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4 February 2025

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LCOE, ROI assessments for C&I solar sector in Saudi Arabia

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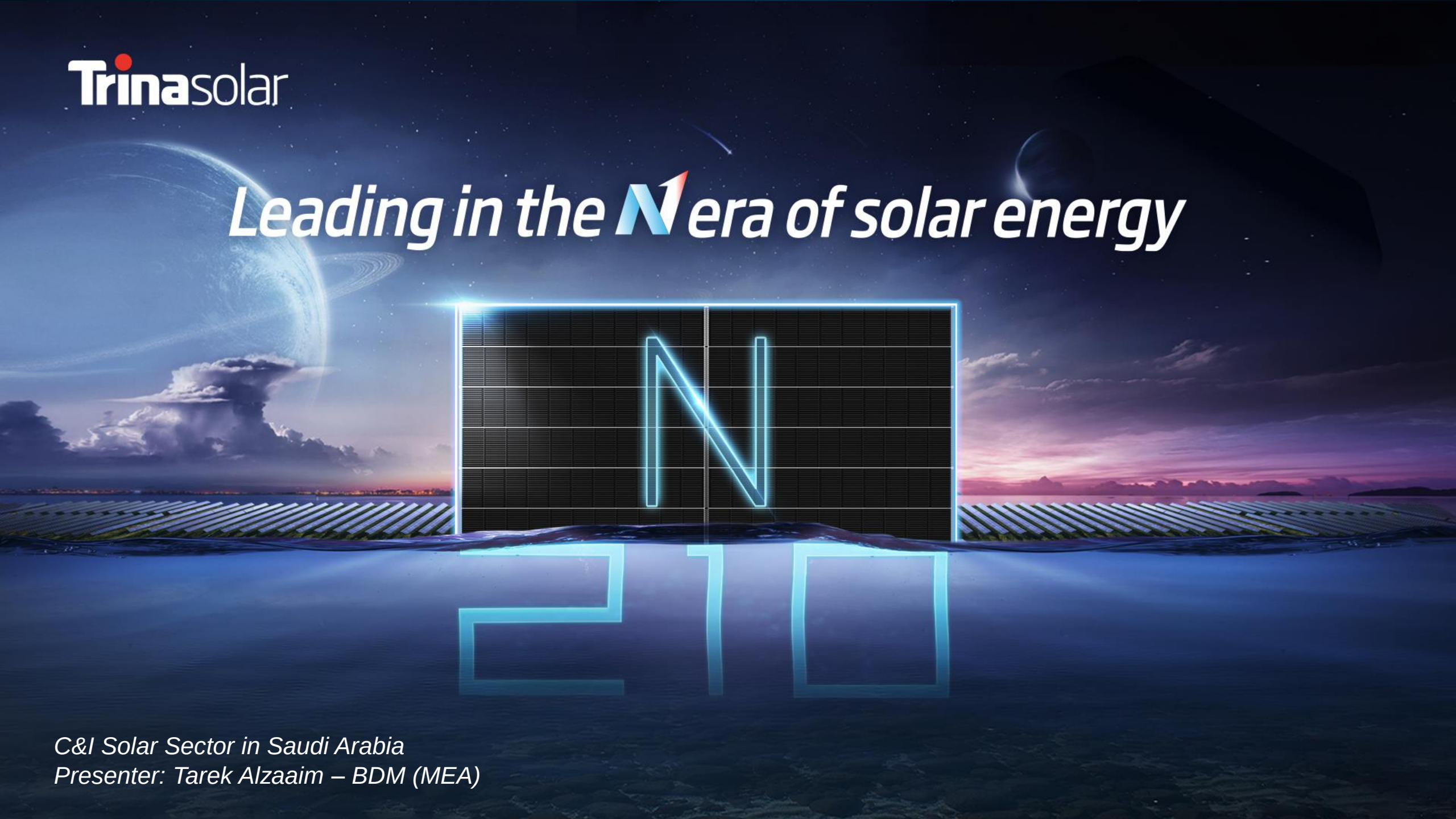


C&I Solar Sector in Saudi Arabia
Presenter: Tarek Alzaaim – BDM (MEA)

About Trinasolar

We are committed to leading the way in smart PV and energy storage solutions and facilitating the transformation of new power systems for a net-zero future.
MISSION: “Solar Energy for All”

240 GW+
Cumulative module shipments By the end of September 2024

170 GW+
Cumulative 210mm module shipments by the end of December 2024

Silicon Wafer Capacity	2024 Module Capacity	Tracker Capacity	2024 Cell Capacity
60 GW	120 GW	10 GW	105 GW

RETC
4th Consecutive
Overall Highest Achiever

kiwa PVEL
10th Consecutive
Top Performer Award for Outstanding Product Reliability and Performance

Wood Mackenzie
TOP
Module Manufacturer

Bloomberg NEF
Tier 1
Energy Storage Manufacturer for four consecutive Quarters in 2024

SMM Shanghai Metals Market
Tier 1
PV Tracker Supplier and BESS Provider

Solar C&I Sector in KSA & 2030 Vision

- **Saudi Arabia's Vision 2030:** The Kingdom aims to diversify its energy mix, achieving 50% renewable energy by 2030 while targeting net-zero emissions by 2060.
- The Kingdom is targeting **130 GW** of renewable energy capacity by 2030. RE account for **50%** of its electricity production by 2030**.**
- Saudi Arabia dominates with over 50% of this potential, followed closely by the UAE, while Oman and Bahrain trail behind.
- Solar deployment potential up to ~ 17 GW

Market	Rooftop Area Segment							Total
	< 2,500 m2	2,500 - 5,000 m2	5,000 - 10,000 m2	10,000 - 20,000 m2	20,000 - 30,000 m2	30,000 - 50,000 m2	> 50,000 m2	
Dubai	1,201	1,024	915	680	273	176	165	4,434
Northern Emirates	1,360	874	678	336	98	107	52	3,505
Abu Dhabi	1,353	512	465	330	121	150	173	3,104
Total UAE	3,914	2,410	2,058	1,346	492	433	390	11,042
Oman	362	243	201	142	58	46	70	1,123
Saudi Arabia	4,478	2,974	3,672	3,141	1,049	752	530	16,596
Bahrain	263	168	168	101	39	45	7	792
TOTAL	**9,018**	**5,794**	**6,099**	**4,730**	**1,639**	**1,277**	**997**	**29,553**

Table (2): Total Solar Potential per Market (in MW)

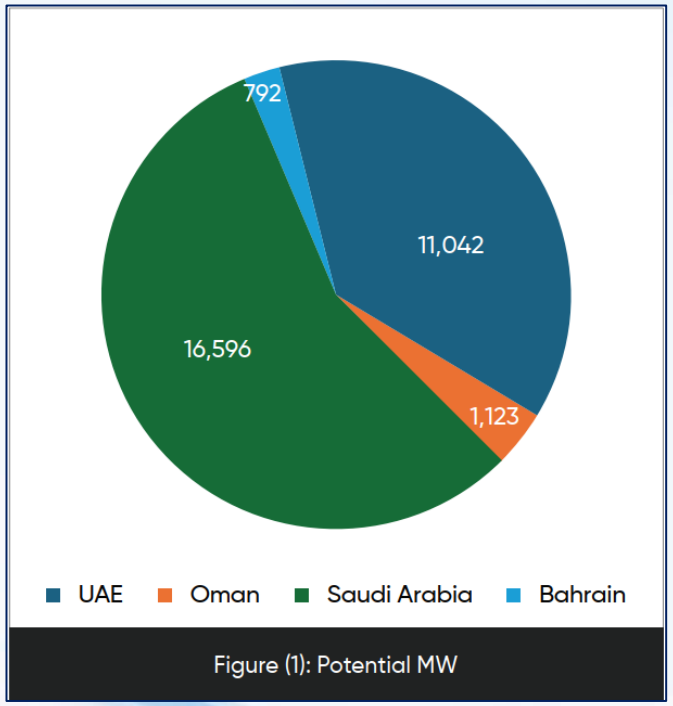


Figure (1): Potential MW

- *Source: MESIA Solar Outlook Report 2024*
- *Planno*

Solar C&I Sector in KSA – Opportunities

Resources

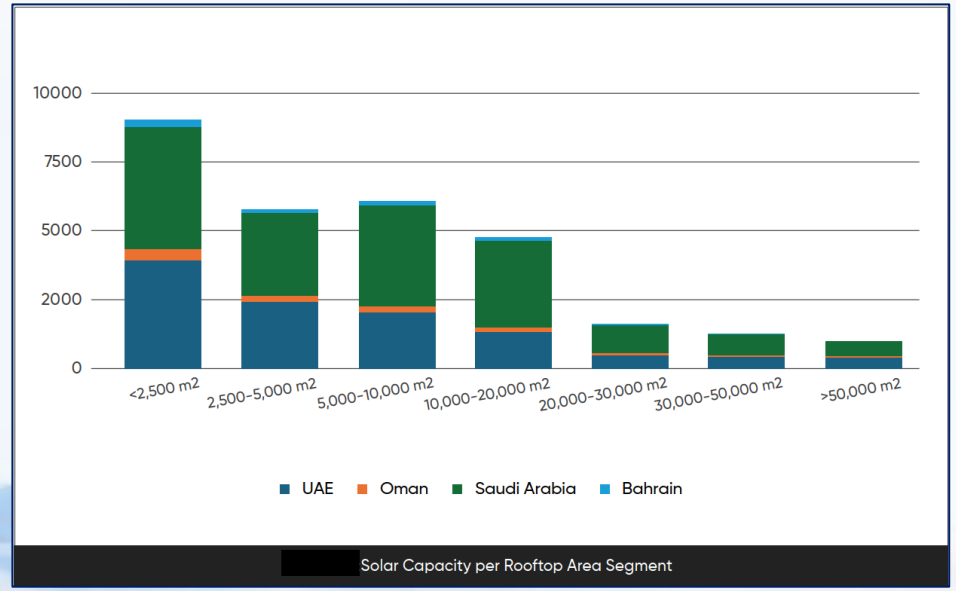
- KSA receives an average of **8.9 daily sunshine hours and solar irradiation of 250 W/m²**, surpassing the global high-potential range of 100–200 W/m².

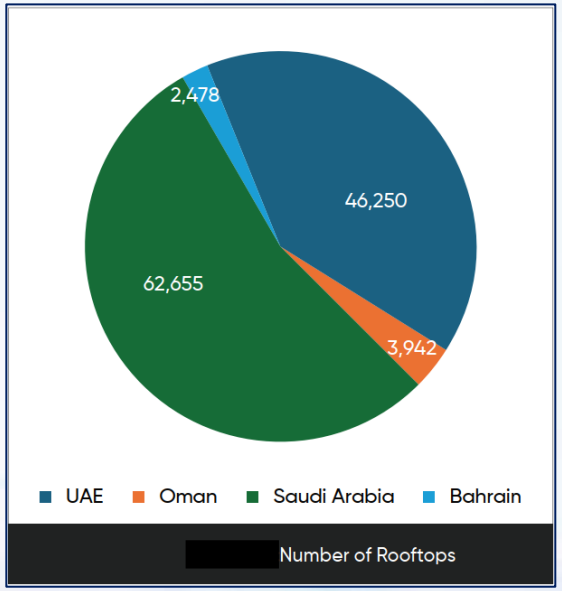
Government Support

- The Saudi Industrial Development Fund (SIDF) - Mutjadeda program offer substantial financing for renewable energy projects, providing up to **USD 130 million** for residential and commercial ventures.
- The National Energy Services Company (Tarshid) Tenders – Forecasted of several MWp in the pipeline for 2025.

Opportunities

- The Kingdom accounts for over 50% of the total rooftop solar potential across GCC countries.





- *Source: MESIA Solar Outlook Report 2024*
- *Planno*

Solar C&I Sector in KSA – Challenges

Regulatory Framework

- Navigating the regulatory landscape can be complex, with evolving policies and procedures that may pose challenges for project development – Project permitting & final connection stage.

Financing

- Securing financing for C&I solar projects can be challenging, especially for small and medium-sized enterprises, due to perceived risks and limited access to capital – presence of world class developers in KSA.

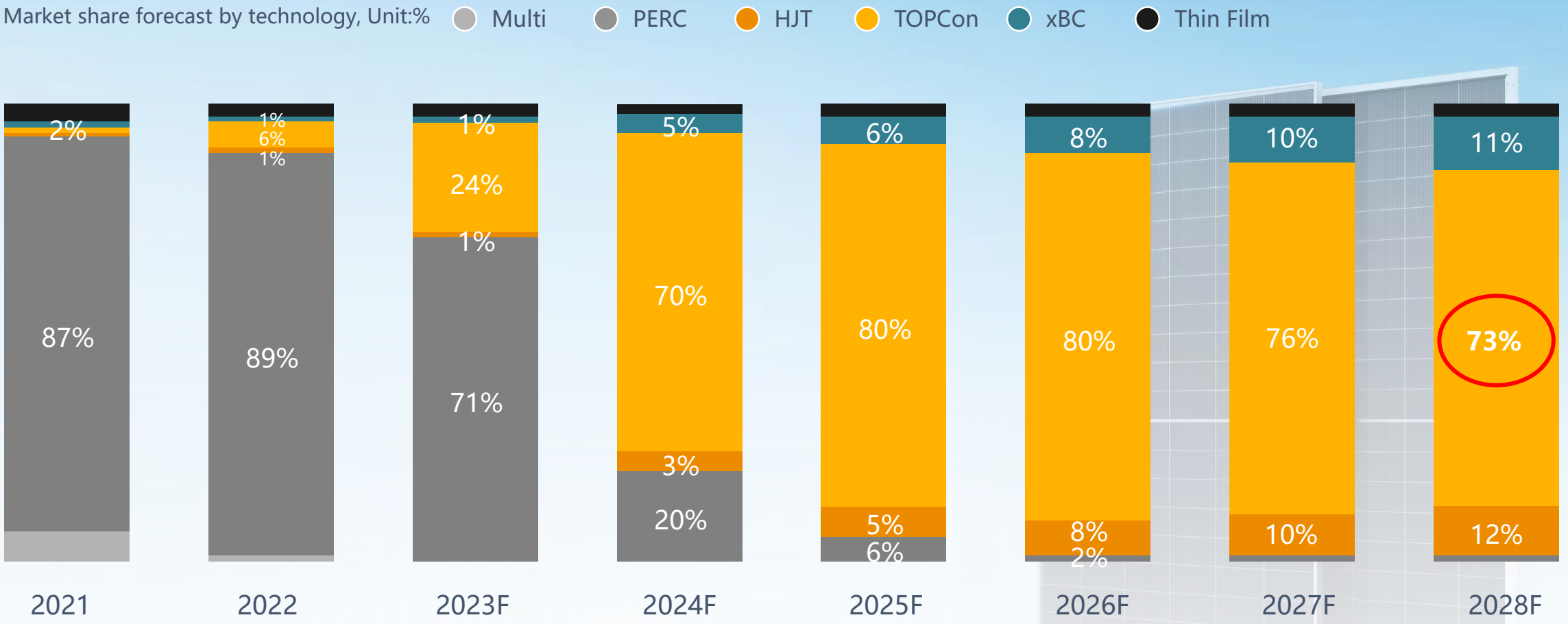
Grid Integration

- Integrating solar power into the existing grid infrastructure requires upgrades and investments to manage variability and ensure stability.

Grid Tariffs

- The low grid tariffs for residential and industrial sectors result in limited financial incentives for distributed generation (DG) self-consumption – 0.18 SAR/kWh.

Third-party agency InfoLink predicts: TOPCon will be the mainstream technology in the next five years



By 2028, TOPCon will have a market share of ~73%

Trinasolar i-TOPCon Technology Roadmap >>>>

2015-2019

i-TOPCon

- In 2015, Base on Trina Solar's State Key Laboratory of Photovoltaic Science and Technology(PVST) ,i-TOPCon Lab was established.

- Innovative hydrogen passivation
- Wafer size 158.75mm×158.75 mm
- Cell efficiency 23.07% (JET certificate) 24.58% (ISFH certificate) mass production efficiency 23.2%
- 500 MW mass production line

2019.12 250MW
Tongchuan 'Top Runner' technical leader project

2019.6.30 250MW
Changzhi 'Top Runner' technical leader project

- The first TOPCon Cell World Record in China, 23.5% (2019)

2020-2022

i-TOPCon Plus

- Wafer size: 210mm×210mm+ 18BB
- 500 MW TOPCon pilot line
- Average production cell efficiency 24.5%
- Cell efficiency 25.15% (ISFH certificate)

Vertex S in Europe

2020.9.30 137MW
Yellow River hydropower in Qinghai

Cell efficiency record

- 25.25% (2022/2, ISFH certificate)
- 25.42%(2022/3, ISFH certificate)
- 25.5%(2022/3, China National Metrology Institute certificate)

2023-2024

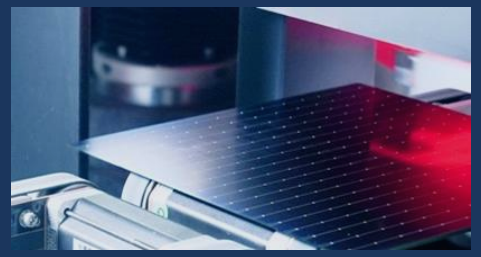
i-TOPCon Advanced

- Selective emitter, Rear planar reflector, Highly low rear TOPCon structure, Laser induced Firing， Edge Passivation Technology
- Large wafer： 210,210R
- Lab efficiency reach 26% (German third-party certificates)
- Comprehensive product portfolio

2025+

i-TOPCon Ultra & Tandem

- i-TOPCon + Full frontal passivation contact cell technology： Efficiency >27%
- i-TOPCon + tandem cell Technology: Cell Efficiency >30%



Vertex N

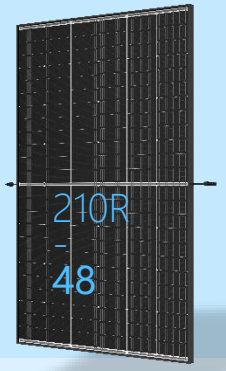
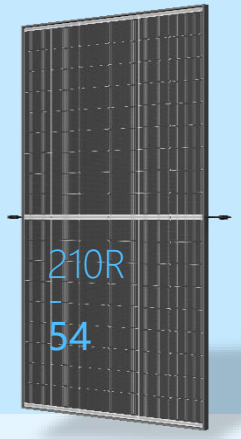
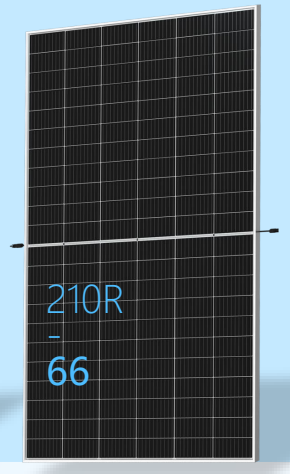
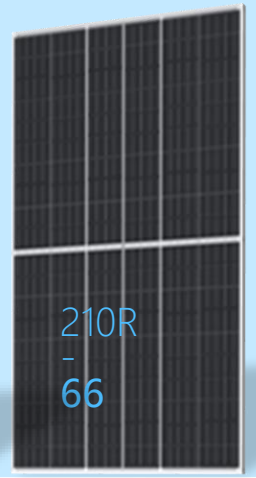
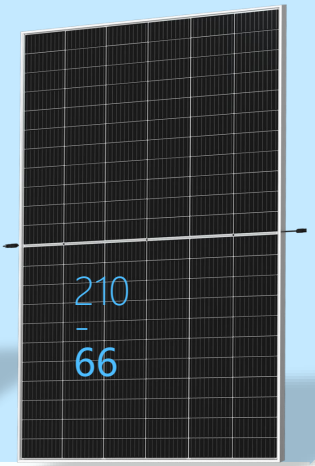
2025 Product Outlook

210 Vertex series high power PV module can be used in all scenarios

Trinasolar

Distributed Solar System

Utility

Vertex S+	Vertex S+	Vertex N	Vertex N	Vertex N
				
210R - 48	210R - 54	210R - 66	210R - 66	210 - 66
Vertex	UP to 460W	UP to 510W	UP to 630W-670W	UP to 670W	UP to 720W
	NEG9R.28	NEG18R.28	NE19R	NEG19RC.20	NEG21C.20

Most used models for C&I applications

510W Module: NEG18R.28

Vertex S+

Maximum Power Output

up to **510W**

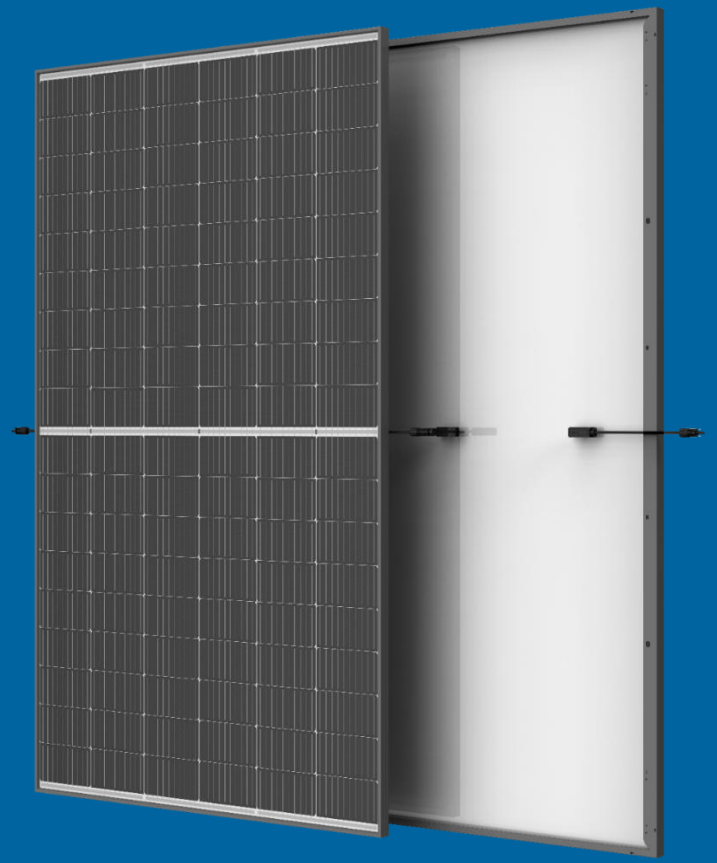
Maximum Module Efficiency

22.9%

- Dual Glass
- 15 years product warranty
- 30 years power warranty

(N type-Monofacial)

Solution for C&I and Residential



Mechanical Parameter

- Dimensions： 1961*1134*30mm
- Weight: 23.5kg

Electrical Parameter

- Open Circuit Voltage： 40.6V
- Impp Current： 15.14A

- I_{mpp} < 15A, compatible with C&I inverters
- Small size module, easy installation
- 1134mm width, flexible array arrangement

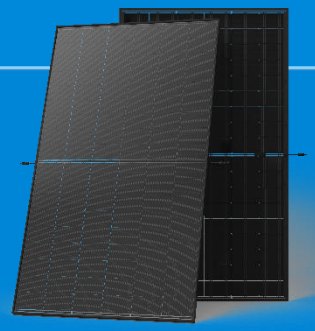
Vertex S+ **500W+**

Rooftop Portfolio

More Design **Choices**.

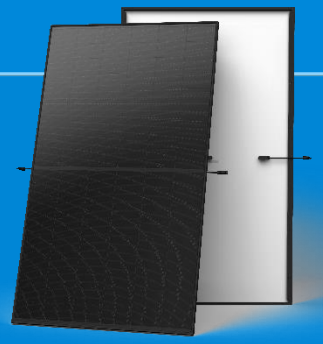
The 500W+ Rooftop Portfolio includes two black modules suited for residential and C&I designed to satisfy those looking for style and power.

RESIDENTIAL +C&I



Vertex S+ 500W+
Clear Black

NEG18RC.27



Vertex S+ 500W+
Full Black

NEG18R.25

Trinasolar

N type Mono-Facial with Backsheet

NE19R

Vertex N

Maximum Power Output

up to **630W**

Maximum Module Efficiency

23.3%

- BEST solution for C&I projects
- Suitable for Rooftop applications

Solution for C&I

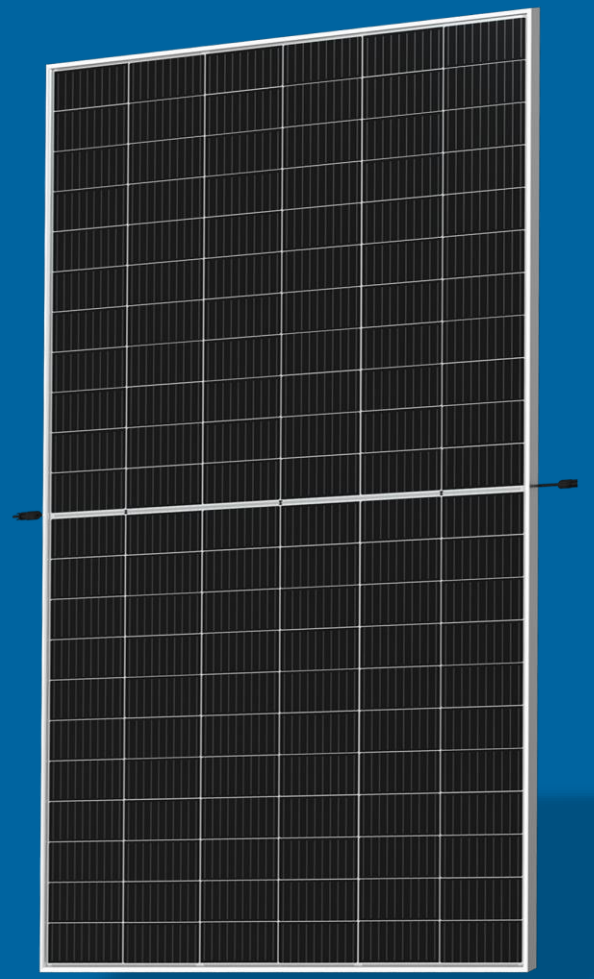
Electrical Parameter

- Open Circuit Voltage： 50.3V
- Impp Current： 15.01A

Mechanical Parameter

- Dimensions： 2382*1134*30mm
- Weight: 27.9kg

- $I_{mpp} \leq 15A$, compatible with C&I inverters
- Mono-facial design with an increased power
- Lighter weight, easier to handle and with reduced rooftop load
- Lower Voltage with a higher string power
- Standard Medium-Size Module



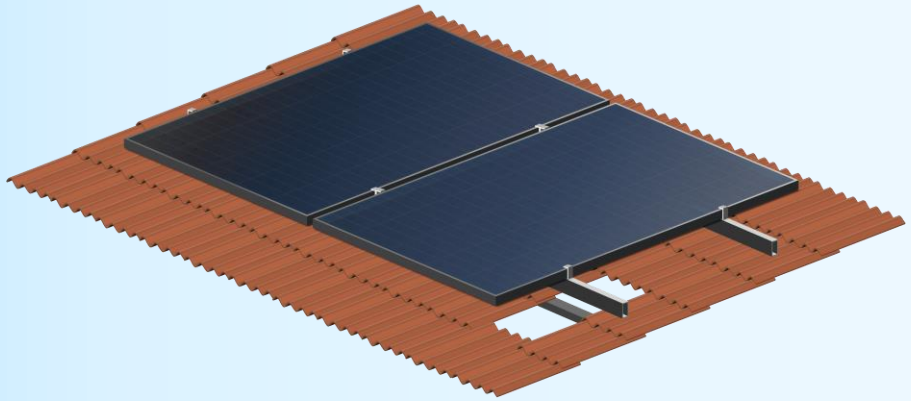
Vertex N Applicable for Residential and C&I Rooftops

Compatible with diverse installation methods
Weight meeting C&I market requirement

Light Weight
Single Glass with Backsheet
10.7kg/m²

Positive Load
5400Pa

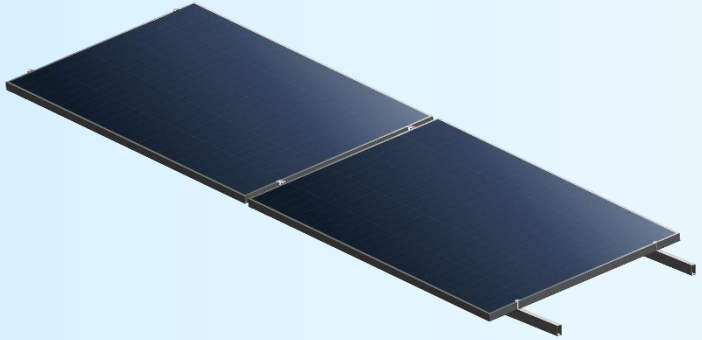
Negative Load
2400Pa



Most Typical Mounting Structure

2 rails, Mounting rails run parallel to the short side frame
(with screws or clamps)

+5400 Pa/-2400Pa



4-point mounting on the short-side
(with clamps)

+2400 Pa/-700Pa

6-point mounting on the long-side
(with clamps)

+2400 Pa/-1500Pa

Vertex N **NEG19RC.20 (Ultra)**

Maximum Power Output

Up to 670W

Maximum Module Efficiency

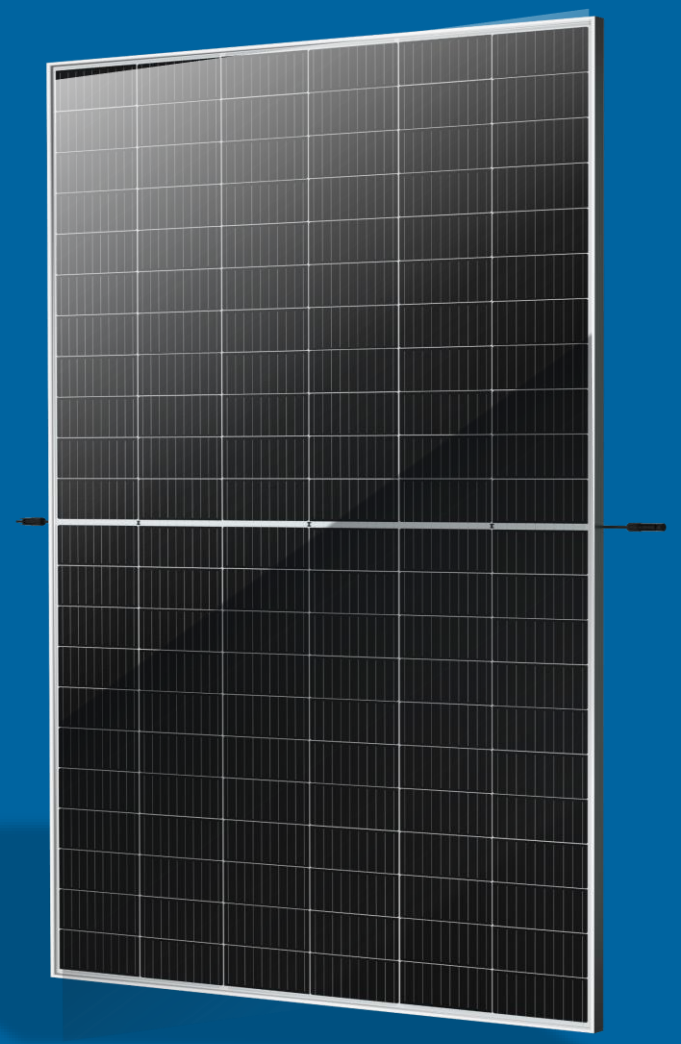
Up to 24.8%

BOS Solution for C&I Applications

BEST compatibility

+

BEST BOS



Electrical Parameter

- Voc Voltage： 50.4V
- Impp Current： 16.86A

Mechanical Parameter

- Dimensions： 2382*1134*30 mm
- Weight： 33 kg

Vertex N TOPCon become the main technology

Project Information

Scenario	Ground-mounted
Location	Rio Verde, Brazil
AC capacity	125 MW
Type of inverter	String inverter
Mounting	1P tracker
Type of module	Bifacial module

PV System Configuration

Vertex N

Reference 182-N

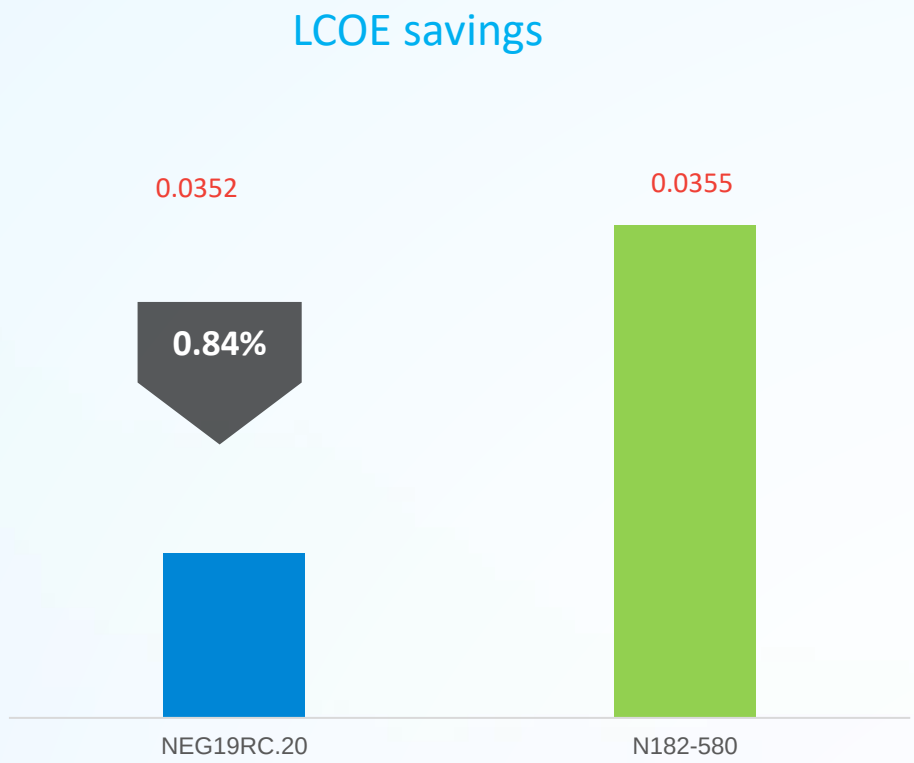
Item	Module type	NEG19RC.20	182N-72pcs
Module	Module power	610W	580W
	Module size (mm)	2382×1134×30	2278×1134×30
	Open circuit voltage	**49V**	**52.70V**
	Short circuit current	15.86 A	14.01 A
Mounting	Installation	Trinatracker 1P new generation	
	Pitch	E-W 6.81m	E-W 6.510m
Inverter	Inverter type	SUN2000-330KTL-H1	
	Inverter power (AC)	330	
	Inverter number	334	334
Layout	Module/string	**31**	**30**
	String power	**18,910W (+13%)**	**17,400W**
	Tracker configuration	**1V93 Portrait**	**1V90 Portrait**
	String/tracker	3	3
	String number	**6610**	**7184**
	Module number	204910	215520
	GCR (%)	**35%**	**35%**
Capacity	DC capacity (MW)	125	**125**
	AC capacity (MW)	100	100
	DC/AC ratio	1.25	1.25

Value assessment: BOS,LCOE assessment Rio verde, Brazil

Unit: USD/Wp

Input Data and Assumptions		
Module type	NEG19RC.20-610	182N-72pcs-580
Project capacity (MW)	125	125
Global horizontal irradiation (kWh/m2/yr)	1,944	1,944
PR Ratio	88.8%	88.5%
BOS* ($ /W)	0.4082	0.4123
Other cost ($ /W)	0.2006	0.2006
CAPEX ($ /W)	0.6088	0.6130
CAPEX Gap (%)	-0.7%	BL
Designed life time (year)	30	30
O &M cost ($ /kW/year)	21	21
Annual escalation rate	4.8%	4.8%
Debt fraction	30%	30%
Tax rate	34%	34%
LCOE ($ /kWh)	0.0352 (0.84%Saving)	0.0355

*includes only the components which make difference with different modules.



The result shows that the Vertex NEG19RC.20-610W module performs better, with a saving of 0.7% in CAPEX and 0.84% in LCOE compared to 182N-580W.

Vertex N

Trinasolar

Reliability and Credibility Recognized by

Authoritative Third-parties

TC600 | DH2000

SML+DML+TC50+HF30

LeTID | PID 192

Indoor Reliability Test and Outdoor Power Gen Test

Visual & EL image inspection
Low irradiance and temperature behavior
LID & PID resistance
Outdoor performance test

Trina Solar has been awarded PVEL "Best Performer" for **10** consecutive years, ranking first in the industry

BloombergNEF

TIER 1 PV Brand

PVTECH

Bankability: Global TOP 5

C&I Sample Project References in KSA

850 kWp
Diesel – Solar PV Hybrid system

877 kWp
Rooftop On – Grid PV System for Residential Compound

2,056 kWp
Car Parking on- grid System

509 kWp
On-grid System


Trinasolar
Leading the way in Smart PV and Energy Storage Solutions

Unlocking the Potential of C&I Solar in Saudi Arabia:

JinkoSolar's Expertise and Field-Tested Results

Edgard Abou Kheir
Technical Services Manager – MENA
Edgard.aboukheir@jinkosolar.com

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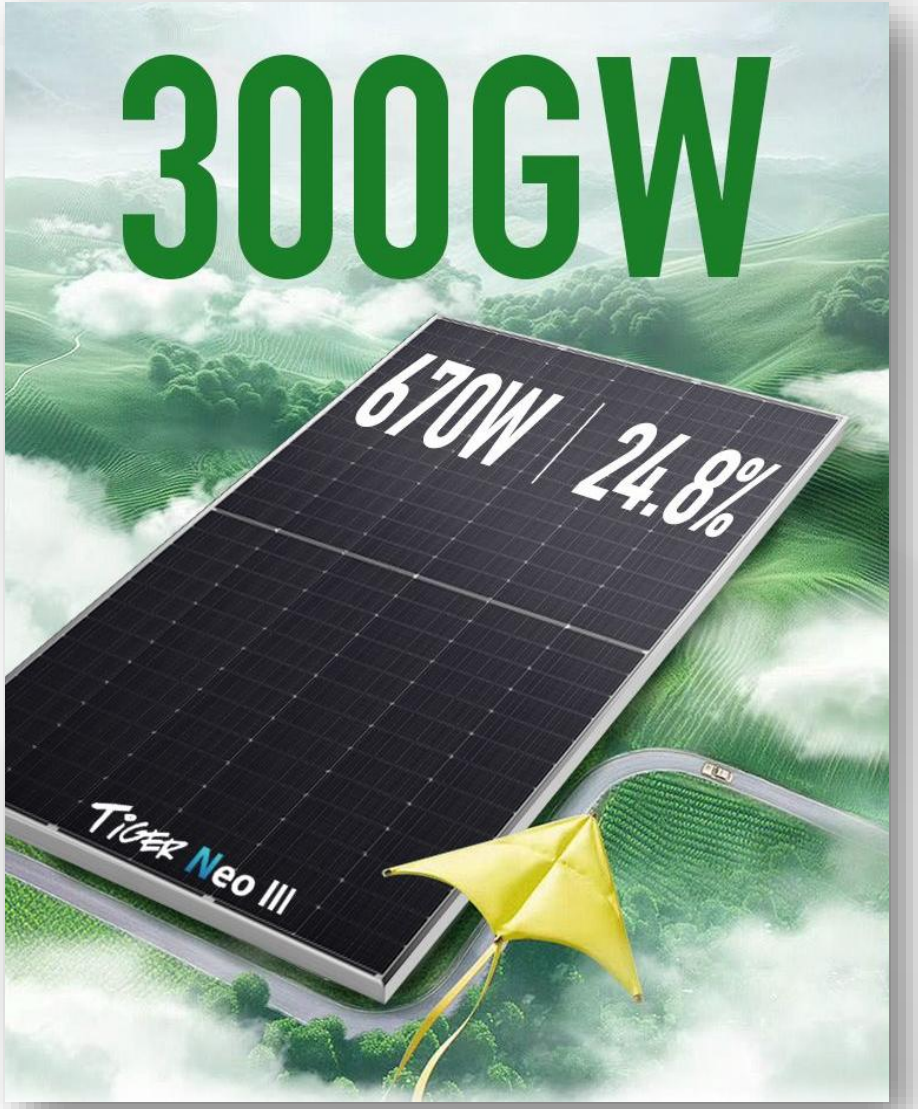

Vertical Integration

Solar JinKO

Wafers

120GW

Cells

95GW

Modules

130GW

300GW
Delivered

15%
Market Share

27
World records

100GW+
n-type module
Capacity

Global Manufacturing and Global R&D

Global Manufacturing

JinkoSolar is the first company in the industry to establish "vertically integrated" production capacity from wafer, cell and module production, with over 10 global manufacturing facilities across China, the US, Southeast Asia, and the Middle.

Global R&D

JinkoSolar has global R&D capabilities, with R&D centers in Haining, Zhejiang Province, Shangrao, Jiangxi Province, Leshan, Sichuan Province, Xining, Malaysia and Vietnam, as well as joint R&D labs in Singapore and Australia.

10+	4	8	4
Production Sites	Overseas Sites	R&D Centers	Overseas R&D

Jinko MEA Milestones

- Shipped +25GW to MEA region more than any other PV supplier
- Jinko modules deployed in +50 utility scale projects across MEA
- 60% Market share with +6.2GW Shipments to Saudi Arabia market in 2024
- 70% Market share in DG market across Saudi Arabia

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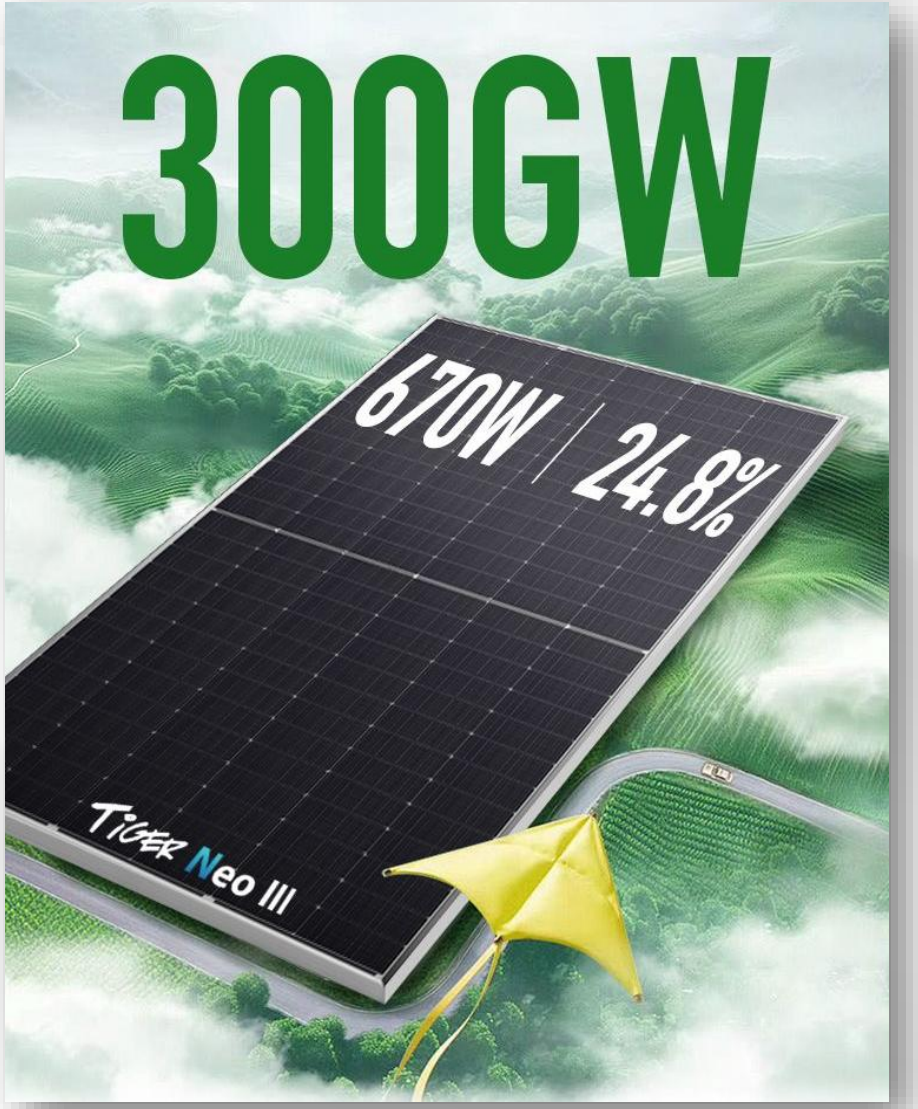
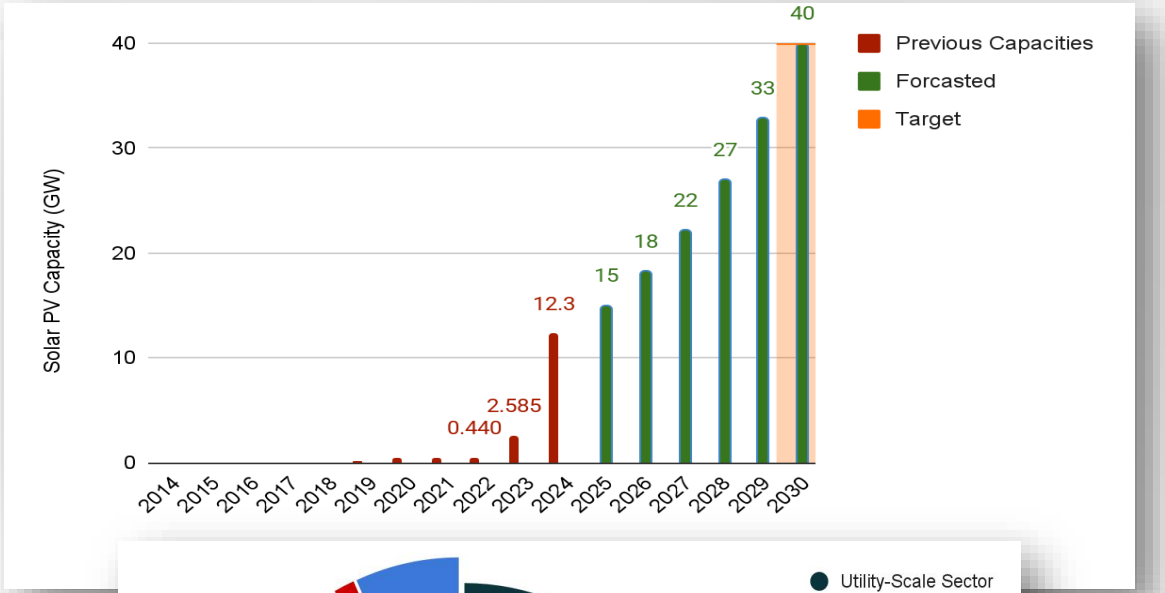
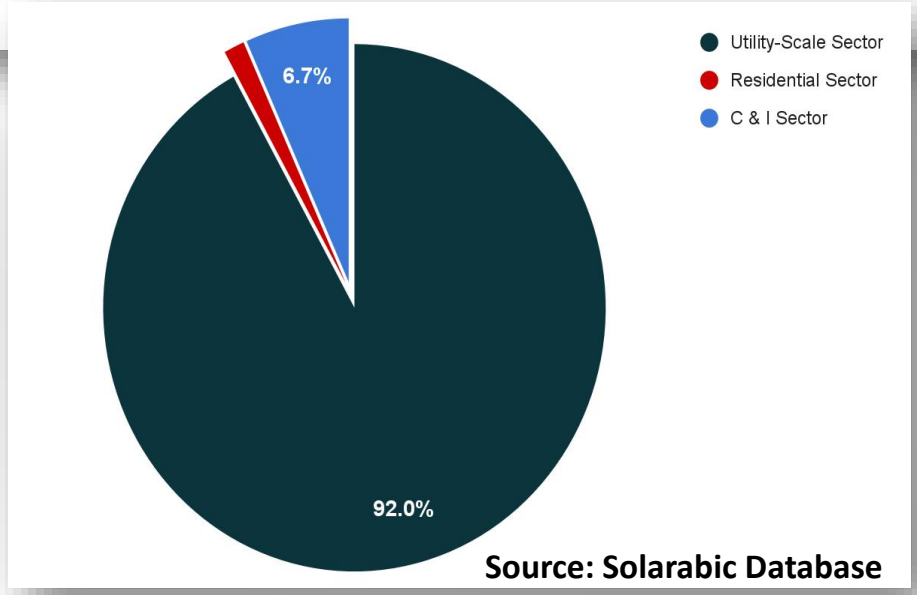


Saudi Arabia Solar distribution

- **Saudi Arabia's Vision 2030 initiative seeks to generate 50% of its electricity from renewable sources,** positioning solar PV as a central component.
- The forecast indicates a rapid growth trajectory, with capacity rising from **12.3 GW in 2024 to 40 GW by 2030.**



- **Utility/Mid Utility Sector:** has been the main driver of solar energy adoption with off takers
- **Distributed Generation (DG) Sector:**
  - ✓ **C&I Sectors:** starting to show more interest in solar energy
  - ✓ **Residential Sector:** still in its early stages.



World record LCOE

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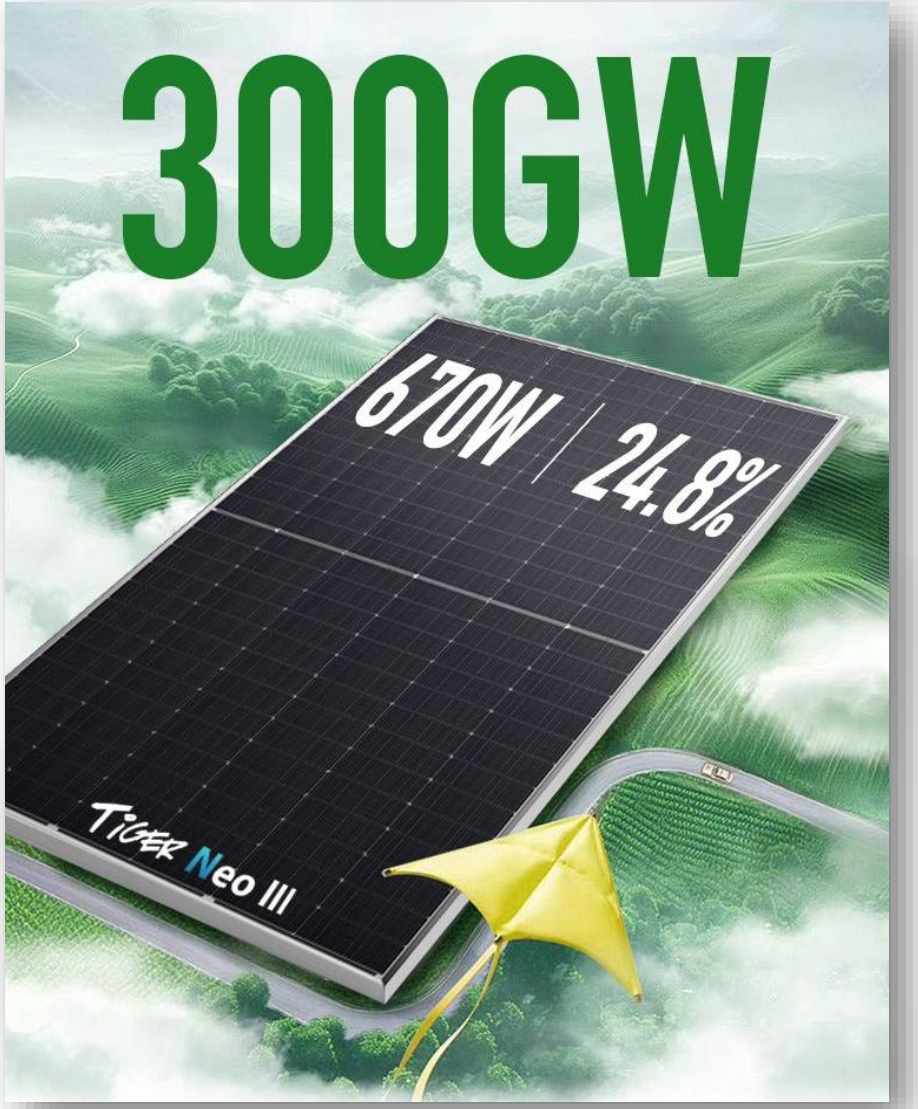
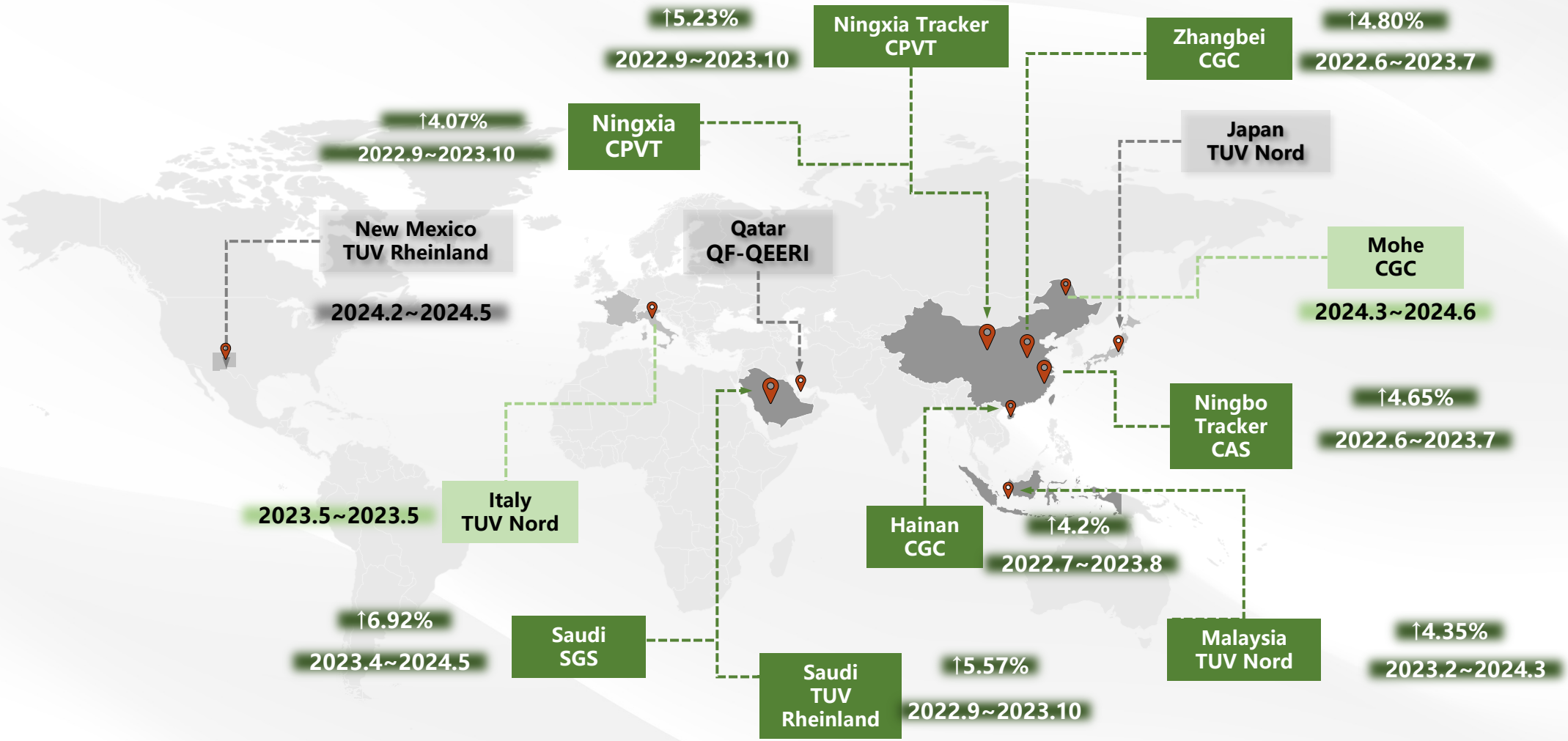


The Global Field Test Overview of TOPCon



Saudi Outdoor Field Test

Location

- Thual, Saudi Arabia

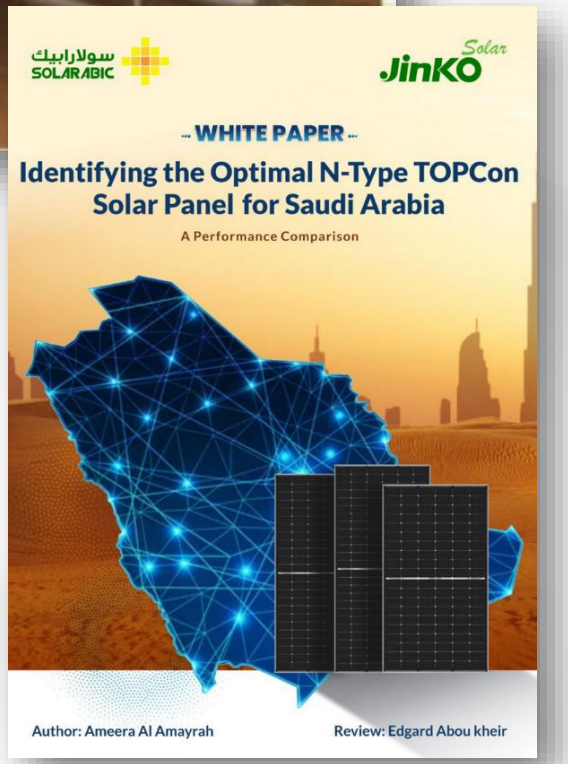
Climate Type

- Desert Climate: High Temperature, High Irradiance, High humidity

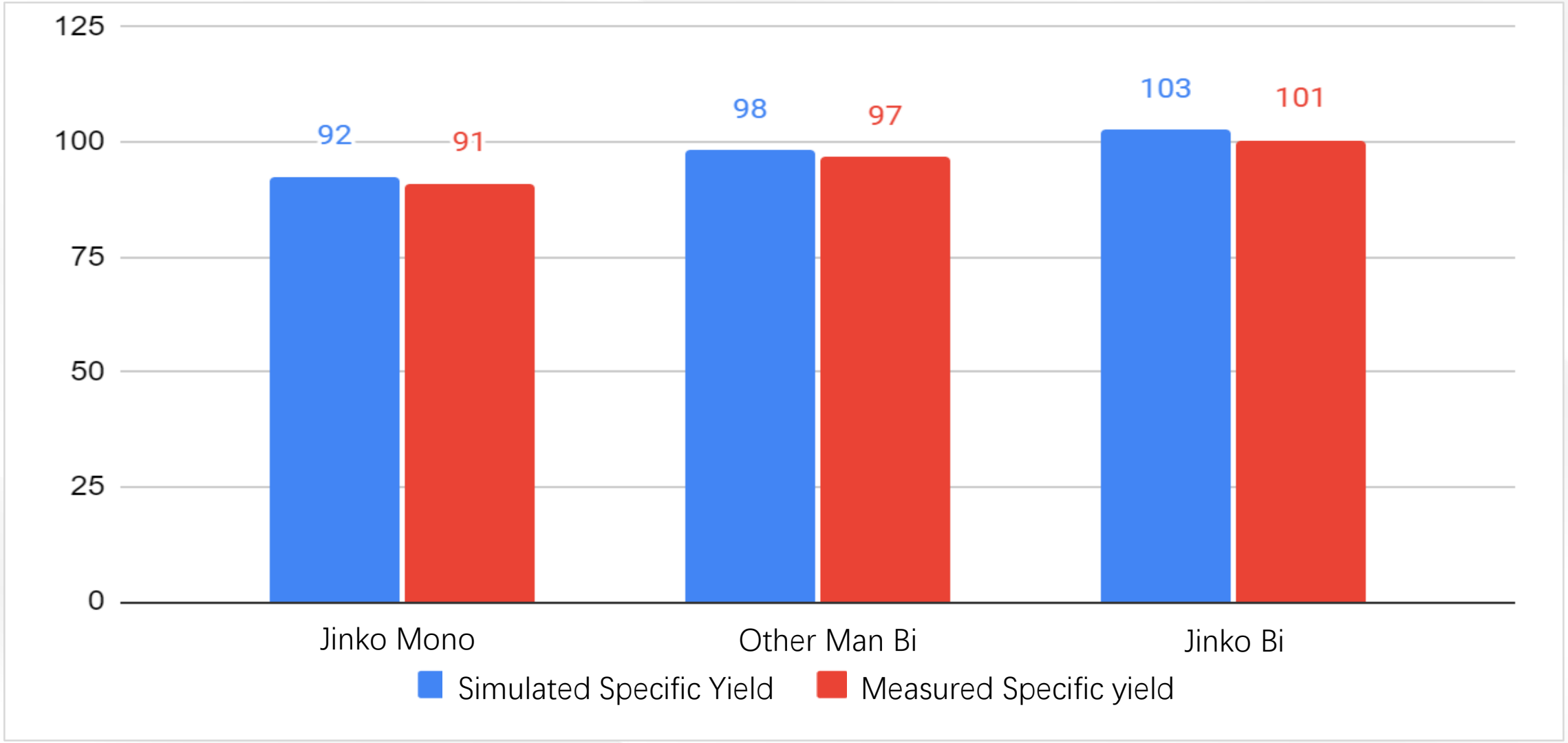
Testing Period

- June 2022 – Sept 2022 (4 months)

Model name	Wafer size	Bifacial factor	Type
Jinko Mono	182 x182mm	-	**Mono facial**
Other Manufacturer Bi	210x210mm	70±5%	**Bi facial**
Jinko Bi	182 x182mm	80±5%	**Bi facial**



Specific Yield results



Qatar Outdoor Field Test

Location

- Doha/Qatar

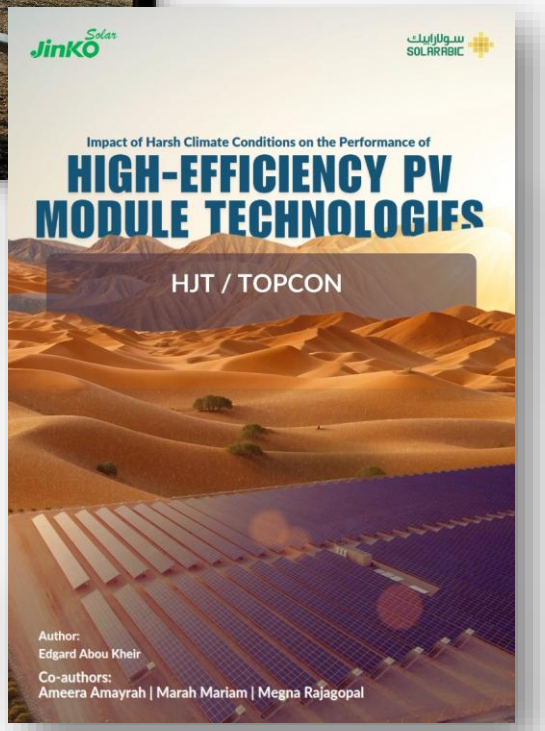
Climate Type

- Desert Climate: High Temperature, High Irradiance, High humidity

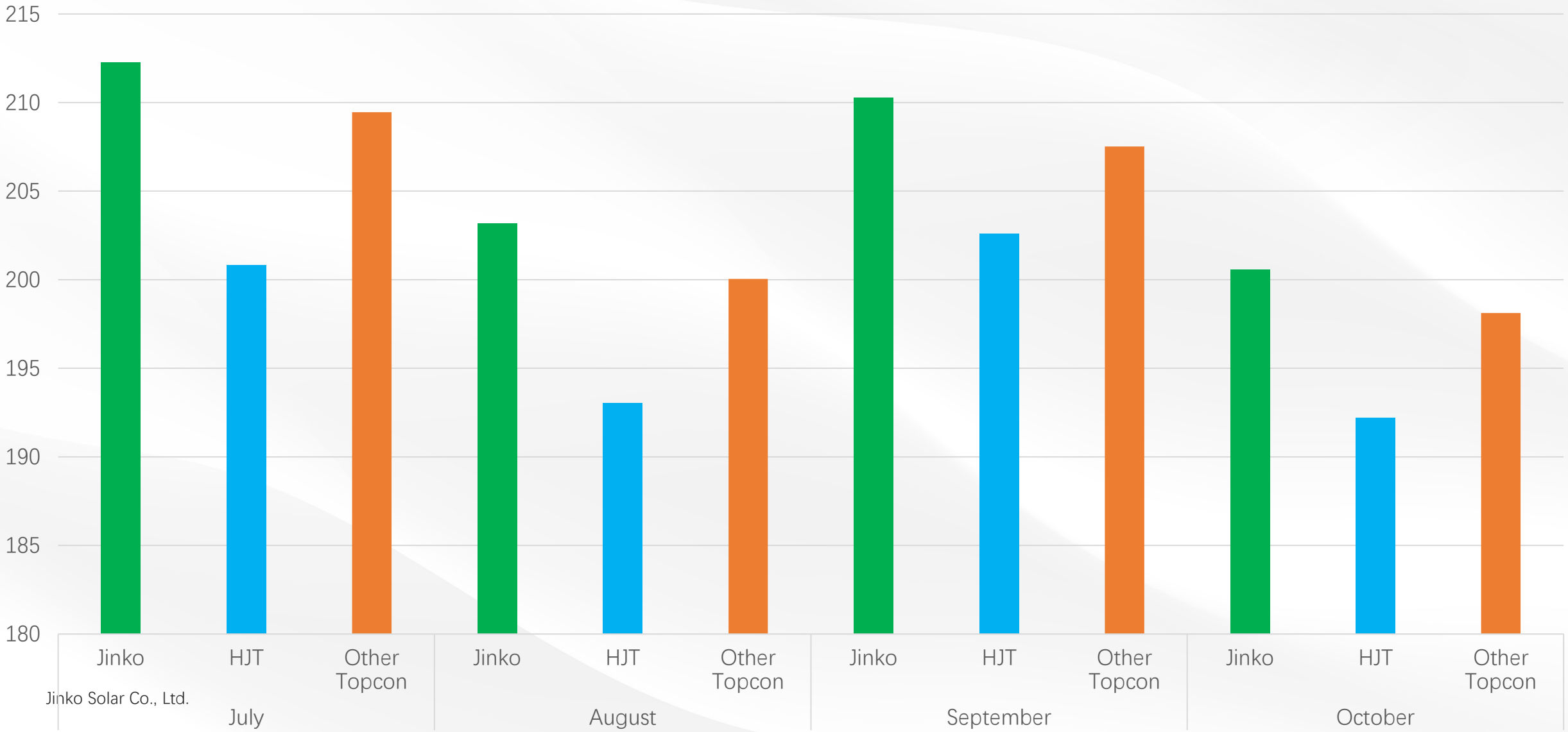
Testing Period

- July 2024 – Oct 2024 (4 months)

Module Manufacturer	Technology	Power	Label Efficiency	Dimensions	Label Temp coeff
Jinko	N-type Topcon	575W	22.26%	2278x1134x30mm	-0.29%/°C
HJT Supplier	N-type HJT	690W	22.21%	2384x1303x35mm	-0.26%/°C
Other Topcon supplier	N-type Topcon	590W	22.30%	2333x1134x30mm	-0.30%/°C

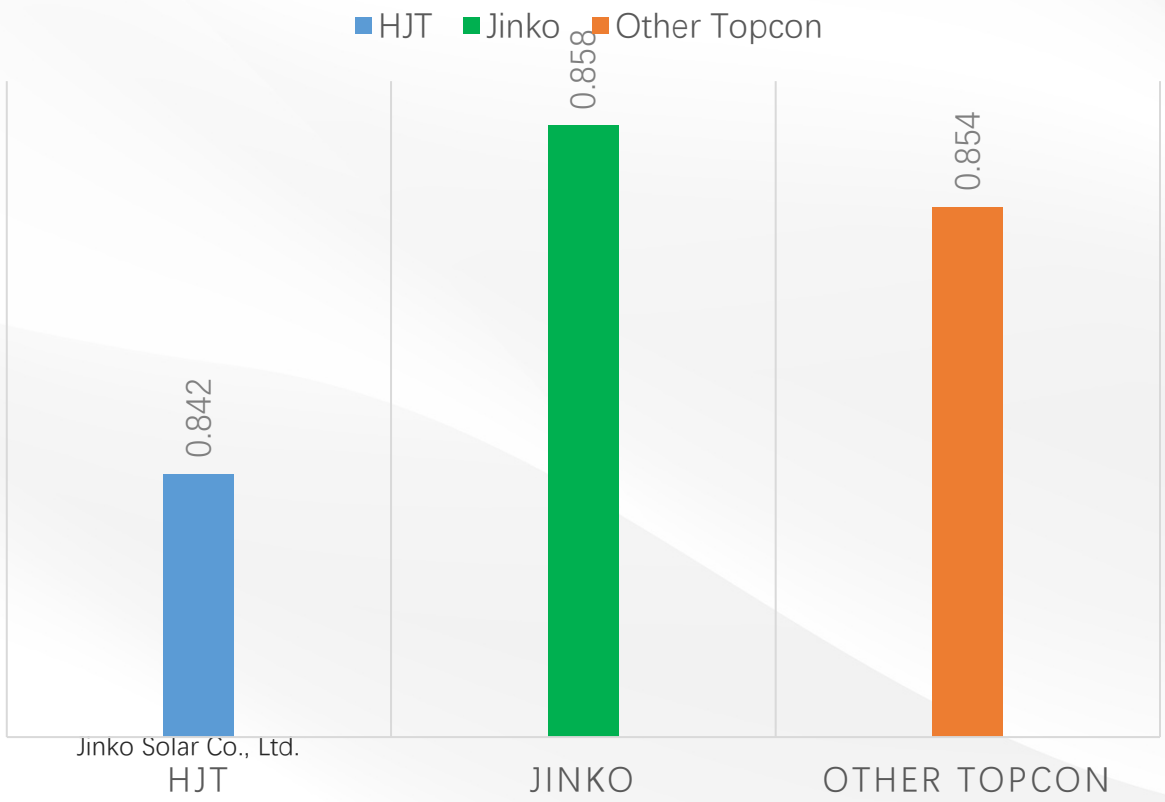


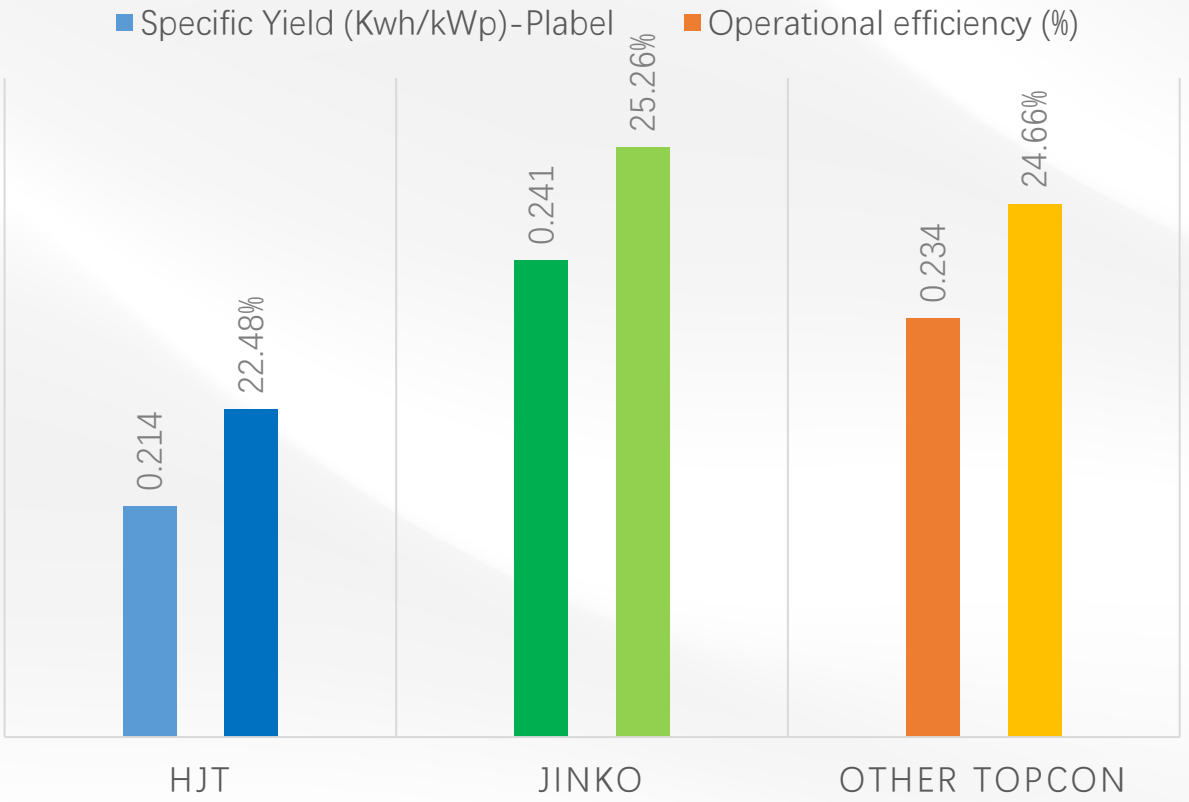
Specific yield



Perfomance at Specific Weather Conditions

Date & Time	Highest Temperature Recorded	Plane of Array Irradiation	Date & Time	Highest Humidity Recorded	Plane of Array Irradiation
13/07/2024 13:15PM	47.8° C	890W/m²	01/08/2024 7:16AM	82%	212W/m²





THANK YOU

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Technical Services Manager – MENA
Edgard.aboukheir@jinkosolar.com

Jinko Solar

Driving Growth in Saudi Commercial and Industrial Sector : JA Solar Solutions

Presenter :Aseel AlSaadi
04-Feb-2025

Overview of the Saudi PV Market Situation
C & I

1

PART

JA SOLAR

Optimal Energy Mix

- The Kingdom has committed to have 50% of its Power generated from Renewable Energy by 2030.
- Saudi Arabia’ s Solar market is showing strong signs of ramping up.
- The major regions in the market are Makkah, Riyadh, Madinah, Qassim, and Eastern Province, among others.

Main Factors Driving the Solar Power Market in Saudi Arabia

- Saudi Arabia’ s key advantage in the solar energy sector is its abundant natural sunlight. With over 3,000 hours of sunshine annually, the country ranks among the sunniest places on Earth.
- The Saudi government has been actively promoting solar energy development through various policies.
- Saudi Arabia has pledged significant investments in renewable energy infrastructure.

» Despite the immense potential and government support, there are several challenges in the Saudi solar power market.

JA Solar - Achievements in 2024

2

PART

Strength in Numbers

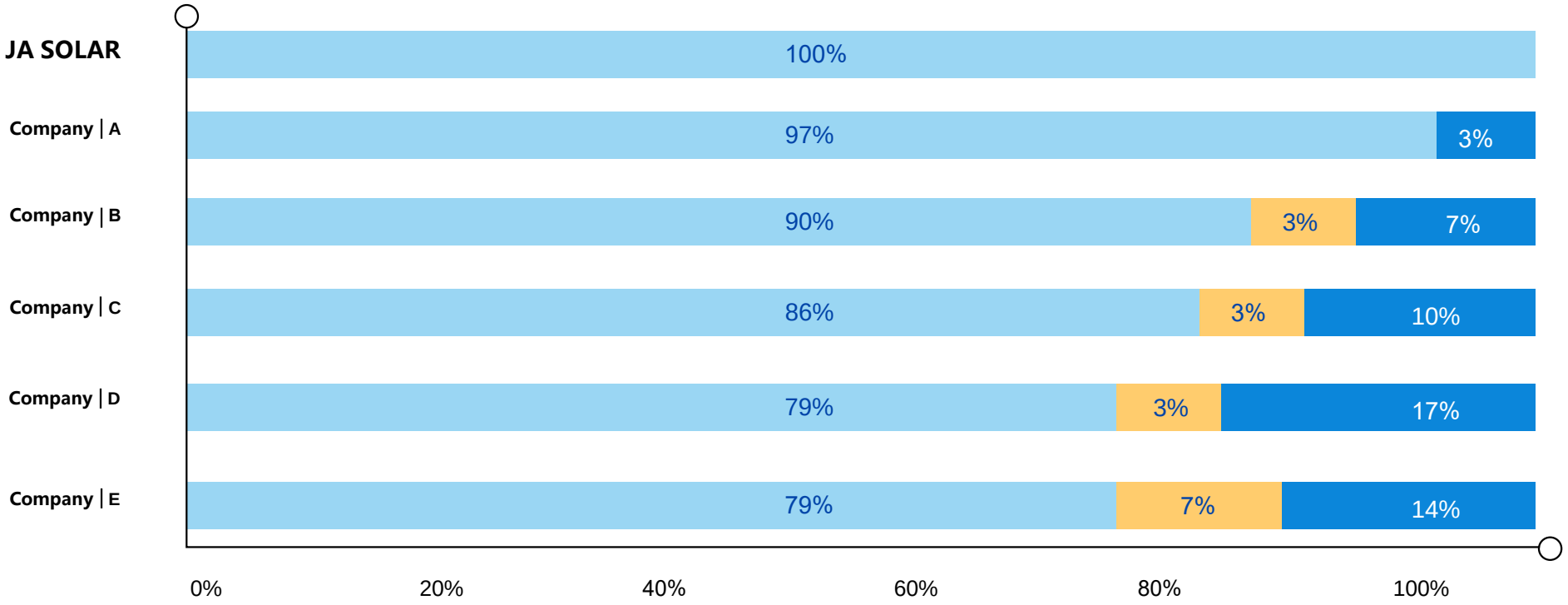
Annual shipment of PV modules reached **70GW** in 2024

As of the end of 2024 Q3, the cumulative shipment of PV modules exceeded **246GW**

Product sales and service network spans **178** countries and regions

As of the end of 2024, **1,899** **valid** patents, including **1,032** invention patents

100% Bankability Recognized by BNEF



(Source: BNEF, 2023)

Accolades from Rating Agencies and Third Party Institutions

Top Performer
PVEL

Overall Highest Achiever
RETC

Silver Medal Group-Level
EcoVadis

Ranked on the
2024 Global Top 500 New Energy Enterprises List

Ranked on the
2024 Top 500 Chinese Manufacturing Enterprises List

Industry Trend In C & I

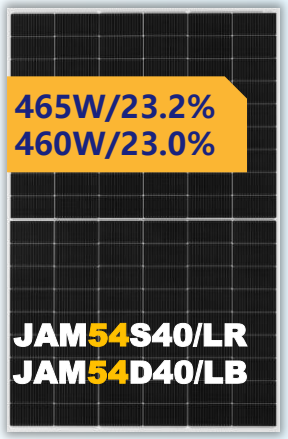
3

PART

JA SOLAR

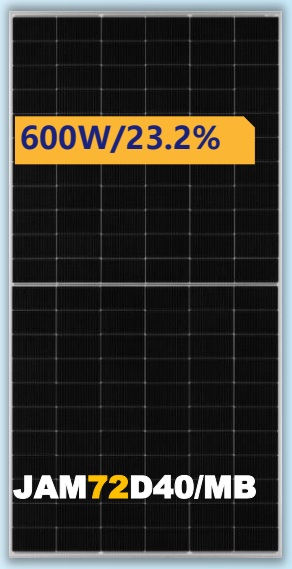
DEEP BLUE 4.0 Pro Series

54c TOPCon



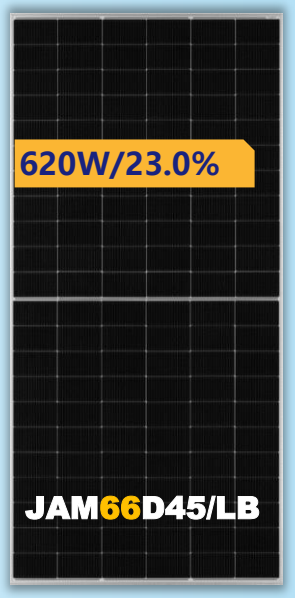
(1762×1134)

72c TOPCon



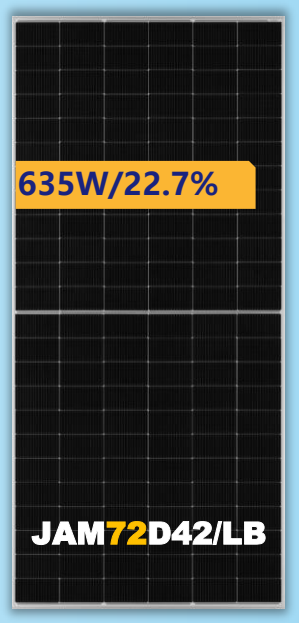
(2278×1134)

66c TOPCon



(2382×1134)

72c TOPCon



(2465×1134)

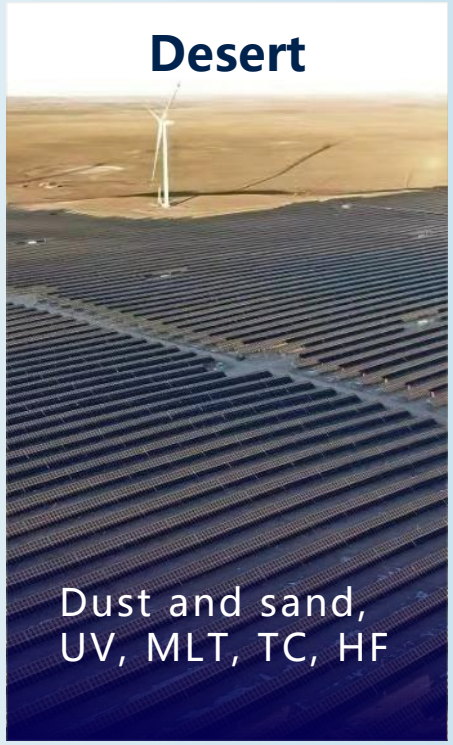
Residential

Residential、Commercial & Industrial, Utility-Scale

Industry Trend：Reliable Performance Across All Climates

Customized modules for reliable performance under various climate conditions.

At JA Solar we have developed specialized applications for various environments.



📊 How to Make This System Even Better ?

A research-backed approach has demonstrated that optimizing key factors below can further enhance bifaciality, increasing gains by **(2-10)%** or even higher for rooftop applications.

1. **Optimizing Surface Albedo** *(High-reflectivity surfaces boost bifacial gain!)*
2. **Adjusting Tilt Angles**
3. **Coverage Ratio %**

📊 To further enhance system efficiency in C&I rooftop applications

1. A study has shown that optimizing the tilt angle—25° during dry periods and 45° during rainy periods—effectively reduces dust accumulation in **Jeddeh** specifically , enhancing overall energy performance.
2. Additionally, JA Solar's Anti Dust Products, featuring drainage holes, helps minimize dust buildup, ensuring sustained high efficiency.

Unlocking the Full Potential of C&I Solar with JA Solar Bifacial Modules

➢ As part of Saudi Arabia's **Vision 2030** initiative, the C&I sector is rapidly adopting renewable energy solutions.

What are the key benefits of bifacial Modules in C&I Projects?

- Higher Energy Yield
- Lower LCOE
- Better Performance in Harsh Conditions
- Accelerate ROI

What role can bifacial solar play in achieving sustainability goals?

- Reduce Carbon Emissions
- Supporting circular economy & Longevity

Hamburg University of Applied Sciences

Faculty of Life Sciences

Performance Optimization of Bifacial Module PV Power Plants Based on Simulations and Measurements

Accurate modelling of the bifacial gain potential of rooftop solar photovoltaic systems

M. Ernst [a,*], X. Liu [a], C.-A. Asselineau [a,b], D. Chen [c,d], C. Huang [c], A. Lennon [c,d]

[a] *The Australian National University, School of Engineering, Canberra, ACT 2600, Australia*
[b] *IMDEA Energy, Av. Ramón de La Sagra, 3, 28935 Móstoles, Madrid, Spain*
[c] *SunDrive Solar Pty Ltd, Kurnell, NSW, 2231, Australia*
[d] *School of Photovoltaic and Renewable Energy Engineering, UNSW Sydney, Kensington 2052, Australia*

The best tilt angle to improve PV module performance in world's worst soiling accumulation zone

Scientists have measured the performance of PV modules under strong soiling conditions in Saudi Arabia and have identified the most suitable tilt angles for improving power generation. They have also found that a key role is played by rain intensity, dust, sandstorms, and cloud cover.

JA Solar has Vertical Integration in Module Manufacture

- Ingots 100GW+
- Wafers 100GW+
- Cells 100GW+
- Modules 100GW+
- Power Plants

Profound knowledge of

- PV Technology
- Raw materials
- Wafer and cells
- Modules and the entire system

Controlling of

- The product quality
- The deliveries
- The production capacity

Worldwide Manufacturing

- China
- Vietnam
- United States
- Oman

Nadec Project
Location :Saudi Arabia

Laila Project
location :Saudi Arabia.
Project : Ground-Mount
15 MWp

Location : Riyadh- Saudi Arabia
Capacity :368KWp
Time :2023
Model Name :JAM72D40 580 /MB

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Premium Cells, Premium Modules

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CLEAN ENERGY CONFERENCE

Thank you for joining today!

Emiliano Bellini
News Director
pv magazine

Moneef Barakat
CEO
Solarabic