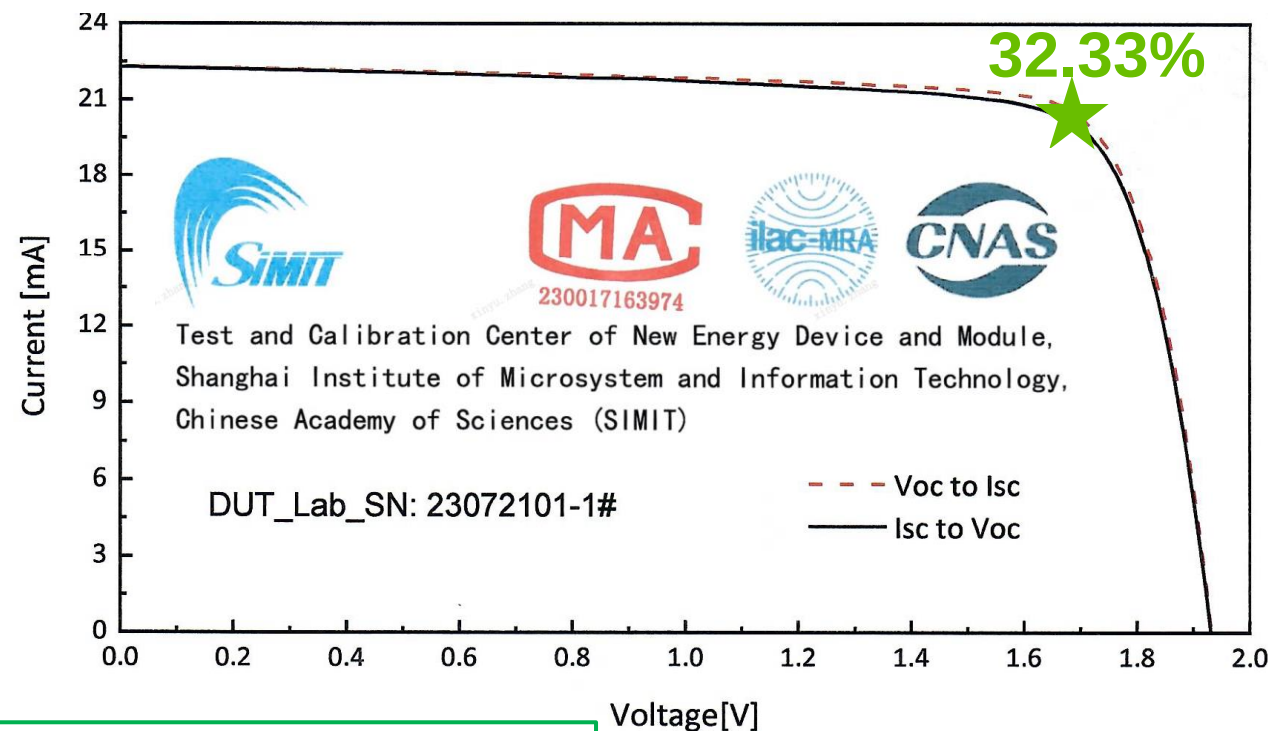


Future- Tandem Structures: Perovskite/TOPCon

JinkoSolar's **New Cell Efficiency Record of 32.33%** achieved on perovskite/TOPCon tandem

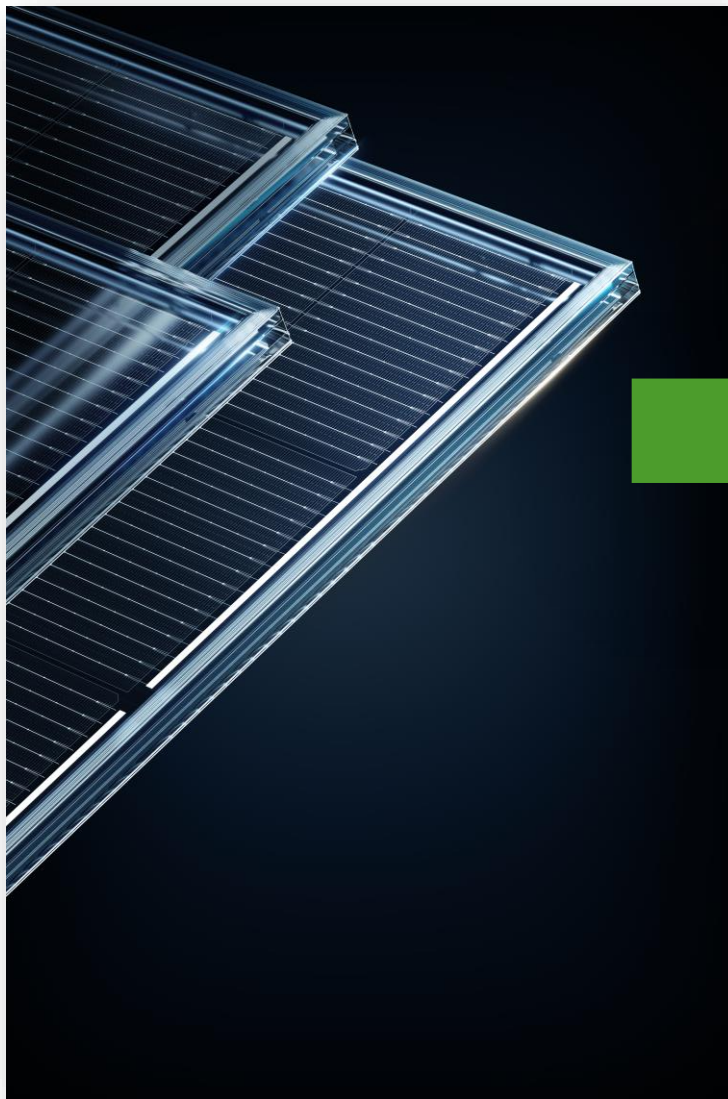


Boosting PCE



- ① **Surface passivation:** optimization of the passivation layer
- ② **Bulk passivation:** additive engineering to lower the hysteresis effect
- ③ **Recombination layer optimization:** high quality TCO with low resistance

Table of Contents



01 JinkoSolar Introduction

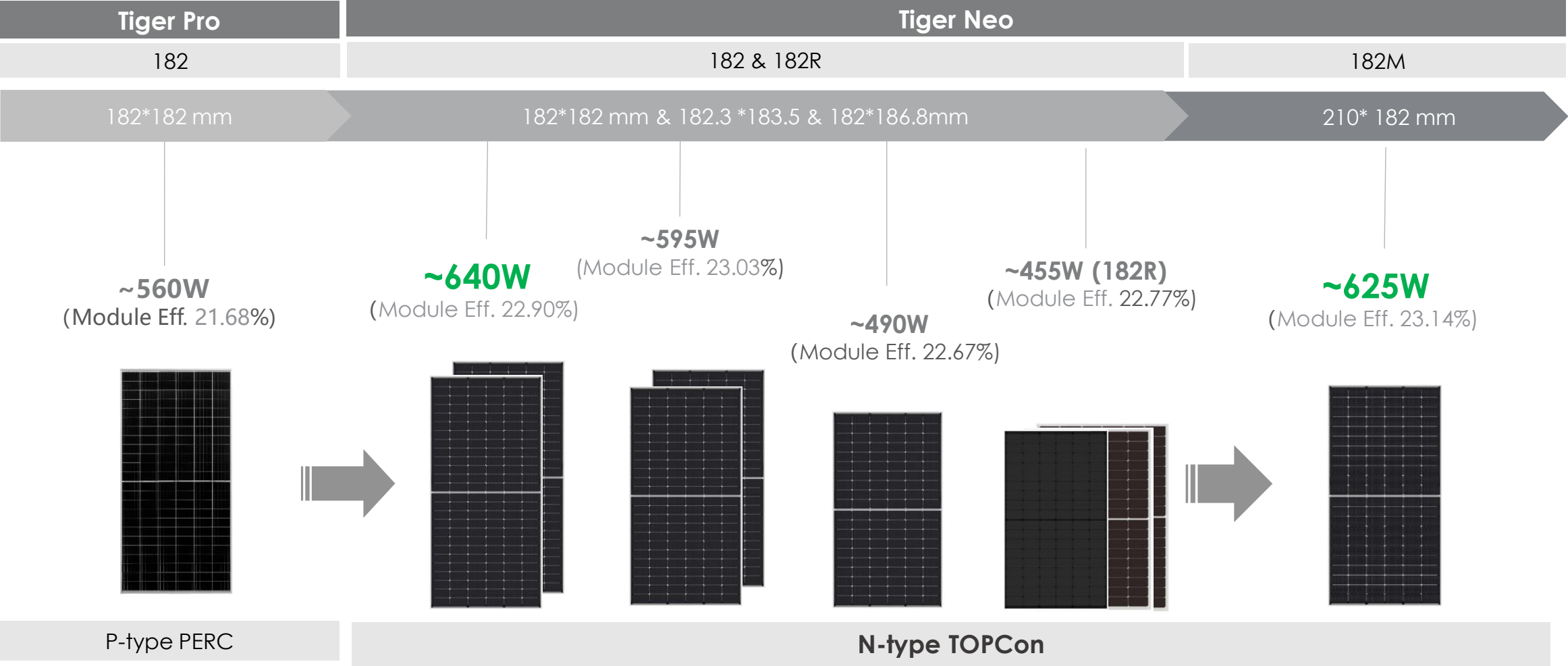
02 Tiger Neo Series

03 Technical Roadmap

04 Strategies for Success

05 Conclusions

Product Portfolio — Tiger Pro and Tiger Neo



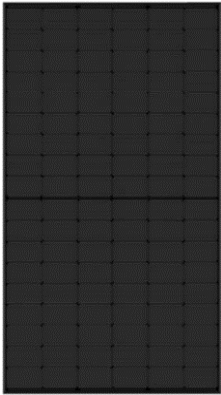
*Based on the maximum prediction power of corresponding mono-facial modules in 2024

Tiger Neo Series 2024 — Portfolio



Tiger Neo

- TOPCON technology
- Higher power
- Higher efficiency
- Lower degradation
- Higher bifaciality

182.3*210mm		182*186.8mm
		
JKMxxxN-66HL4M-BDV	JKMxxxN-66HL4M-(V)	JKMxxxN-54HL4R-BDB
600-620W	610-625W	425-445W
22.21-22.95%	22.58-23.14%	21.27-22.27%
2382*1134mm	2382*1134mm	1762*1134mm
66P	66P	54P
Bifacial	Monofacial	Bifacial-All Black

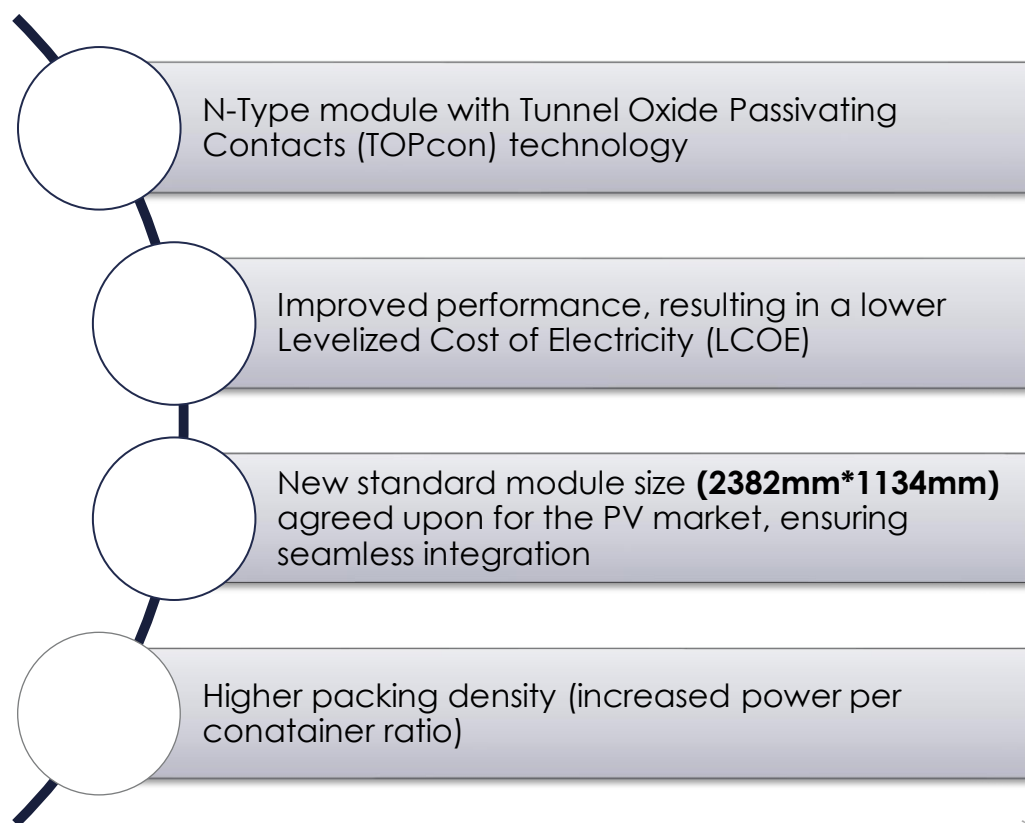
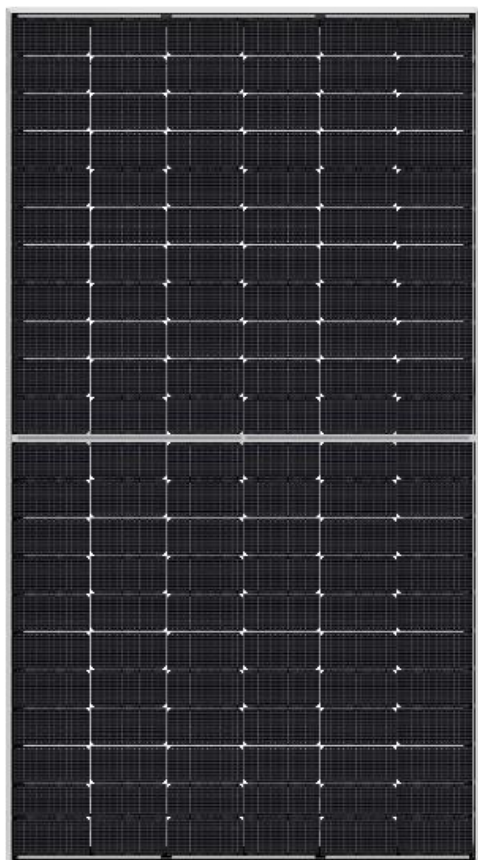
.Maximum power is based on the highest efficiency BOM of 2024 Q4 Forecast

Tiger Neo Series 2024 — Utility



Maximizing Energy Generation, Lowering Costs

66 Bifacial Dual Glass JKMxxxN-66HL4M-BDV & 66 Monofacial JKMxxxN-66HL4M-V



15GW+

Module capacity*

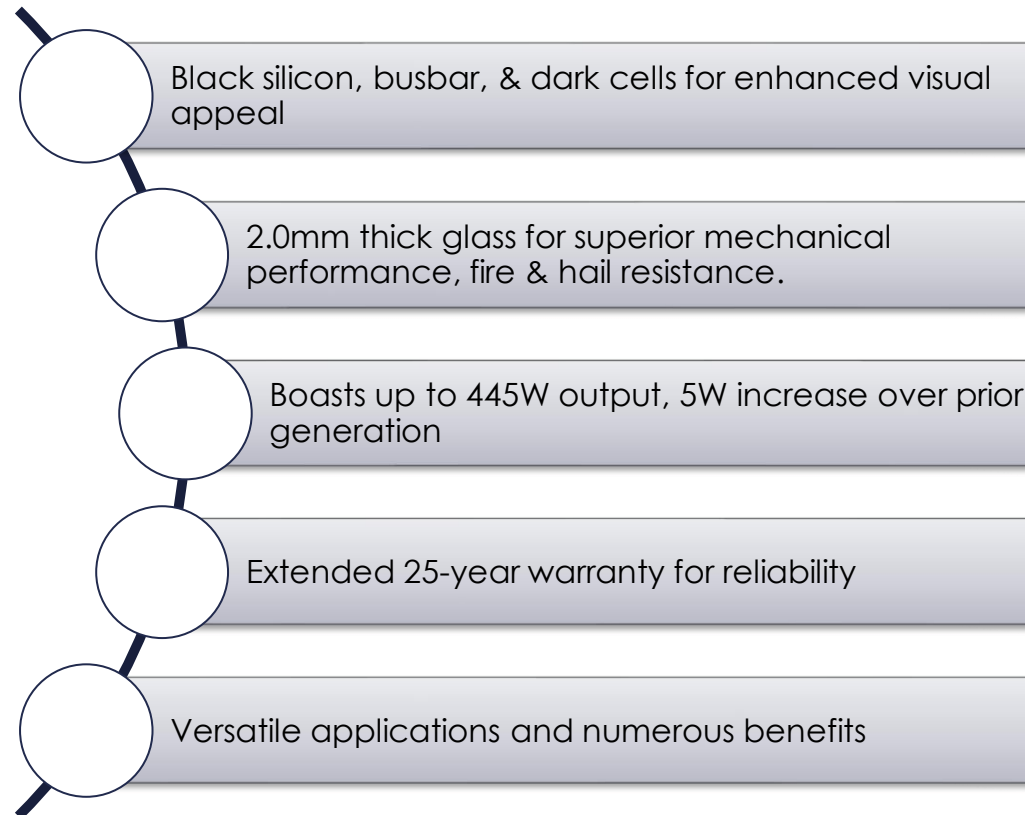
*Tiger Neo 66 Monofacial & Bifacial Dual Glass

Tiger Neo Series 2024 — Residential



Elevate Aesthetics, Amplify Performance

54 Bifacial Dual Glass: JKM425-445N-54HL4R-BDB



Special Products — Triple-Advantage Module



Empowering Resilience: Unbeatable Strength, Hail & Fire

72 Bifacial Dual Glass: JKM570-590-72HL4-BDX

Power Range: **570 – 590W**

Module Eff.: **22.07-22.84%**

Module Dimension: **2278*1134mm**

Glass thickness: **2.5mm** (front & rear)

Weight: **36.8kg**

Cell Qty: **72 pcs**

Packing: **648 pcs/40'HQ container**



N-Type module with Tunnel Oxide Passivating Contacts (TOPcon) technology

Improved Hail Resistance- Passed the IEC 61125-2 for **55 mm diameter ice-ball**.

Enhanced mechanical loads: Certified to withstand **+6000 Pa /-4000 Pa**

Enhanced Fire Rating: Obtained **Fire Rating A** (TÜV Nord/TÜVRheinland/TUV Süd/UL test report)

Special Products — Offshore Tough Module



Unyielding Performance for Offshore Demands

72 Bifacial Dual Glass: JKM570-590-72HL4-BDV-U

Power Range: **570 – 590W**

Module Eff.: **22.07-22.84%**

Module Dimension: **2278*1134mm**

Glass thickness: **2.0mm** (front & rear)

Weight: **31 kg**

Cell Qty: **72 pcs**

Packing: **720 pcs/40'HQ container**



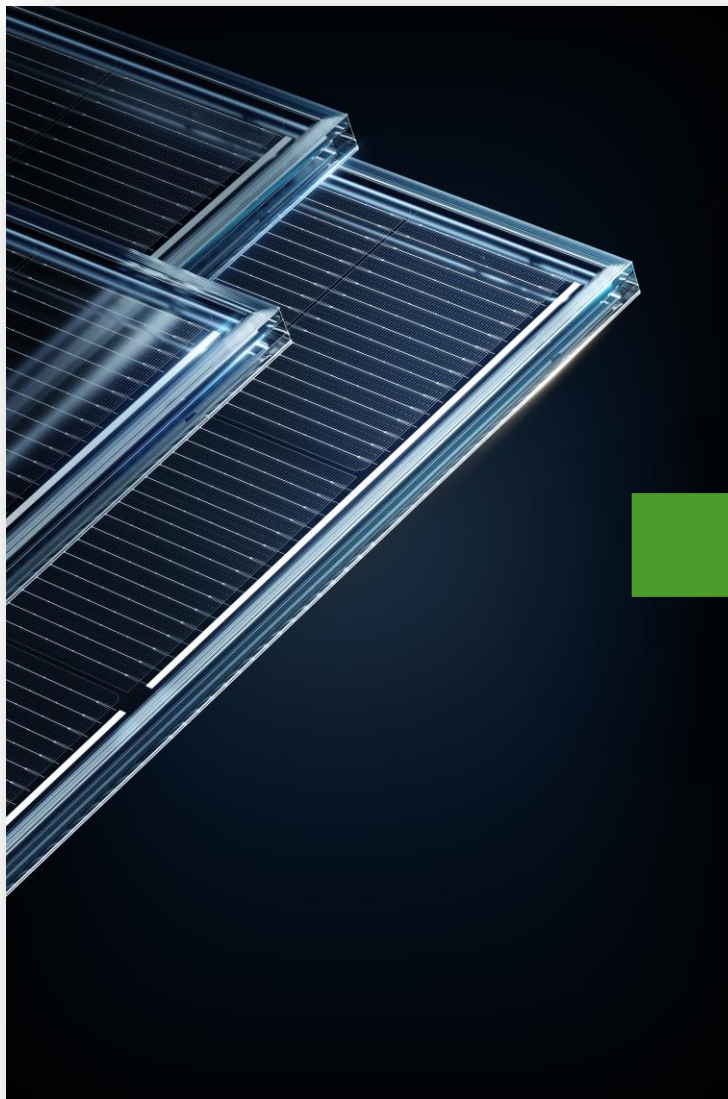
N-Type module with Tunnel Oxide Passivating Contacts (TOPcon) technology

Improved Resistance to moisture, corrosion, salt mist and other environmental factors.

Enhanced mechanical loads, stronger reliability and safety, proven with additional testing.

Enhanced thermal and UV resistivity, due to a comprehensive Bill of Material (BOM) selection.

Table of Contents



- 01 JinkoSolar Introduction
- 02 Tiger Neo Series
- 03 Technical Roadmap**
- 04 Strategies for Success
- 05 Final conclusions

Technical Roadmap: Why TOPCon?

Higher Theoretical Limits

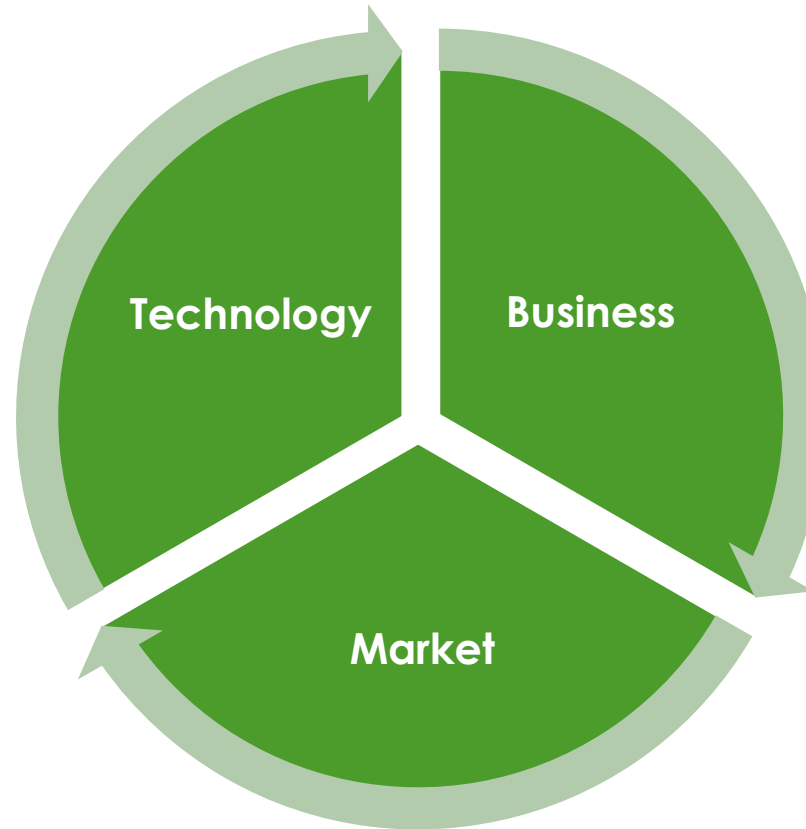
$\eta = 28.7\%$ vs. Others^[1,2]

Mass Production Viability

Lowered delamination,
hotspot, and moisture risks

Maturity & Compatibility

PERC experience

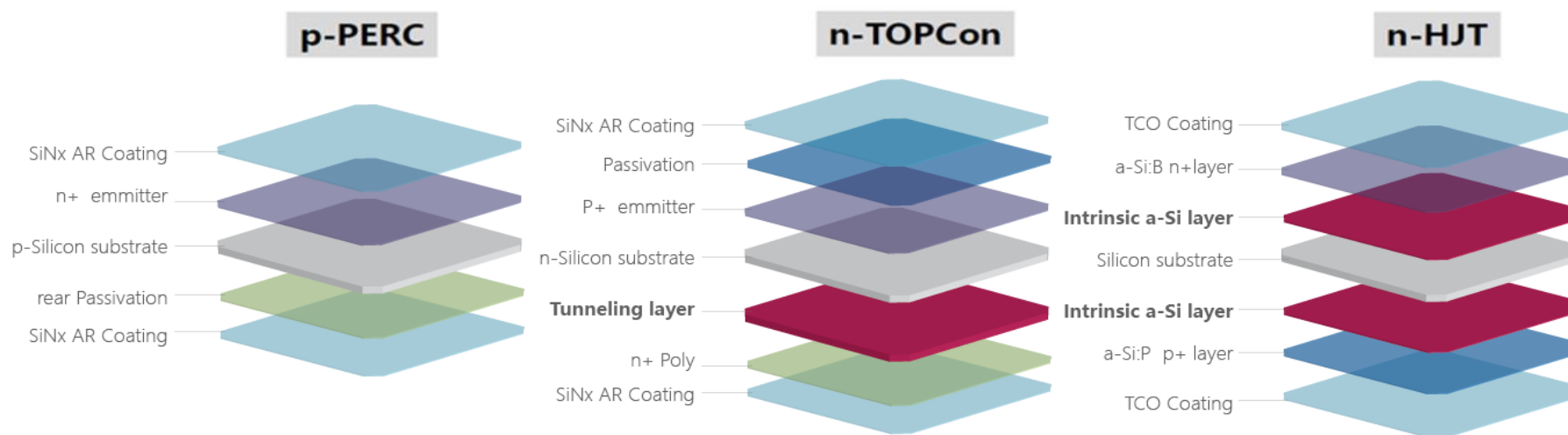


Costs
Supply Chain
Operational Efficiency

Market Demand & Trends
Regulatory Landscape

- [1] Brendel, R., Rienaeker, M. & Peibst, R. 2016, "A quantitative measure for the carrier selectivity of contacts to solar cells", Proc. 32nd EU PVSEC, Munich, Germany, doi:10.4229/EUPVSEC201620162CO.4.1.
[2] Brendel, R. & Peibst, R. 2016, "Contact selectivity and efficiency in crystalline silicon photovoltaics", IEEE J. Photovolt., Vol. 6, No. 6, pp.1413–1420, doi:10.1109/JPHOTOV.2016.2598267.

Technical Roadmap: Features Comparison

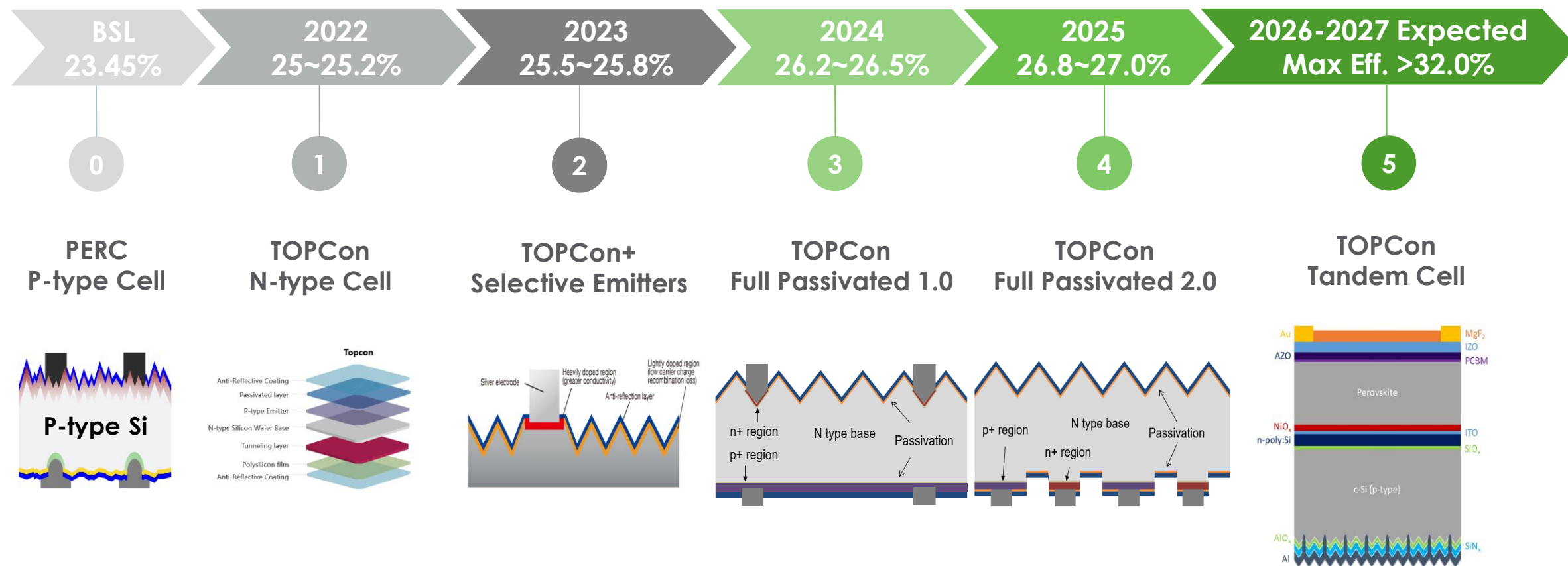


	p-PERC	n-TOPCon	n-HJT
Theoretical Efficiency	24.50%	28.70%	>28%
Temp. Coefficient	~ -0.34	~ -0.29 (*)	~ -0.27
Bifaciality	~75	~80	~85
Delamination Risk	Low	Low	High
Moisture Sensitivity	*	*	*****
Hot Spot Risk	*	*	*****

[1] Brendel, R., Rienaeker, M. & Peibst, R. 2016, "A quantitative measure for the carrier selectivity of contacts to solar cells", Proc. 32nd EU PVSEC, Munich, Germany, doi:10.4229/EUPVSEC201620162CO.4.1.

[2] Brendel, R. & Peibst, R. 2016, "Contact selectivity and efficiency in crystalline silicon photovoltaics", IEEE J. Photovolt., Vol. 6, No. 6, pp.1413–1420, doi:10.1109/JPHOTOV.2016.2598267.

Technical Roadmap: Development trend



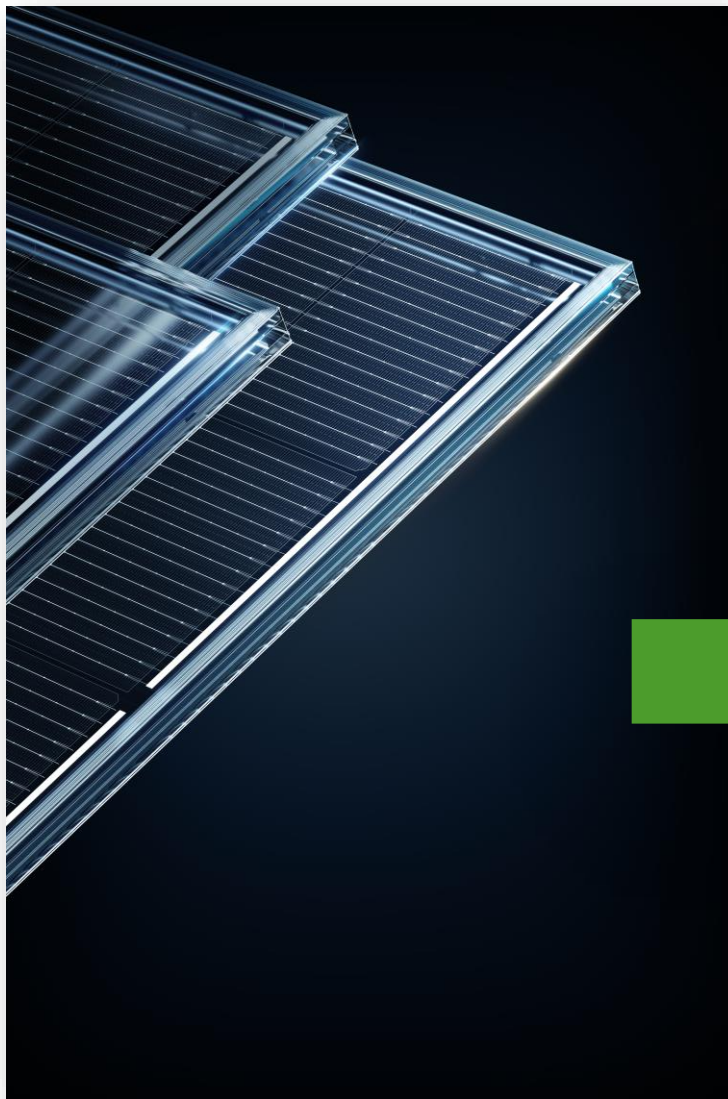
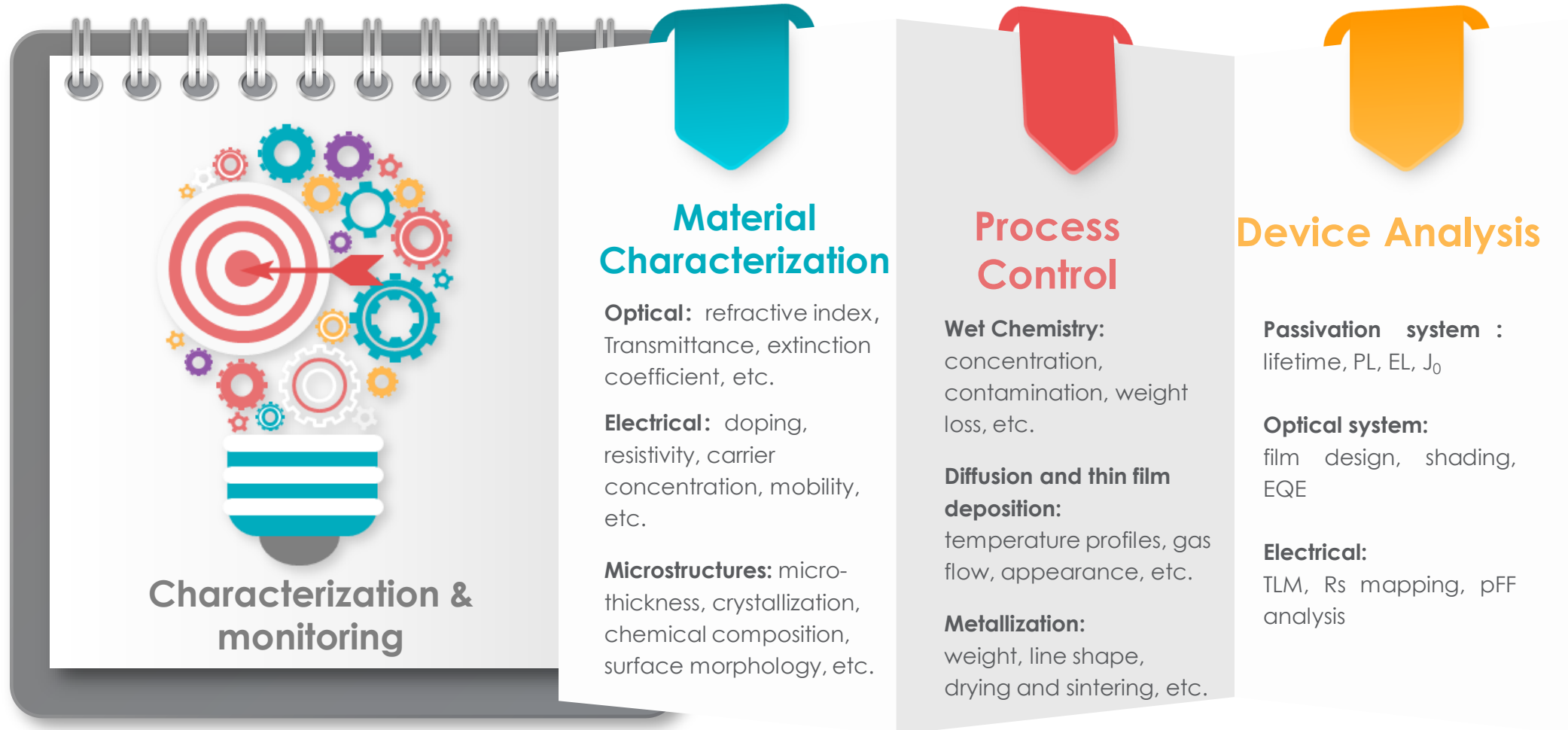


Table of Contents

- 01 JinkoSolar Introduction
- 02 Tiger Neo Series
- 03 Technical Roadmap
- 04 Strategies for Success**
- 05 Conclusions

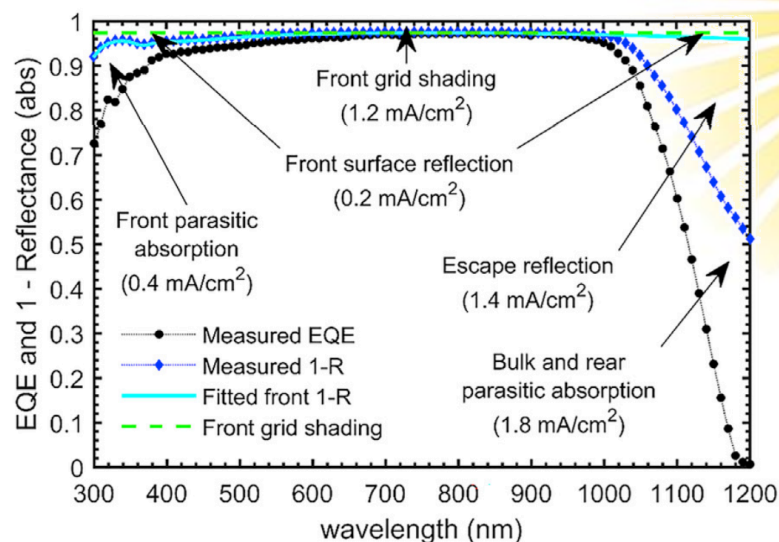
Strategies for Success: In-depth grasp of critical parameters

Well equipped R&D center enables comprehensive analysis & investigation



Strategies for Success: In-depth grasp of critical parameters

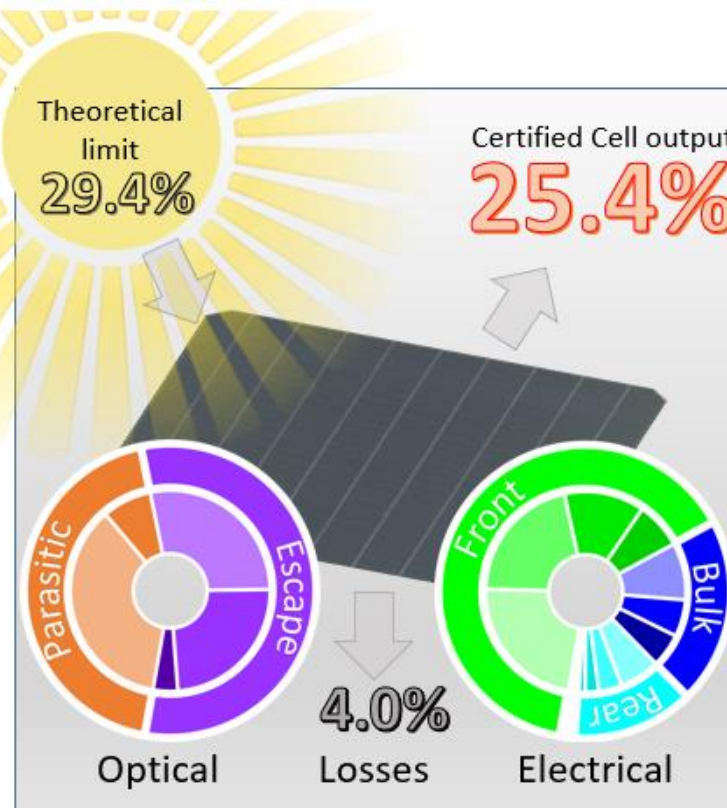
Optical Losses Analysis [3,4]



- **Significant optical losses:** bulk and rear parasitic absorption; escape reflection.
- **Potential solutions:** thinner films, optimized coating

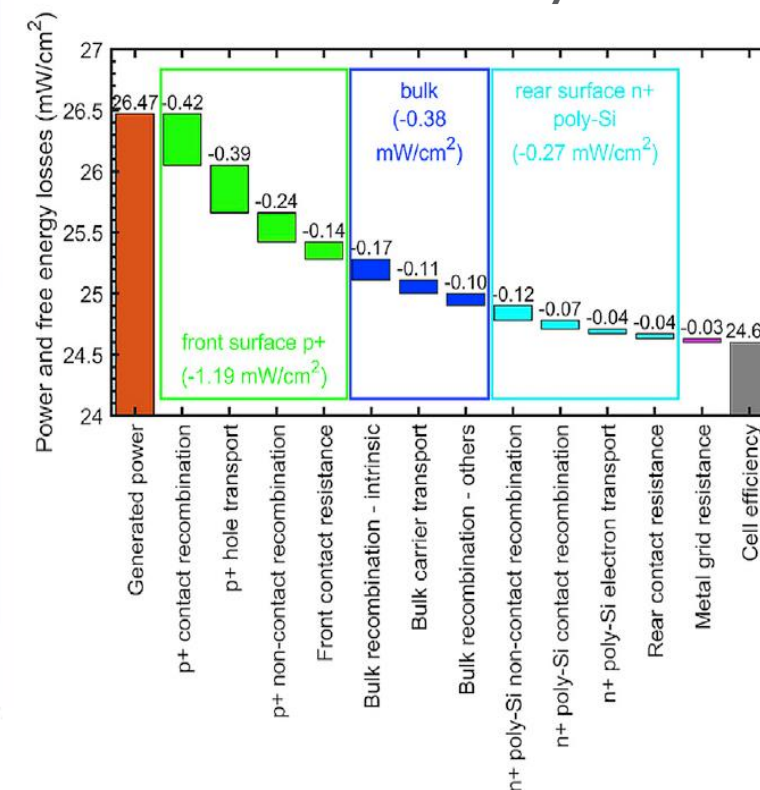
[3] Zheng P, Yang J, Wang Z, et al., "Detailed loss analysis of 24.8% large-area screen-printed n-type solar cell with polysilicon passivating contact," Cell Reports Physical Science 2, vol. 100603, October 20, 2021, doi: 10.1016/j.xcrp.2021.100603.

[4] Bonilla J, Giehl R, Magistris C and Murgioni R. TOPCon efficiency breakthrough from cell to PV modules. Photovoltaics International Ed. 48



November 2021 champion cell

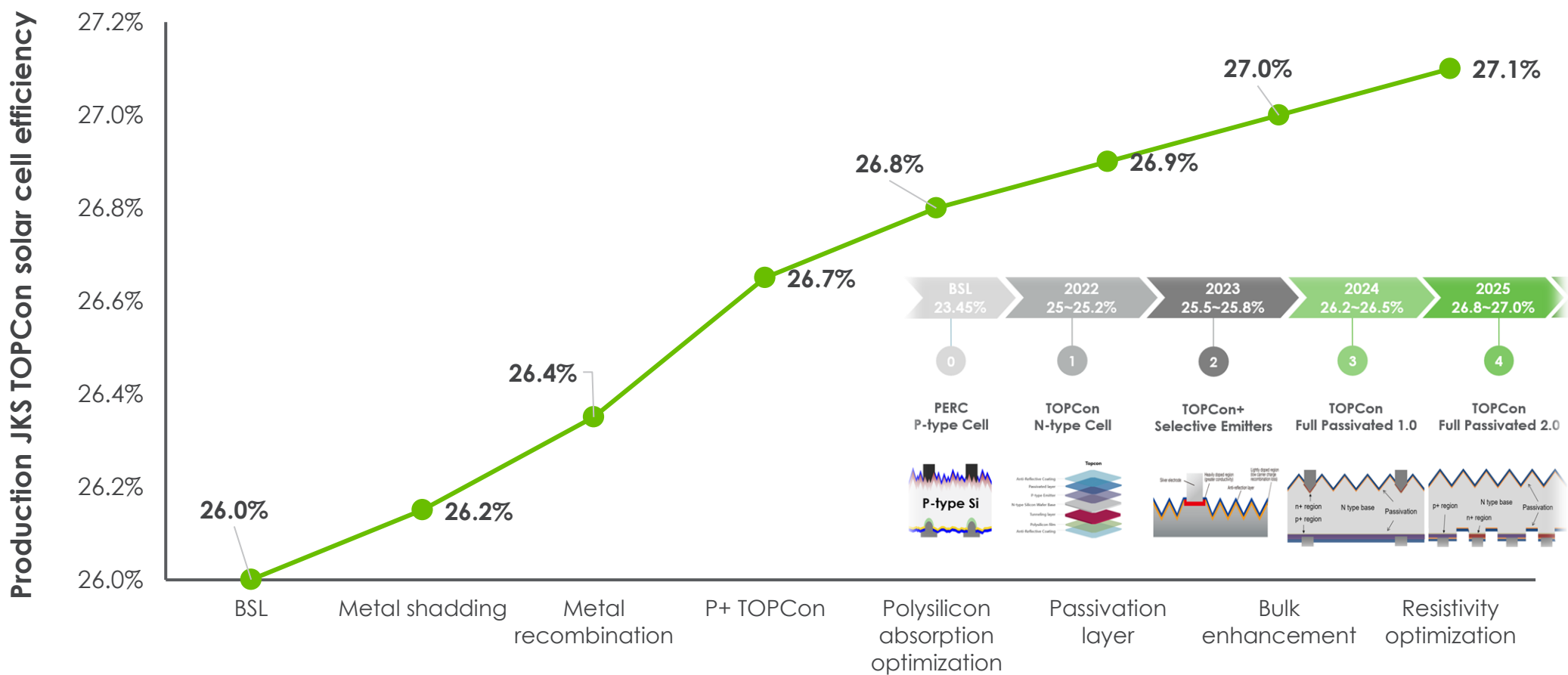
Electrical Losses Analysis [3,4]



The **boron-diffused region on the front surface** accounted for losses of **1.19mW/cm²**, representing **63,5% of the total losses**

Strategies for Success: Practical path

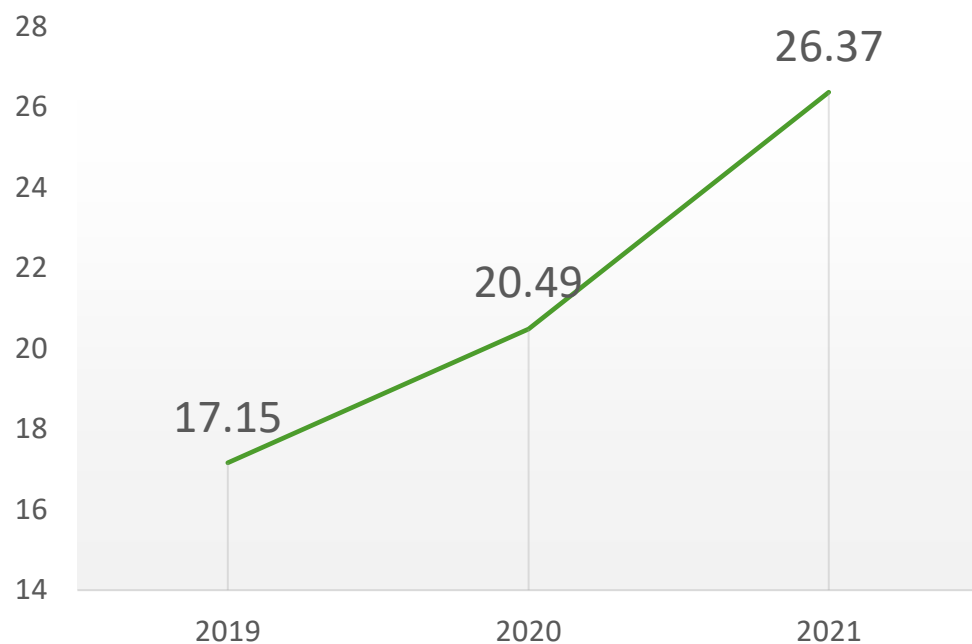
Steps towards >27% TOPCon solar cell in the near future



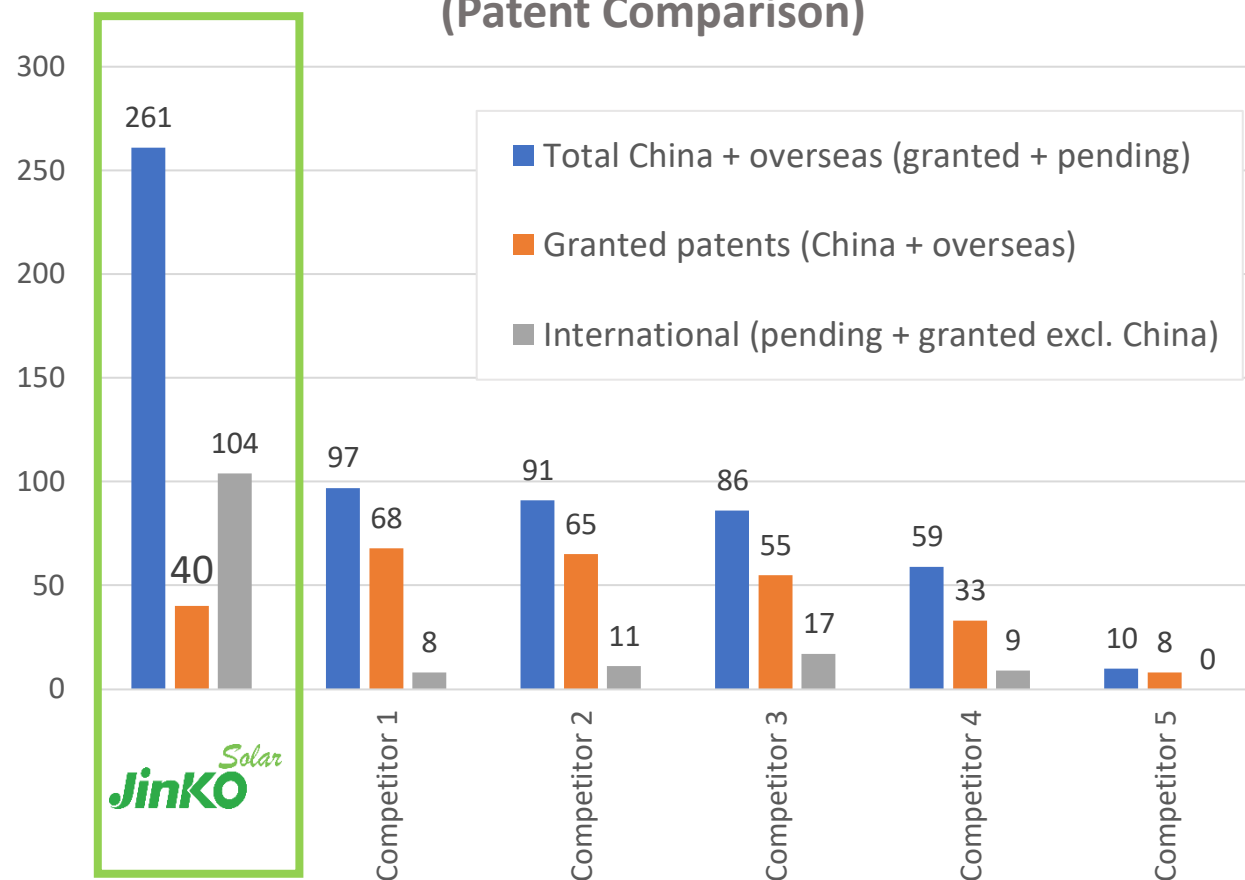
Strategies for Success: R&D Investment and Patent Forging

JinkoSolar's R&D Investment from 2019 to 2021

(Hundred Million RMB)



Intellectual Property TOPCon (Patent Comparison)

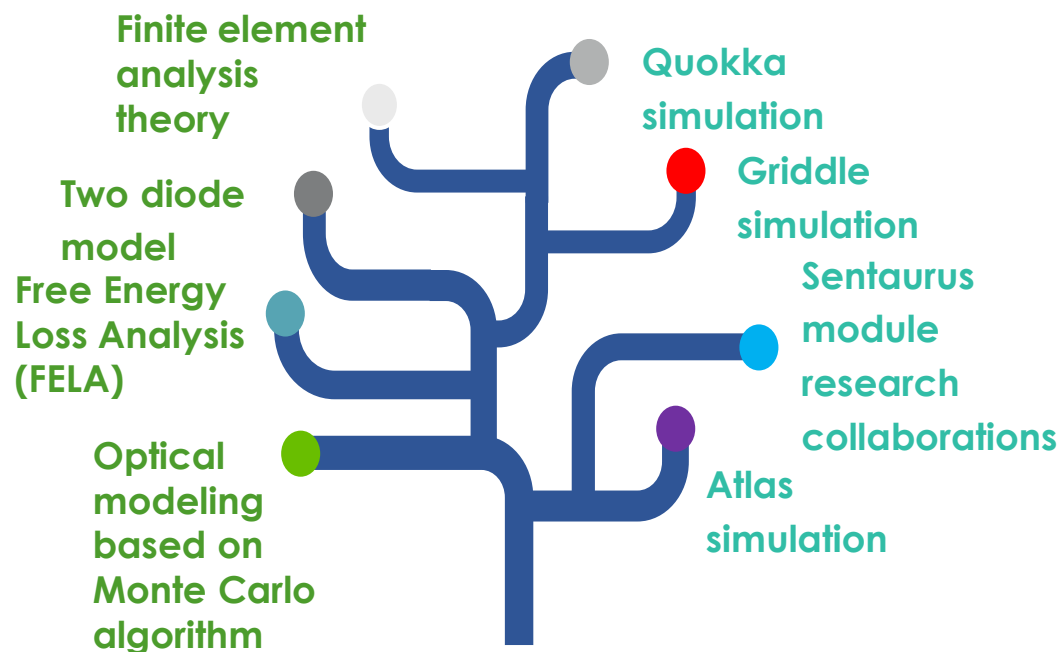


Source: before 2023/11 based on PatSnap public database..

Strategies for Success: Data & More Data

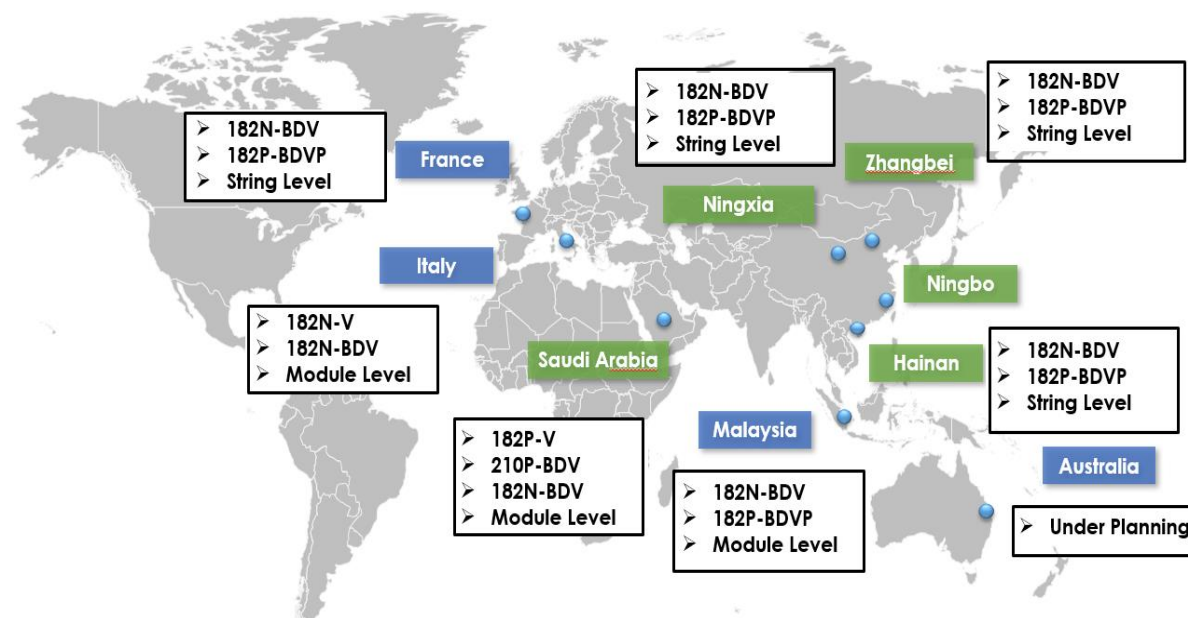
Strong R&D

fundamental research & simulation



Worldwide Field Tests

Energy yield & long-term performance



Strategies for Success: Testing & more testing



Historical Scorecard

The table below shows the history of top performance for all manufacturers featured in the 2023 Scorecard. Manufacturers are listed by the number of years they have been designated a Top Performer, in alphabetical order.



	2023	2022	2021	2020	2019	2018	2017	2016	2014
Jinko	•	•	•	•	•	•	•	•	•
Factory Witness, Characterizations and Light-Induced Degradation Measurement									
Thermal Cycling	Damp Heat	Backsheet Durability Sequence	Mechanical Stress Sequence	Hail Stress Sequence	Potential-Induced Degradation	LETID Sensitivity	PAN File & IAM Profile	Field Exposure	
TC 200	DH 1000	DH 1000	Static Mechanical Load	Hail	85°C, 85%RH MSV (+ and/or -) 192 hrs	LETID 162 hrs (75°C, Isc-Imp)	PAN File	Field Exposure 6 Months	
Characterization	Characterization	UV 65 kWh/m²		Characterization		Characterization	IAM Profile		
TC 200	DH 1000	Characterization	Dynamic Mechanical Load	Dynamic Mechanical Load	Characterization	LETID 162 hrs (75°C, Isc-Imp)		Characterization	
Characterization	Characterization	TC 50 + HF 10	Characterization	Characterization		Characterization		Field Exposure 6 Months	
TC 200	Stabilization 80°C, Isc, 48 hrs	UV 65 kWh/m²	TC 50 + HF 10	TC 50 + HF 10		LETID 162 hrs (75°C, Isc-Imp)		Characterization	
Characterization	Characterization	Characterization	Characterization	Characterization		Characterization			
		TC 50 + HF 10							
		UV 65 kWh/m²							
		Characterization							
		TC 50 + HF 10							
		UV 6.5 kWh/m²							
		Characterization							

<https://scorecard.pvel.com/top-performers/>

Three Times Reliability Test

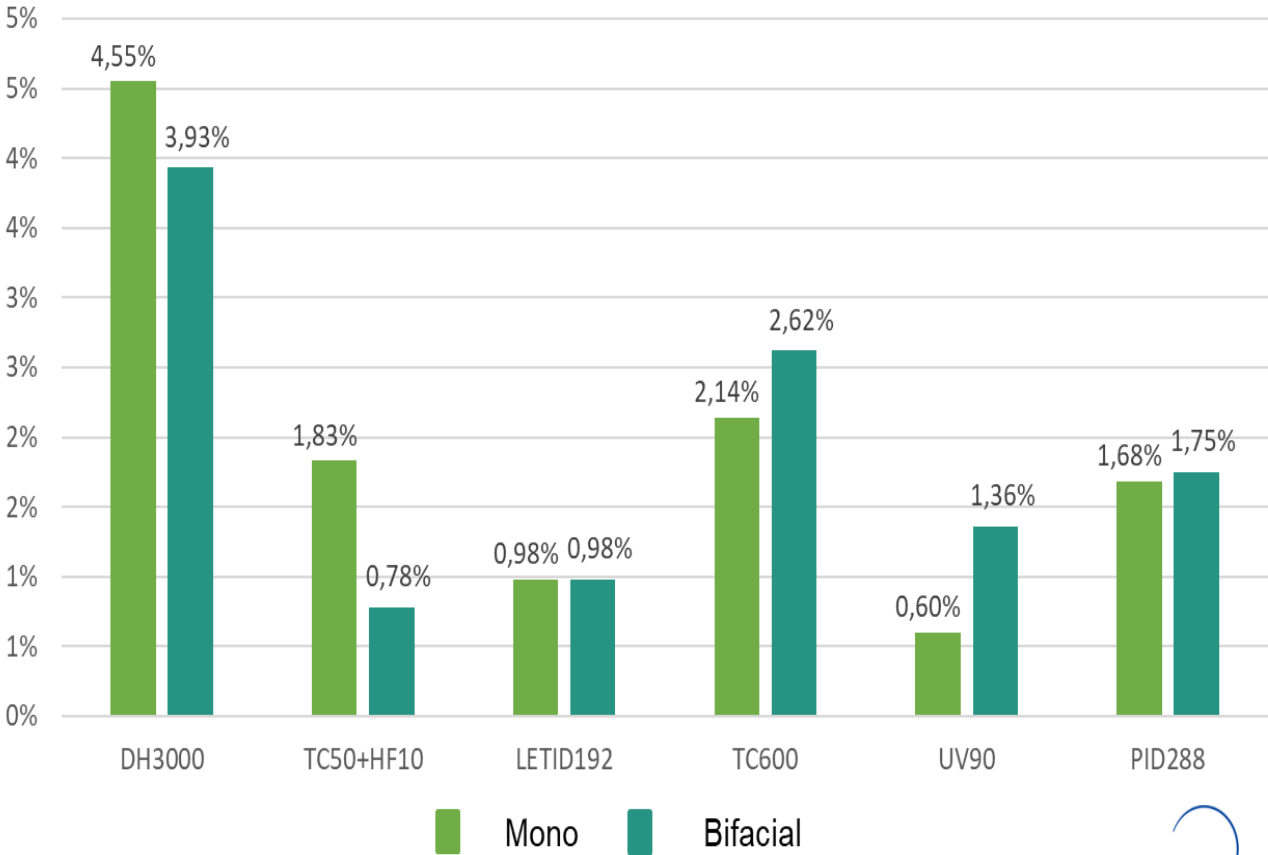
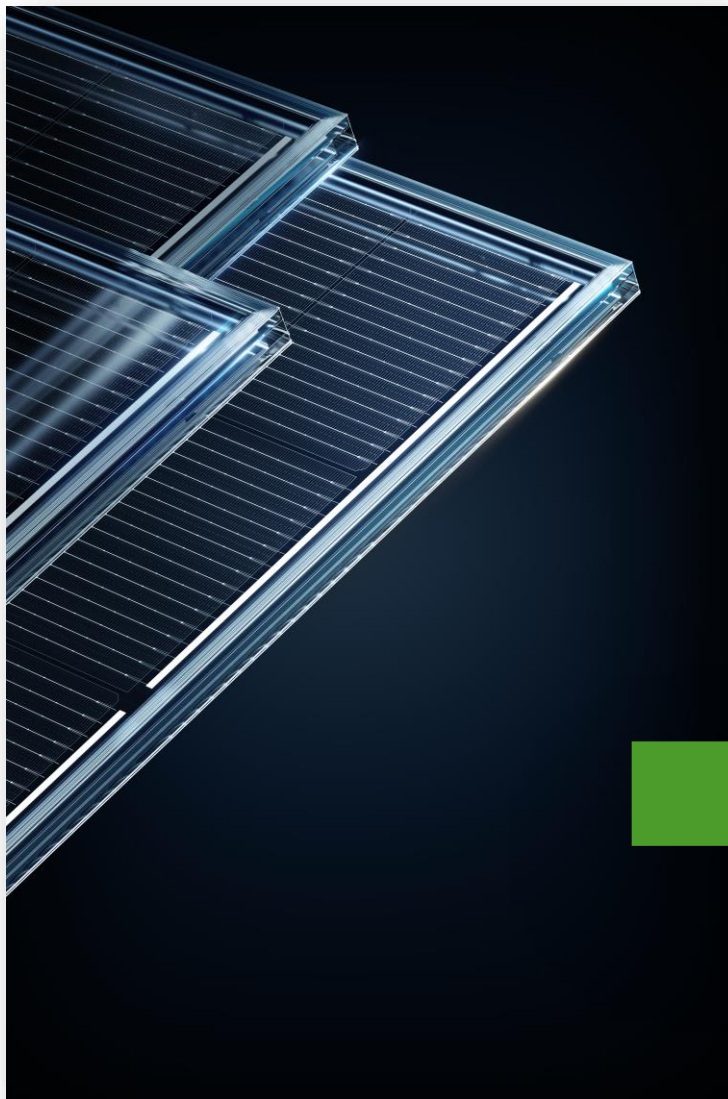


Table of Contents



- 01 JinkoSolar Introduction
- 02 Tiger Neo Series
- 03 Technical Roadmap
- 04 Strategies for Success
- 05 Conclusions**

Conclusions: JinkoSolar and TOPCon



➤ Long-term partner:

- **Reliable manufacturer** - solid finance, well-defined strategy, reliable local teams.
- **State of the Art technology** – worldwide **Leader** on N-type TOPCon.
- **Adaptable solutions** - products designed the cover main needs.

➤ Foundation in R&D:

- **Data Driven** - cornerstone before product launches.
- **Proactive** measures are taken to address potential issues and ensure seamless integration.

➤ Continuous Learning Process:

- Mass production involves a learning process.
- **Correction** is acknowledged as part of the process, **but emphasis on proactive quality check & prevention.**

➤ Readiness and Resilience:

- Challenges require **mitigation, innovation and dedications to quality.**

➤ Clear technical path: Feasibility & upscaling.

Thank you!

Carlos Magistris

Senior Technical Service Manager Europe