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Trinasolar TrinaTracker TRENDFORCE

Drive your utility solar success with Trina Solar's Upgraded Vertex N 700W+ modules

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EVENTS | PUBLISHING | RESEARCH

Evolving Trends in Advanced Technologies Across the Global Solar PV Industrial Chain

TRENDFORCE 集邦咨询

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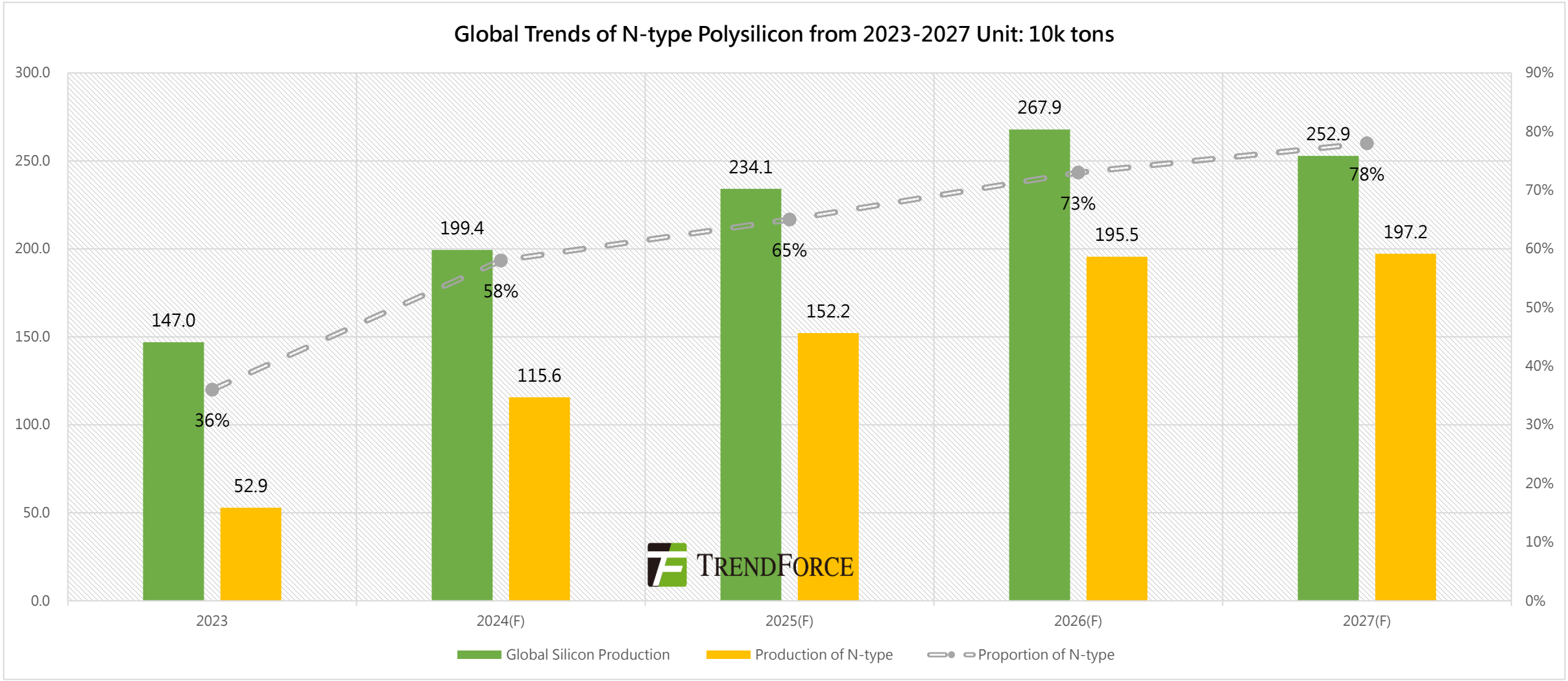
TRENDFORCE

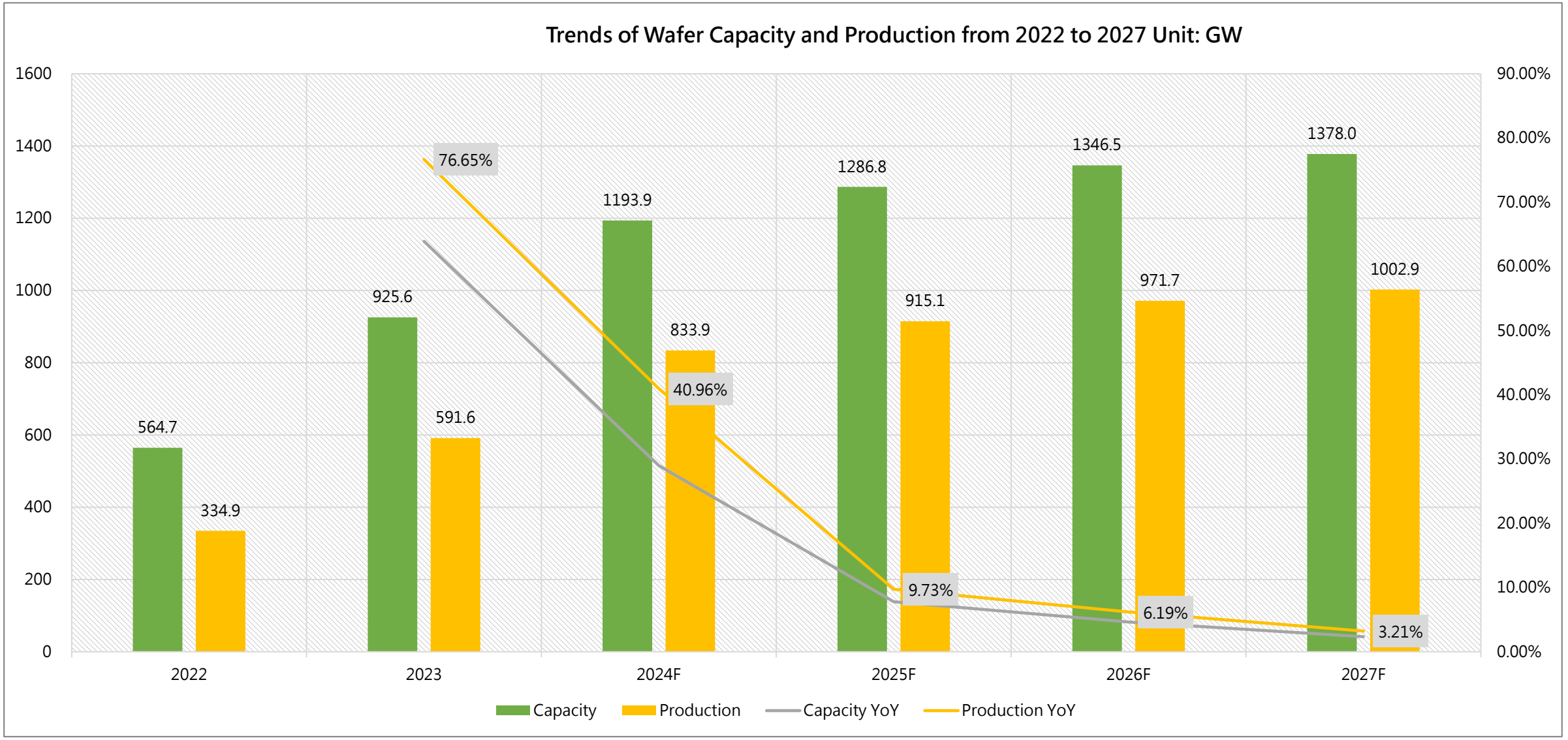
ENERGY TREND

Unlocking Opportunities of Rectangular Wafer Advancements and the N-Type Technology Transition

Ascending Production Share of N-Type Polysilicon and the Tight Balance in Supply and Demand of High-Quality N-type Polysilicon Amidst Surging Customer Needs

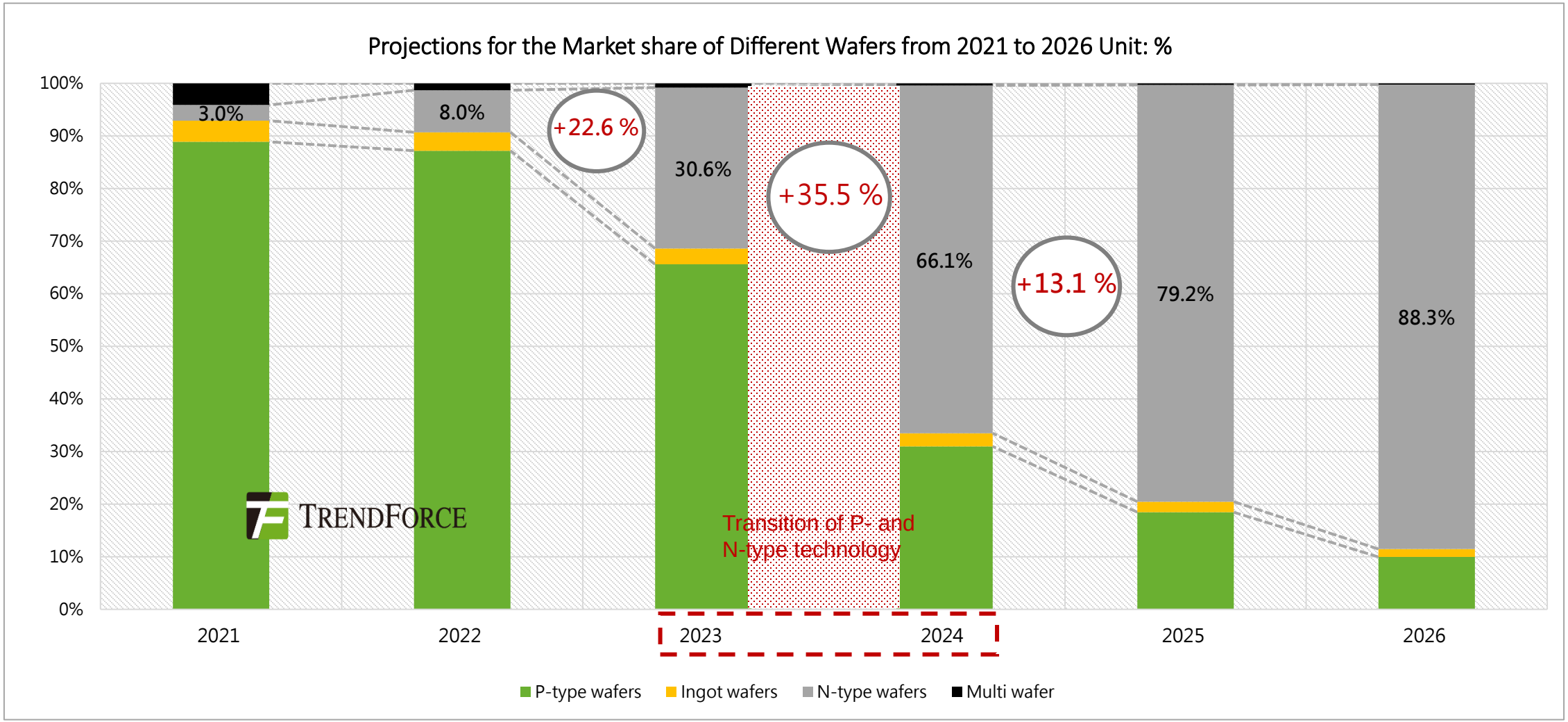


N-Type Wafer Output Speed and Cost Control Vital for Enterprises' Performance Excellence

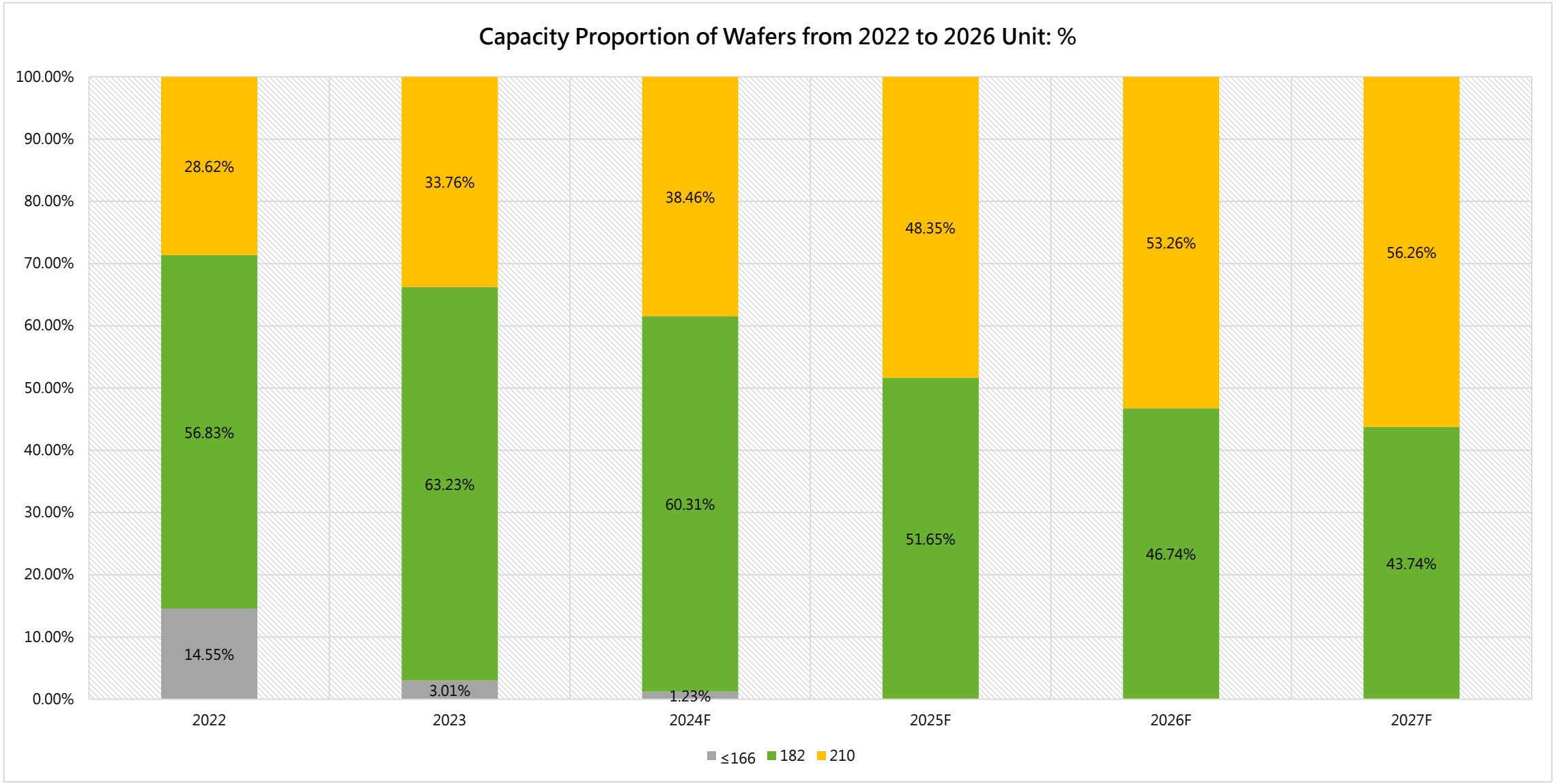


2024: A Pivotal Transition from P-Type to N-Type Wafers, Anticipating a 66.1% Market Share Surge

- **We anticipate that the market share of N-type wafers will climb to 66.1%, marking a 35.5% increase from the 2023 figures.**
- **A significant volume of N-type capacity is set to come online next year following the commissioning process.**

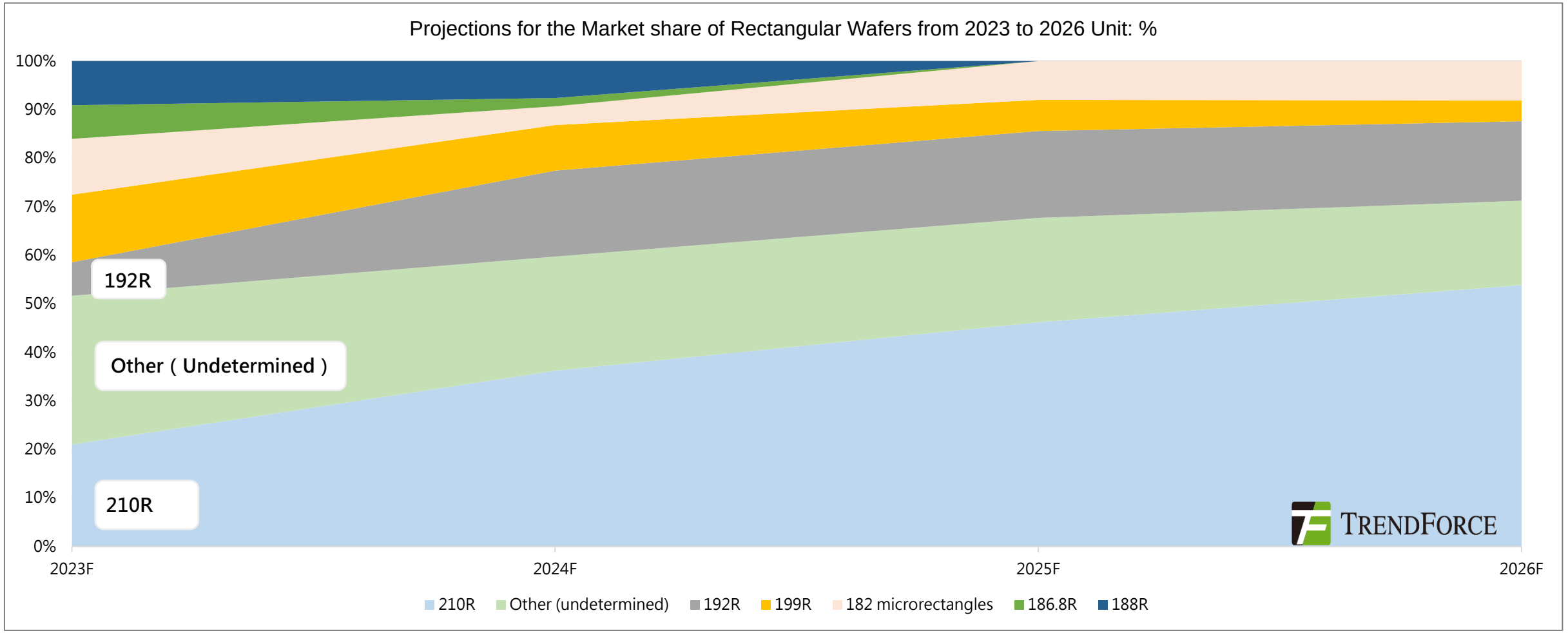


Large Format Wafers Secure Nearly 99% of Total Production in 2024, Emphasizing the Clarity in Rectangular Wafer Format Choices



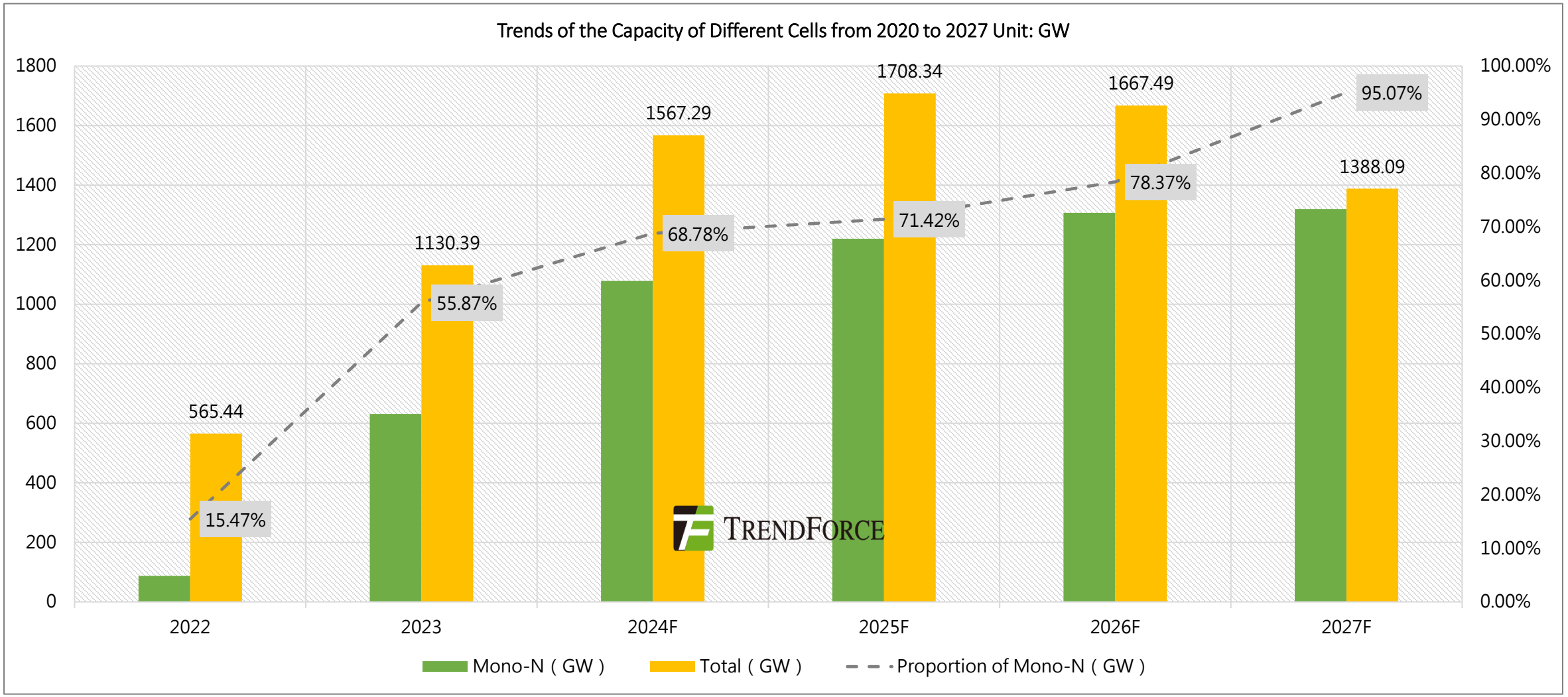
Revolutionizing Efficiency: Rectangular Wafers Benefit the Efficiency Improvement of Medium-Format Modules, and 210R Emerges as the Dominant and Advantaged Mainstream Size

- **Manufacturers aiming for efficiency breakthroughs in 182mm medium-format modules are increasingly focusing on rectangular wafers.**
- **In July 2023, nine prominent module enterprises came together and reached a consensus to standardize medium-format modules using rectangular wafers. This collaborative effort aims to bring order to the diverse and varied formats of rectangular wafers prevalent in the market.**

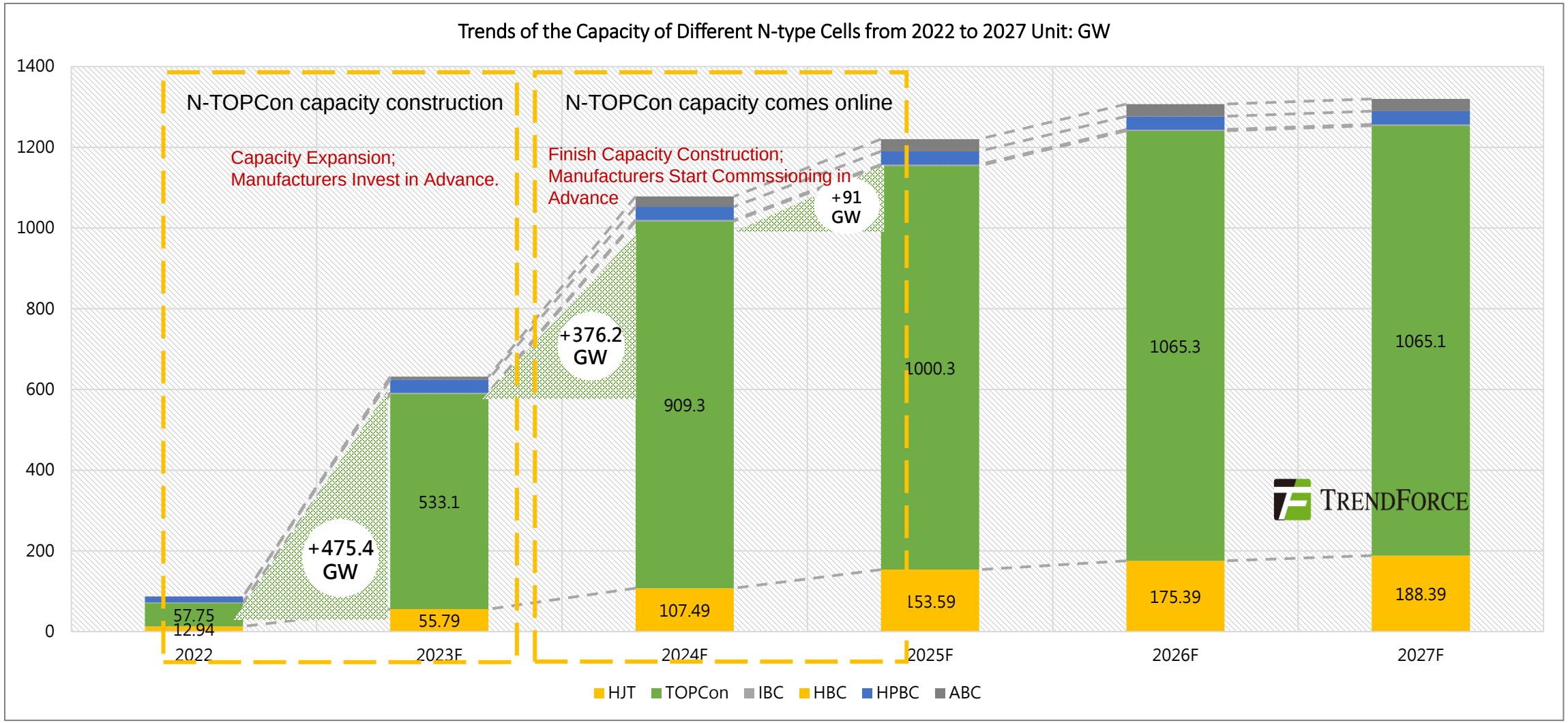


Examining Cell Technologies and Competitive Capacities

Phasing Out Outdated P-Type Capacity and N-Type TOPCon Cells Become Mainstream Choice in the Market



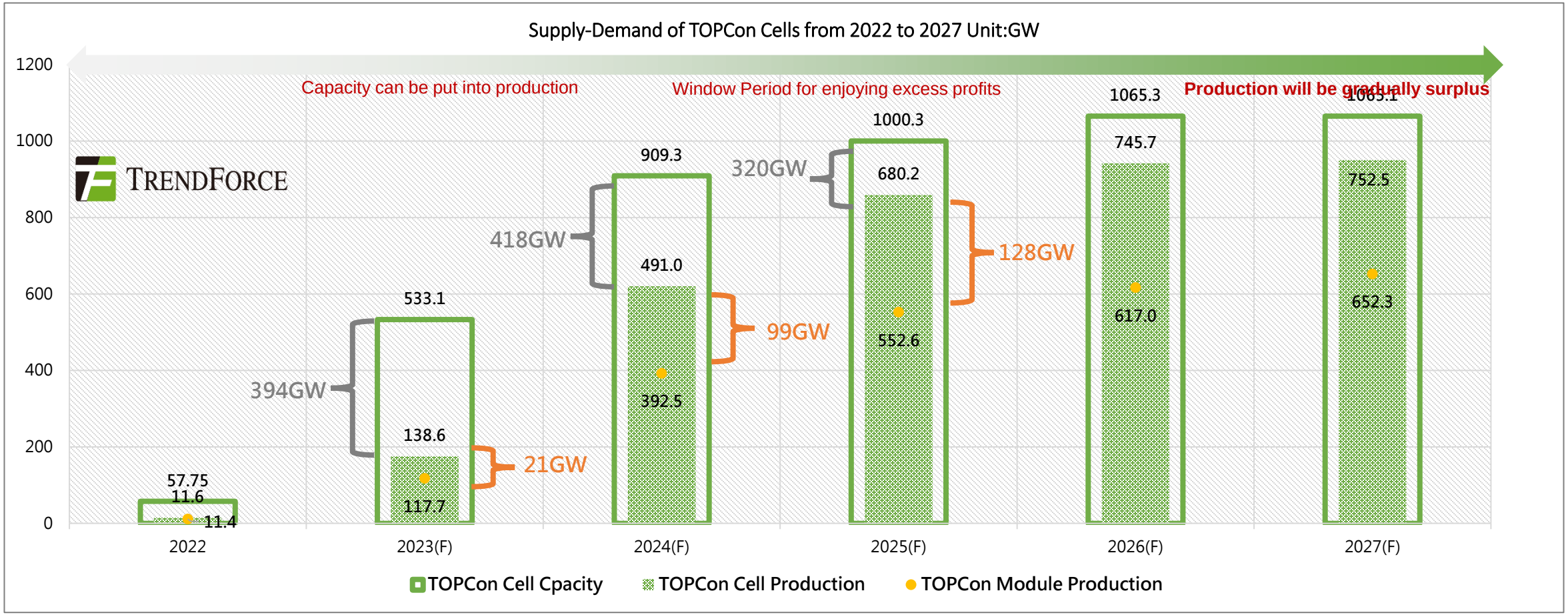
TOPCon Capacity Soars in 2023, Paving the Way for a Substantial Surge in N-Type Mass Production in 2024



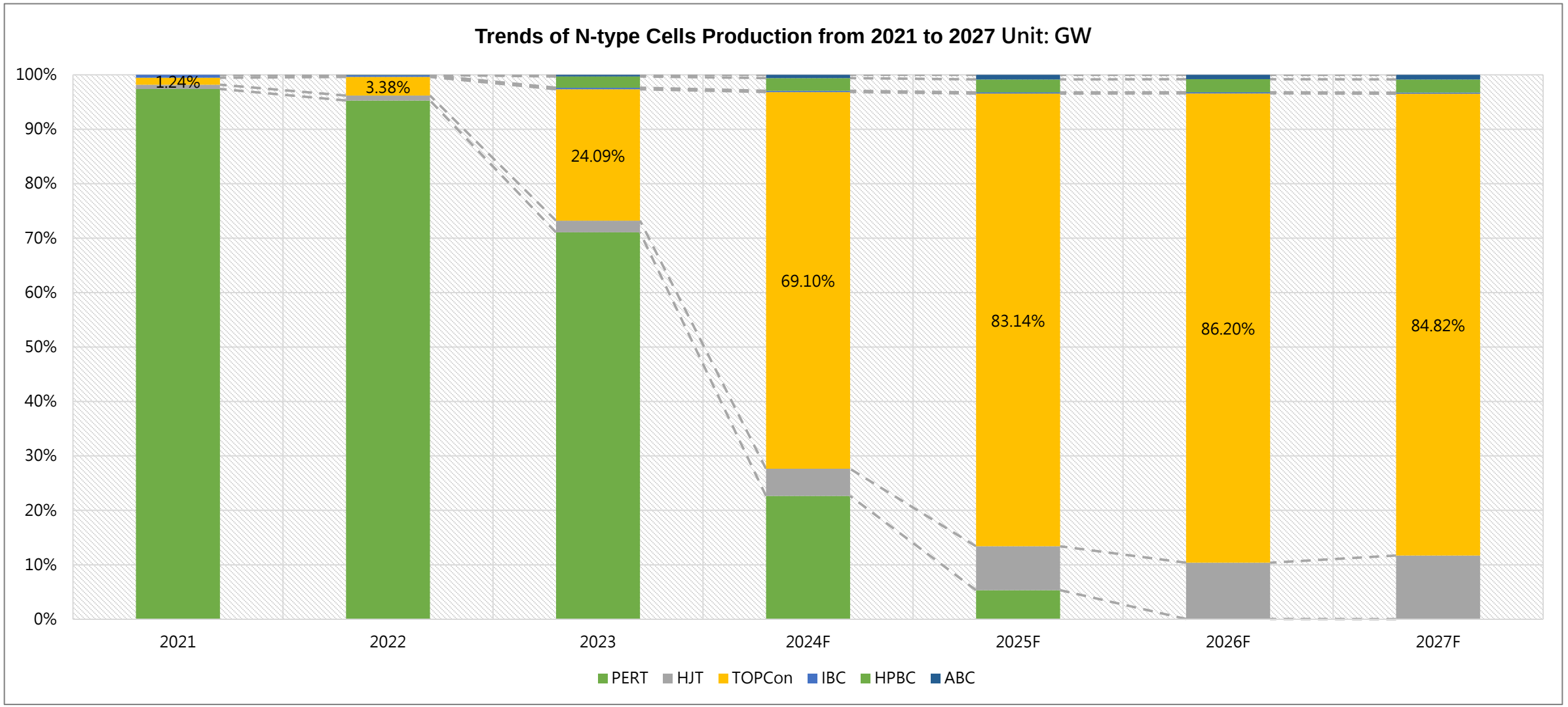
Note: The capacity we calculate above is nominal capacity, including the capacity that is uner construction.

Unveiling the Three Stages of TOPCon Technologies: Anticipating Excess Profits in 2024 and 2025

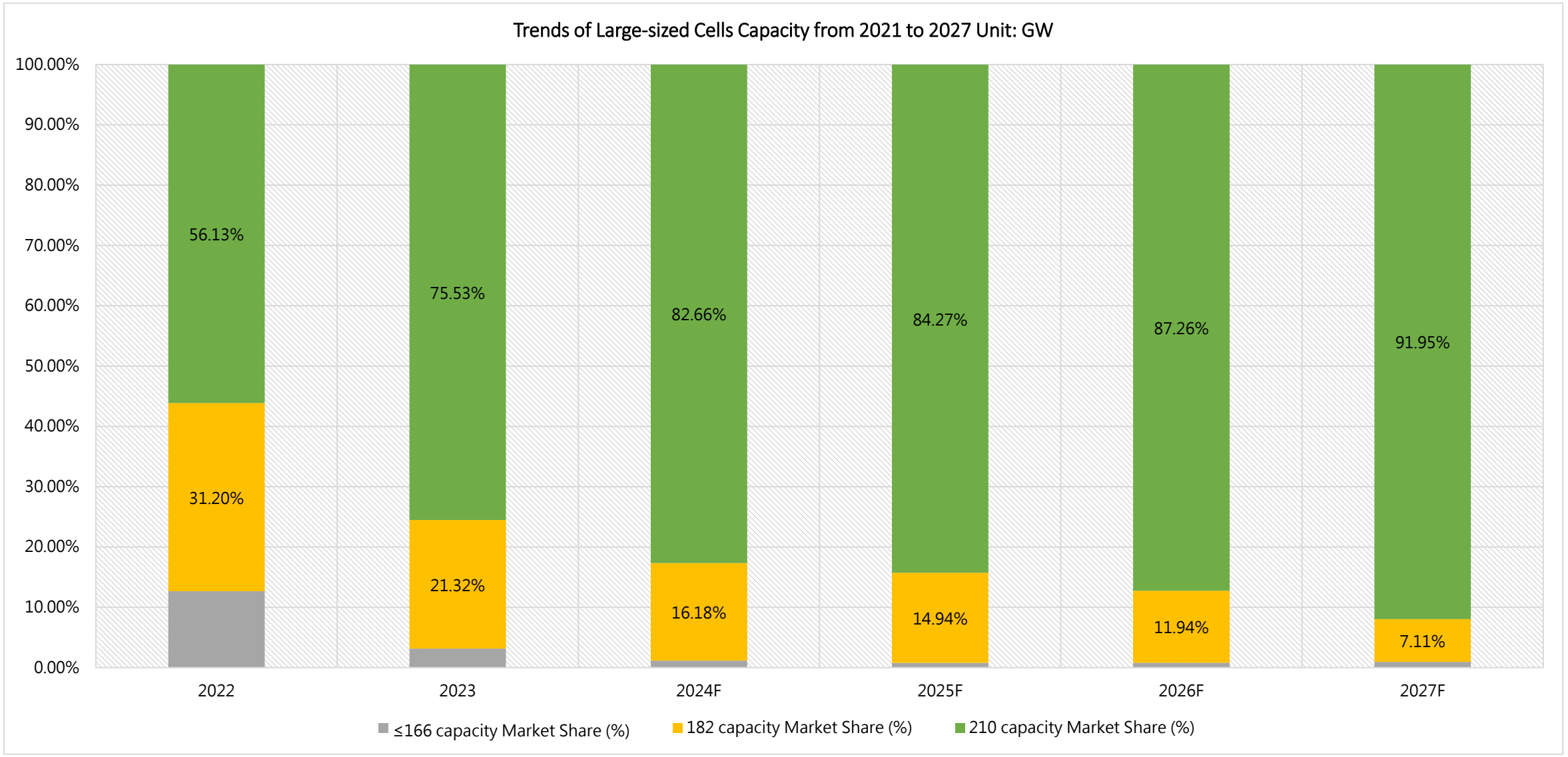
- Between 2023 and 2025, capacity construction will conclude, exacerbating the issue of oversupply.
- By the first half of 2024, leading manufacturers are expected to complete their commissioning processes, and customer demand will undergo rapid changes in the subsequent period. During this time, the supply and demand for high-efficiency TOPCon cells will maintain a tight balance.
- Post-2025, the supply is projected to exceed demand, leading to a decline in profits attributed to new technologies.



Advancements in Various Technologies: TOPCon Cells Poised to Lead N-Type Innovations Over the Next Three to Four Years

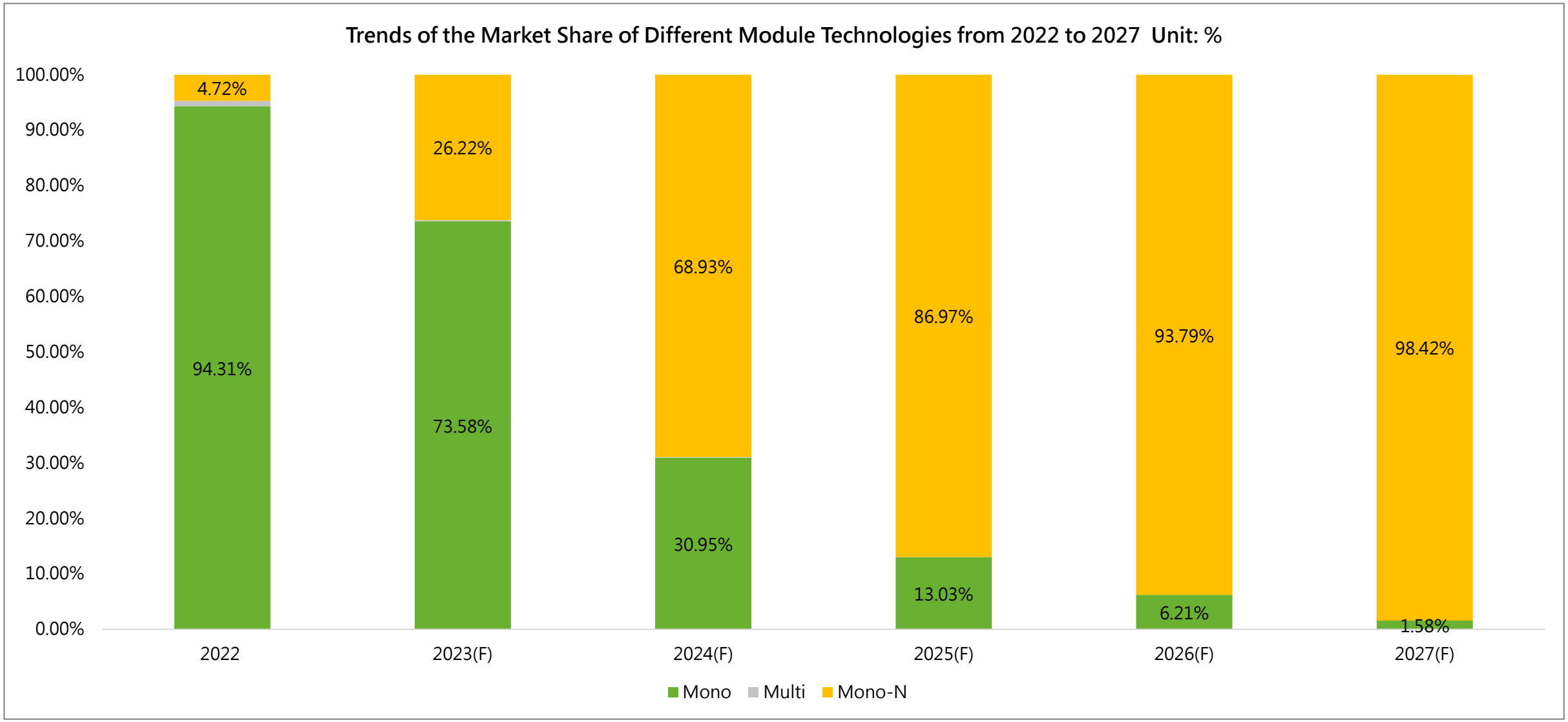


Embracing Large Format Cells: A Definite Trend with Production Expected to Reach 99% in 2024

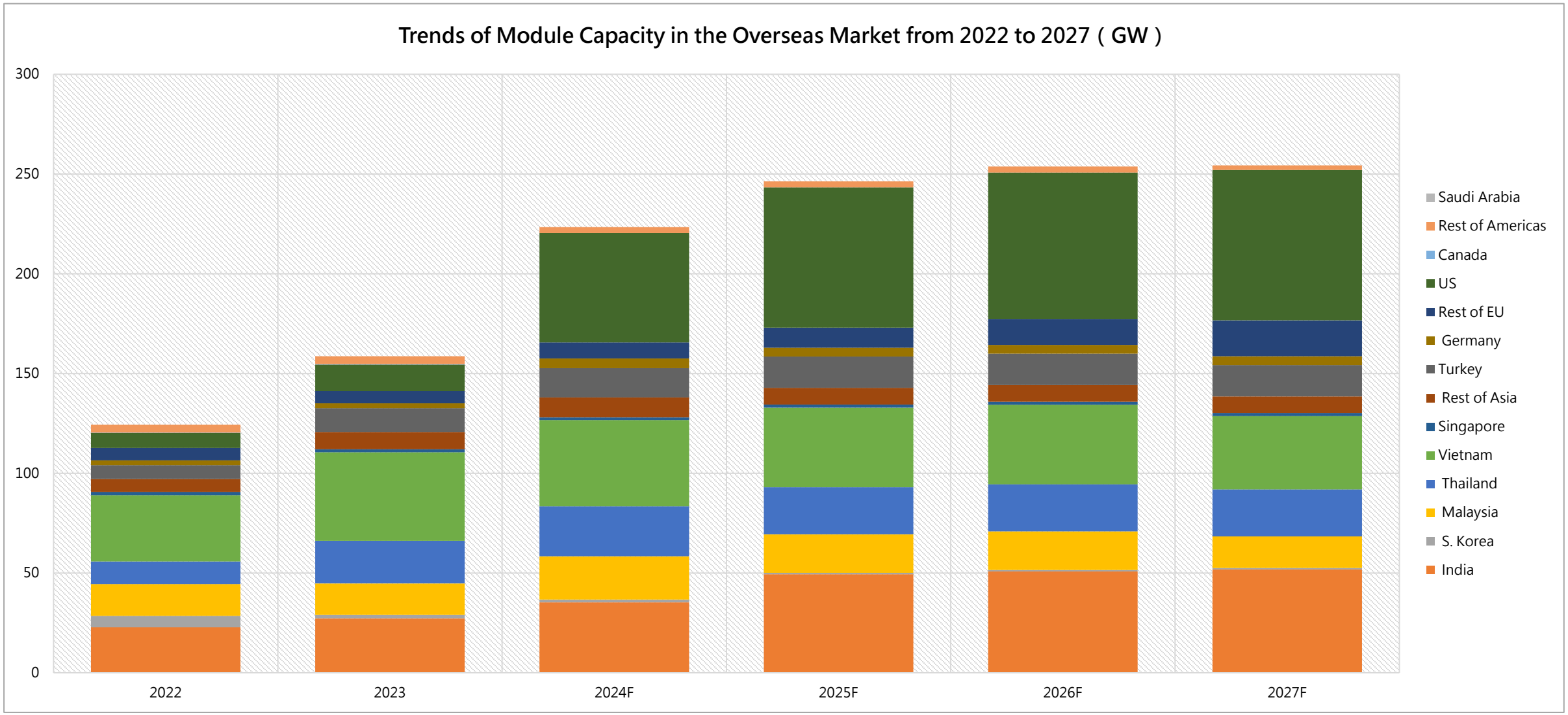


Unraveling Technological Transitions and Power Shifts Among Major Module Enterprises

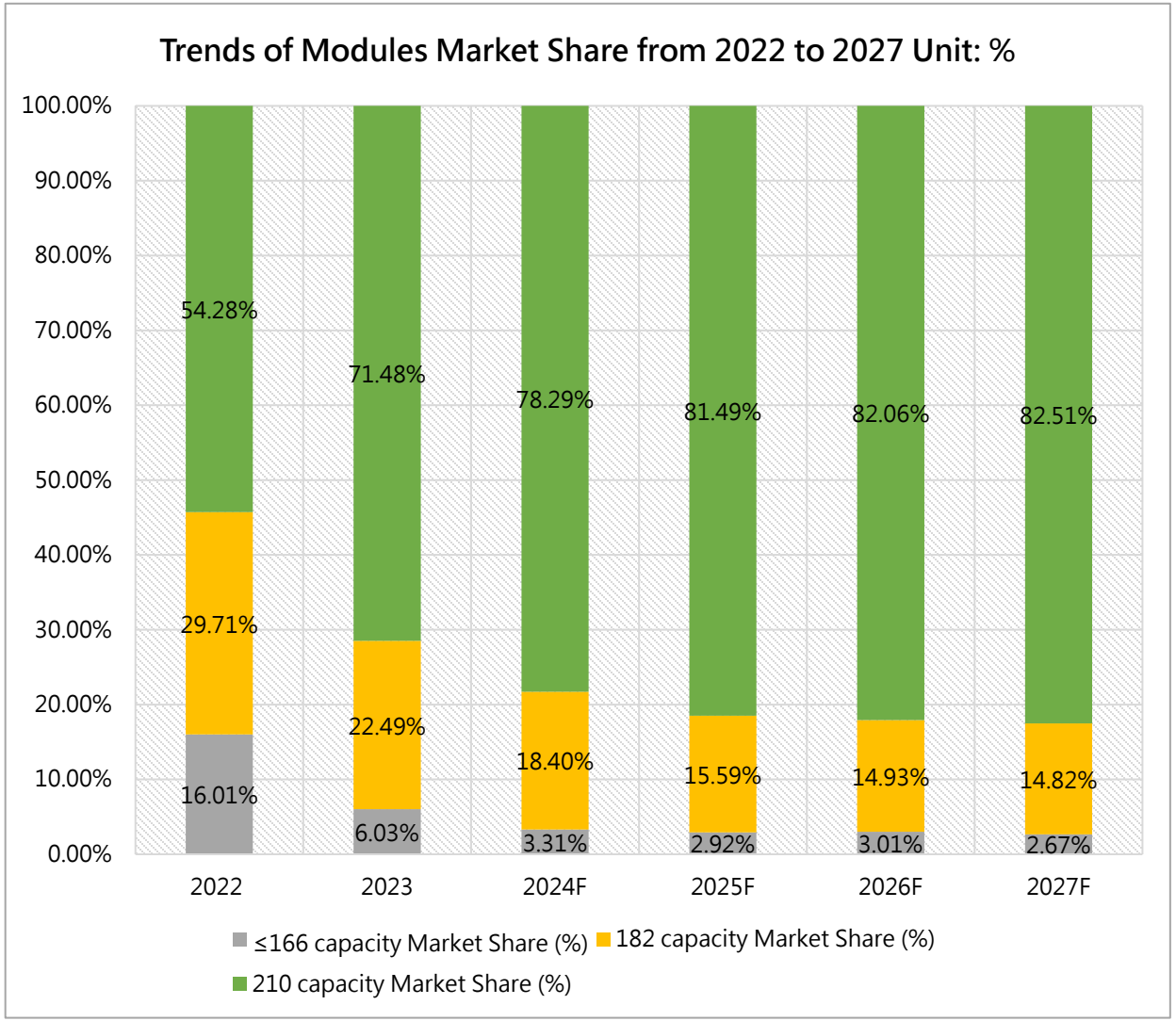
N-Type Technology Emerges as Key Player in Diversified Competition, With its Market Share Expanding Rapidly

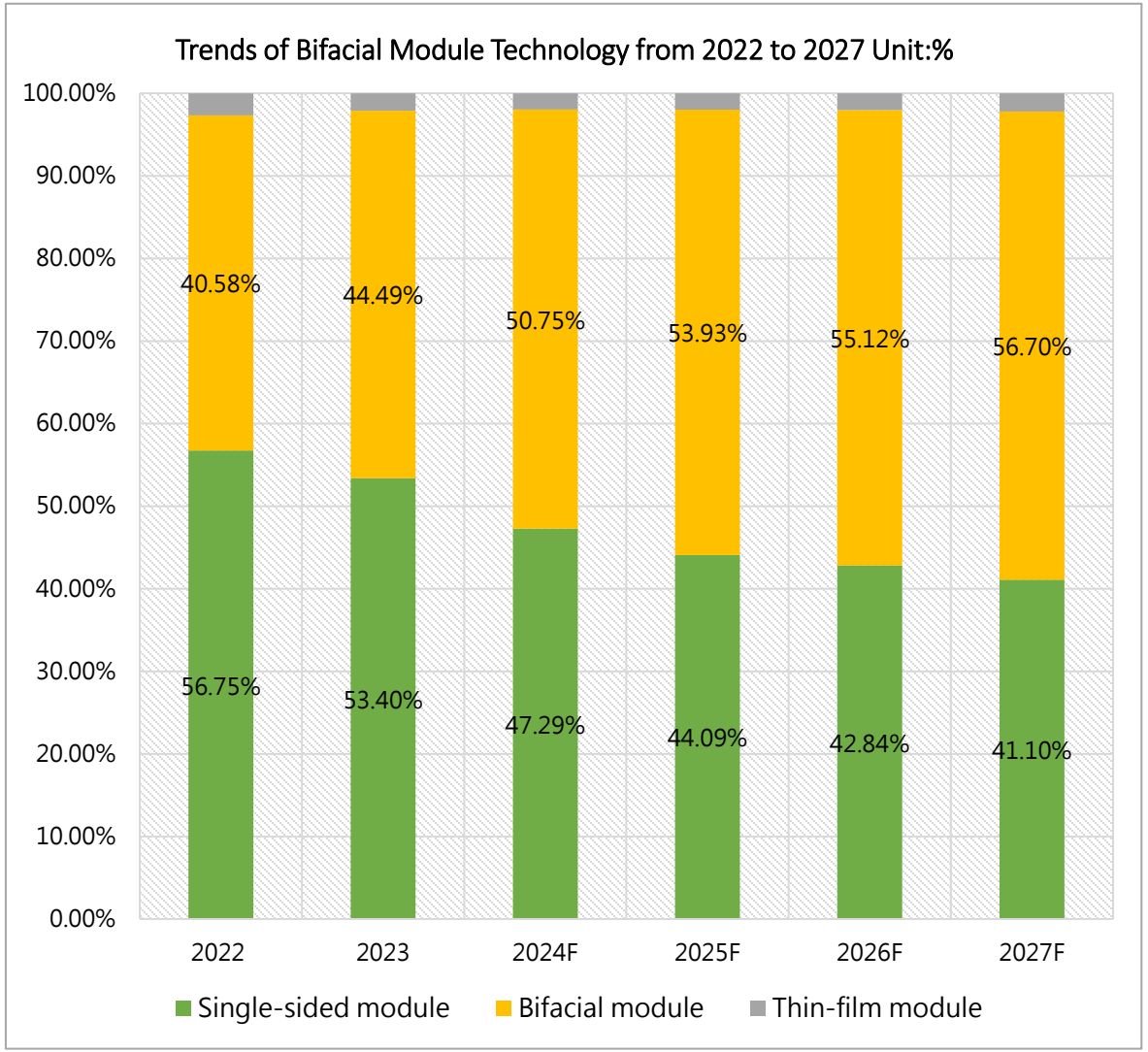


Strategic Significance of Medium to Long-Term Self-Supply in Overseas Capacity; Chinese Production Capacity Continues to Uphold Global Module Market Domination in the Short Term



Large Format Modules Capacity Surpasses 95%, and Bifacial Glass Module Penetration Rate Rises Fast



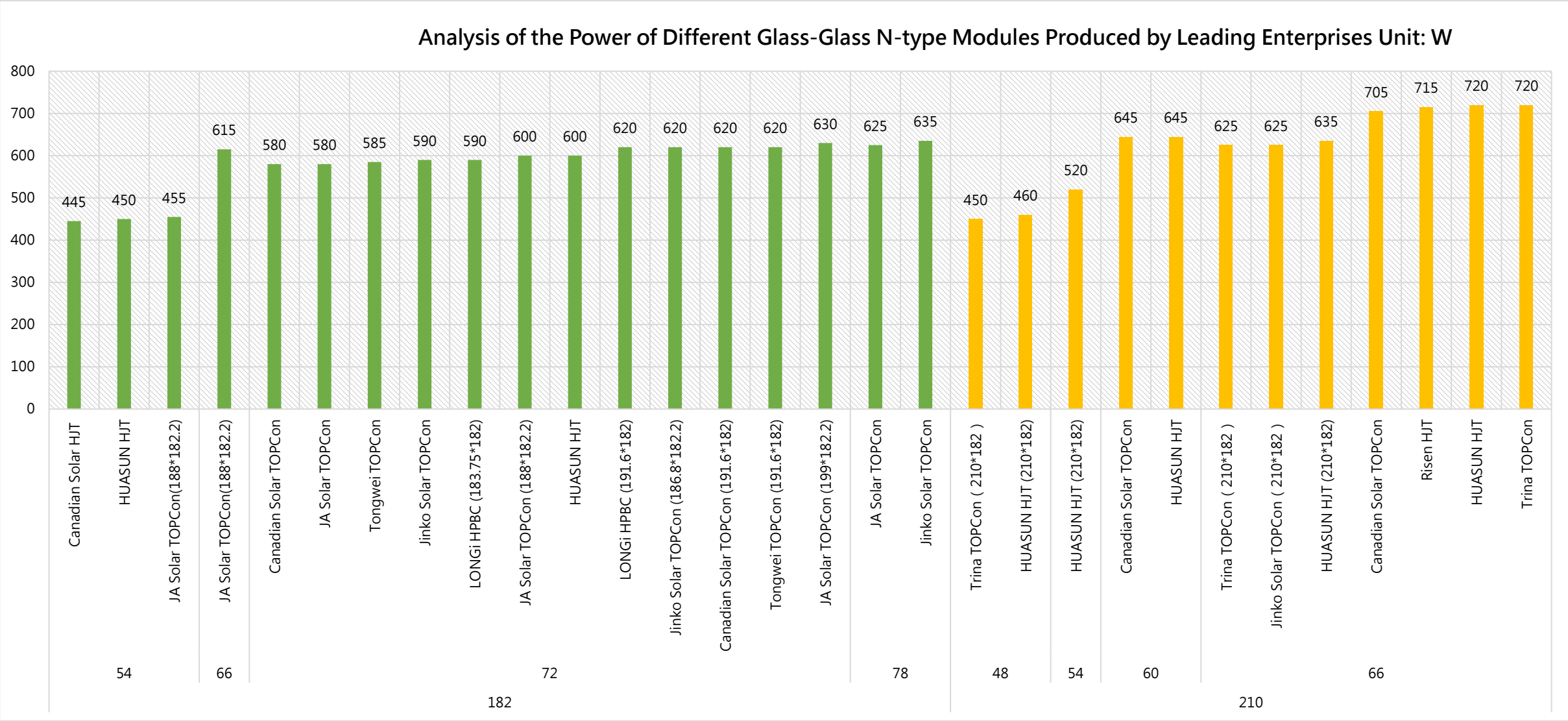


183.75mm and 210R Formats Poised to Lead Rectangular Module Market

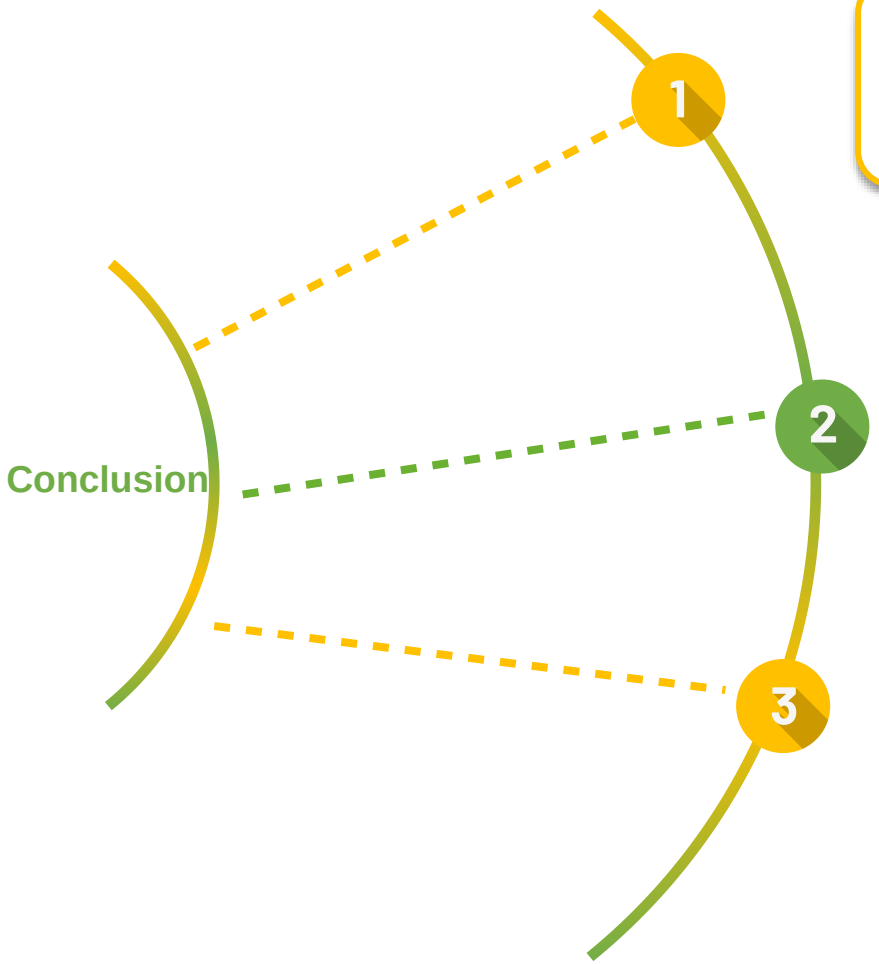
	182*182	183.75*182	185.3*182	186.8*182.2	188*182	191.6*182	199*182	210*182	210*210
Jinko	Mass Production			Mass Production				Obtain product certification and the product will be on the market.	
JA	Mass Production		Pilot Line		Mass Production		Obtain product certification and the product will be on the market.	Obtain product certification and the product will be on the market.	
Trina Solar								Mass Production	Mass Production
LONGi	Mass Production					Obtain product certification and the product will be on the market.			
Tongwei	Mass Production					Obtain product certification and the product will be on the market.		Obtain product certification and the product will be on the market.	
Canadian Solar	Mass Production					Being built.			Mass Production
Risen Energy	Mass Production					Production lines have been built.			Mass Production
Chint	Mass Production							Obtain product certification and the product will be on the market.	
DMEGC						Mass Production		Layout in Products.	

Prominent manufacturers enhancing their modules to conform to the dimensions of 19XR and 210R.

Swift Advances in N-Type Module Mass Production and Breakthroughs: Achieving 700W+ Power in 210+n Modules



Conclusion



① The N-type wafer market is poised to claim a 66% share in 2024.

② Large-format wafers will nearly dominate the total wafer production, reaching nearly 99%, with rectangular wafers progressively dominating production. The production share of 210R and 210mm format modules is expected to witness a significant surge this year.

① PERC cell capacity will be phased out faster and N-type TOPCon cell will be mainstream technology in the next three to five years.

② The production proportion of 210R and 210mm format modules is projected to climb further, reaching around 83%, establishing it as the mainstream cell size.

① N-Type technology emerges as a crucial factor in diverse competition, with its market share anticipated to rapidly rise to 68.9% in 2024.

② The capacity proportion of large-format modules is set to surpass 95%, with 210R potentially becoming the mainstream rectangular module format. Simultaneously, the penetration rate of bifacial modules is accelerating.

③ The mass production of N-type modules is expected to accelerate, with 210+N-type modules achieving a breakthrough power level of up to 700W+.

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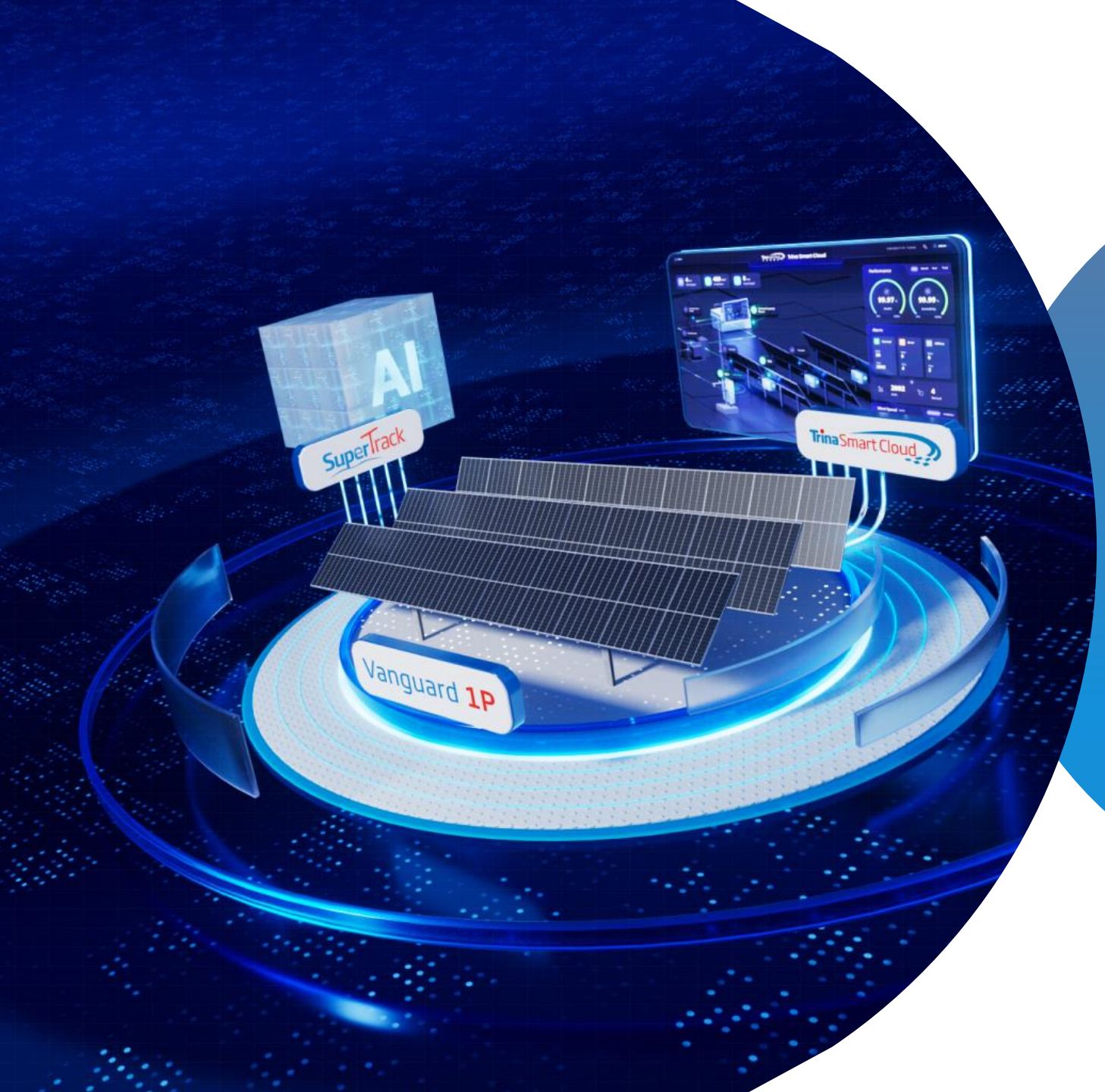

2024

Upgraded Vg1P & 700W+ solution

Power beyond solar

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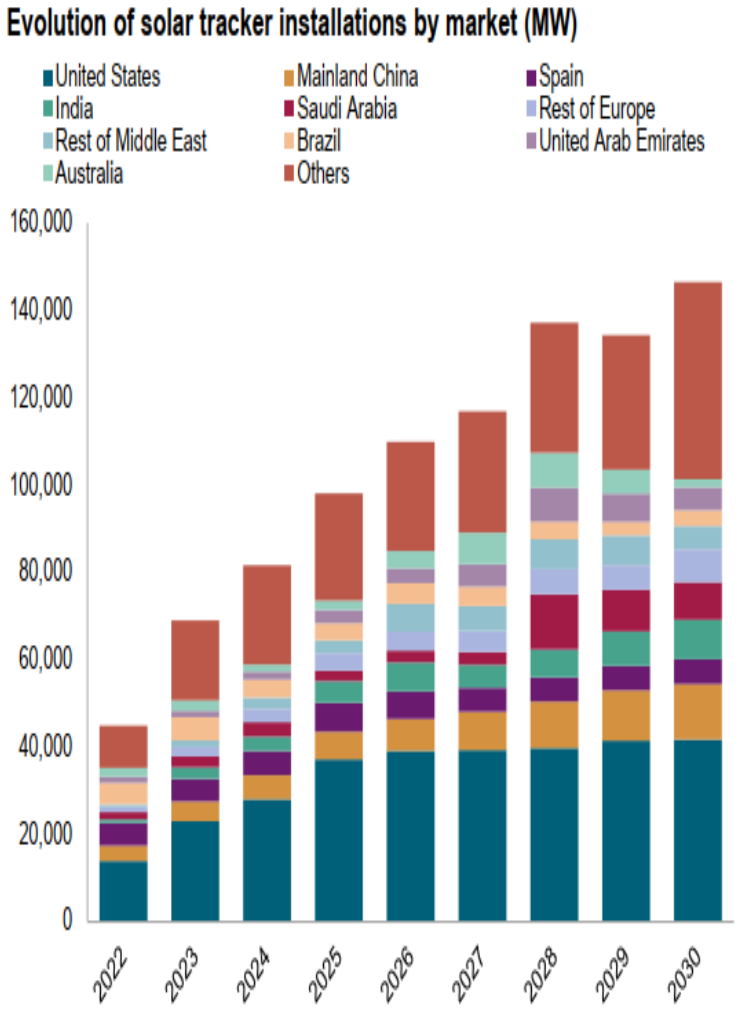
Tracker industry overview



Analysis of core growth point

	2022-2023	2024E-2030E
NA	• The United States: The ITC policy subsidy subsidy ratio increases, power plant plant investors prefer the investment of investment of large-scale photovoltaic photovoltaic power plants, and the growth growth of power generation will bring bring higher returns	• United States: IRA and ITC subsidy policies policies make the United States photovoltaic new grid-connected projects projects continue to increase; Drive Drive tracking bracket demand • With the implementation of IRA, tracking tracking stent brings a higher proportion of proportion of tax subsidies, tracking stent tracking stent demand growth
EU	• Spain: Energy prices have fallen, but are but are still high, developing new energy energy resources and getting rid of of dependence on natural gas	• Italy: Agricultural photovoltaic related related policies have been introduced, and introduced, and the demand for trackers trackers will bring a certain increase
MEA	• Middle East: Middle East countries have have introduced new energy targets to to reduce dependence on oil exports in exports in exchange for economy, etc. In etc. In order to match lower electricity electricity costs, trackers are more favored	
CHN	• Agri-PV, stimulates the demand for 2P for 2P tracker	• China: photovoltaic installed capacity capacity continues to rise, and the demand the demand for trackers for grid-friendly friendly protection is growing steadily

Tracker application scenarios

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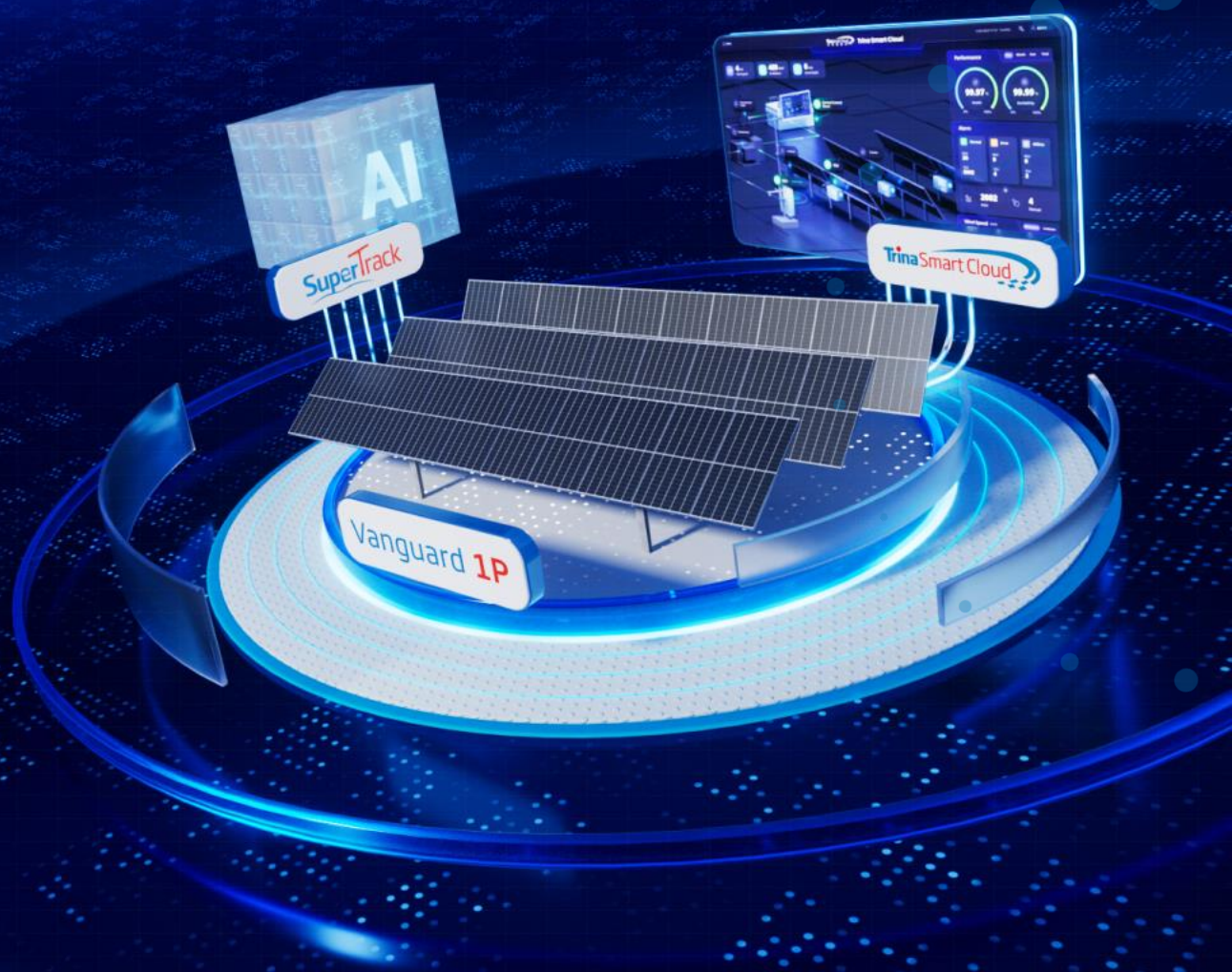
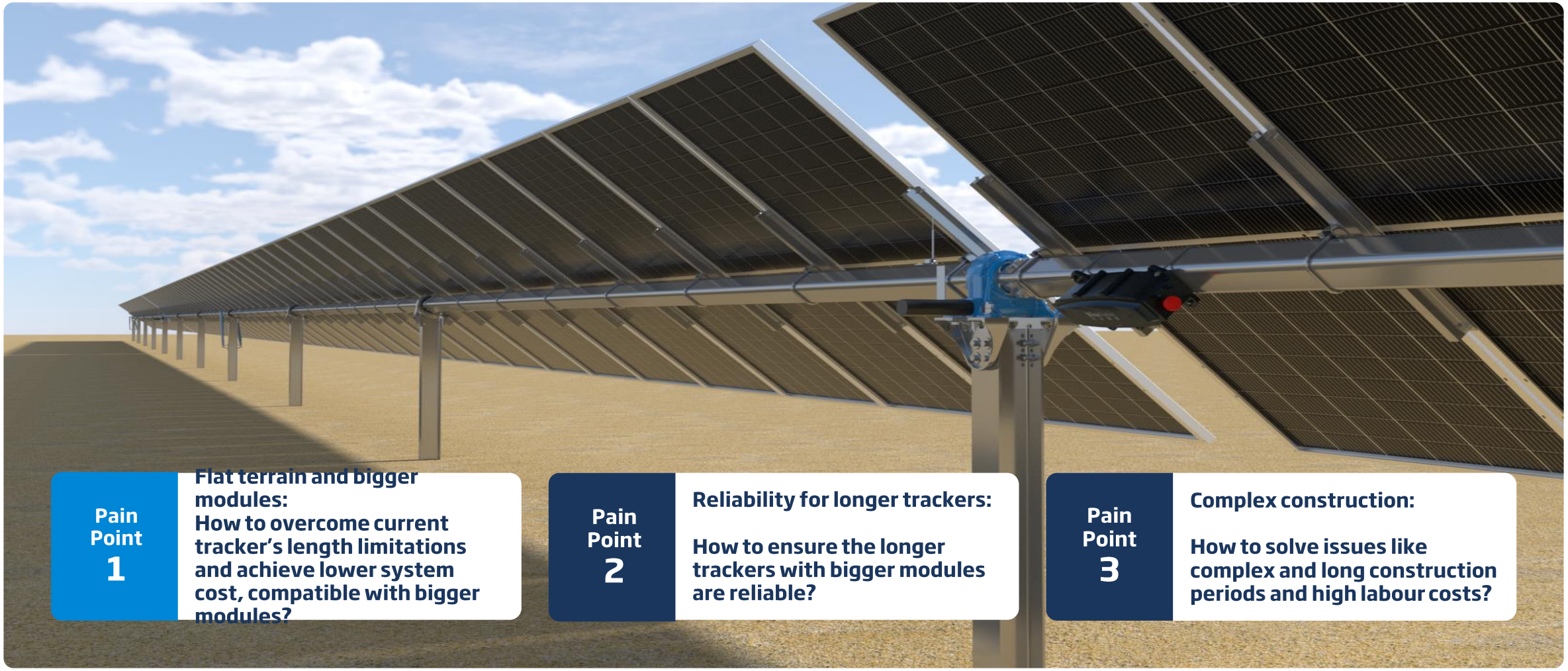


Upgraded Vg1P- Fully solves scenario pain points



Pain Point 1

Flat terrain and bigger modules:
How to overcome current tracker's length limitations and achieve lower system cost, compatible with bigger modules?

Pain Point 2

Reliability for longer trackers:

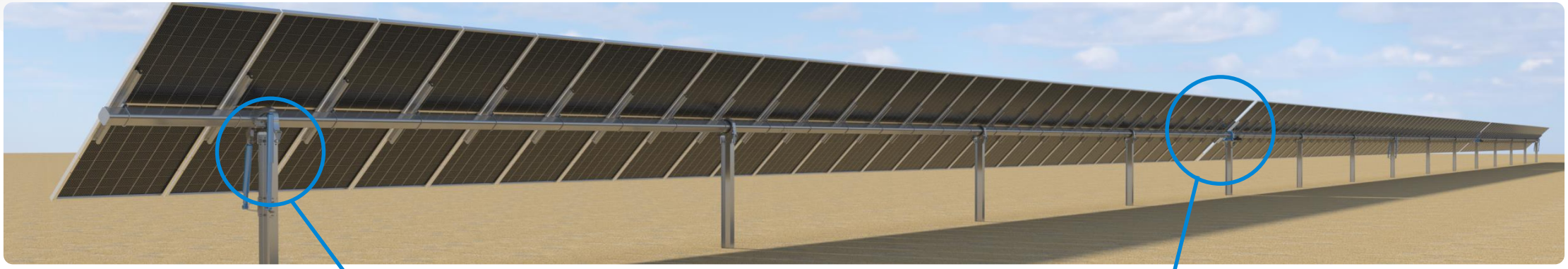
How to ensure the longer trackers with bigger modules are reliable?

Pain Point 3

Complex construction:

How to solve issues like complex and long construction periods and high labour costs?

How achieve the lowest system cost?



Bi-Damper system — **Effectively improve the working wind speed**

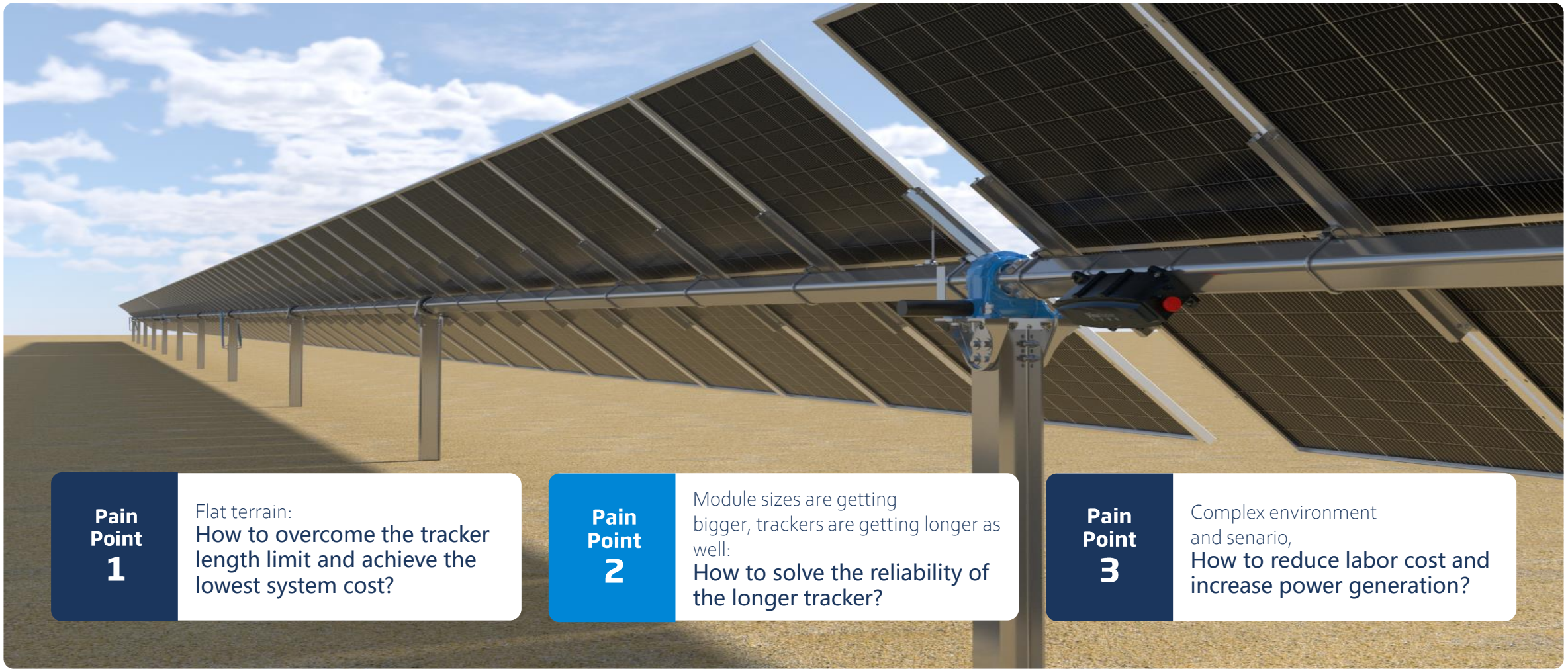
Multi-motor system — **Provides ample driving force and holding torque**

Make full use of land resources. Make full use of design length

Module type	Power	Width of tracker	No. string/tracker	Length of tracker	Power/Tracker
NEG21C.20	710	1303	3 or 4*	116 or 140m	60 or 77kW/tracker
NEG19RC.20	620	1134	4	130m	69.4kW/tracker
182-72	615	1134	4	130m	68.8kW/tracker
182-78	625	1134	4	120m	65kW/tracker

* In the above calculation data, T=0℃.
* Under special conditions

Upgraded Vg1P- Fully solves scenario pain points



Pain Point 1

Flat terrain:
How to overcome the tracker length limit and achieve the lowest system cost?

Pain Point 2

Module sizes are getting bigger, trackers are getting longer as well:
How to solve the reliability of the longer tracker?

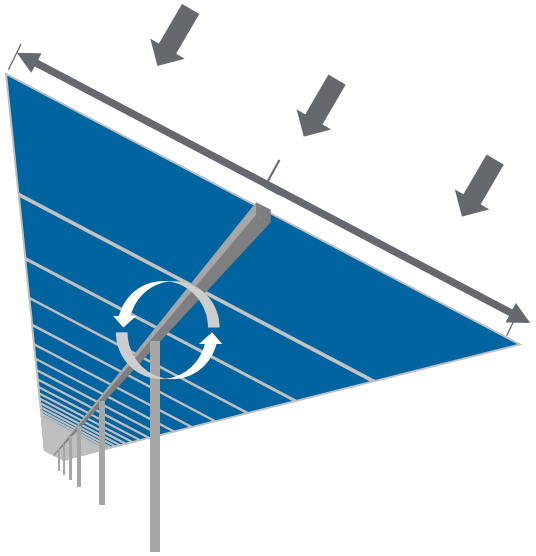
Pain Point 3

Complex environment and senario,
How to reduce labor cost and increase power generation?

Module size variation

As the power of the module increases, the chord length of the module also increases.

How to solve the reliability of the longer tracker?
Multi-motor system



Normal force $F = GC_N \times DAF \times q_h \times A$

Torque moment $T = GC_M \times DAF \times q_h \times A \times L$ ★★★

GC_N: normal force coefficient

GC_M: moment coefficient

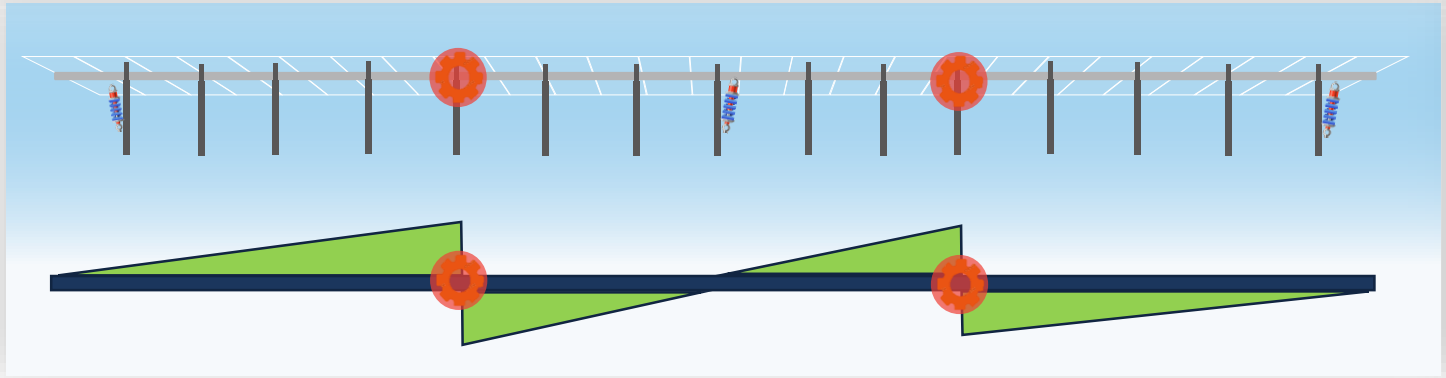
DAF: dynamic amplification factor

q_h: wind pressure

A: reference area

L: chord length

Obtained from WTT



Multi-motor drive system

- Less torque peak, more evenly distributed, longer tracker
- Better wind resistance

How to solve the reliability of the longer tracker?
Wind tunnel test

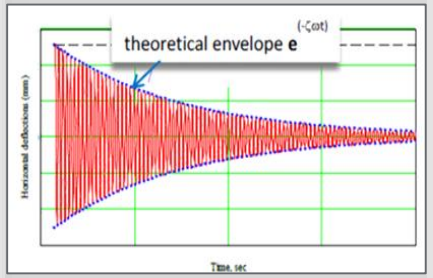
The wind tunnel report shall be provided by a credible third-party wind engineering consulting company. CPP

L1 Pressure study

- Model: Rigid tracker model
- Output: Static pressure coefficient, torque coefficient
- Application: Main beam, column, purlin

GC_N GC_M

L2 Free vibration test



- Model: Full-size tracker
- Output: Natural frequency and damping ratio in torsion and vertical bending directions， DAF
- Application: Matching of dampers

DAF

L3 2D sectional model test

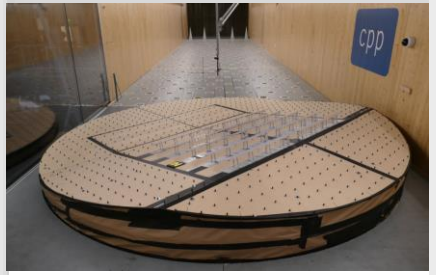
- Model: Torsion spring suspension model
- Output: Flutter derivative for flutter critical wind speed evaluation
- Application: Spacing of brackets of various sizes

L4 Aeroelastic Study

- Model: Flexible tracker model
- Output: Minimum critical wind speed
- Application: Extreme weather protection strategies

Optimum wind protection Angle

L5 Slope Study



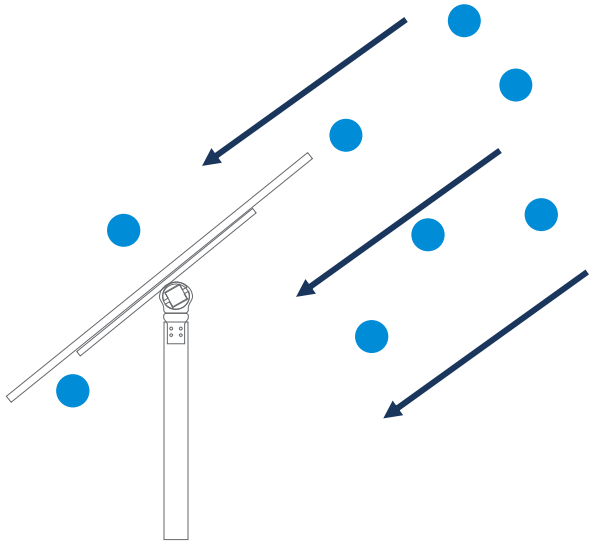
- Model: tracker model
- Output: EW15%, SN30%
- Application: Inner and outer perimeter ratio of tracker

Layout strategy

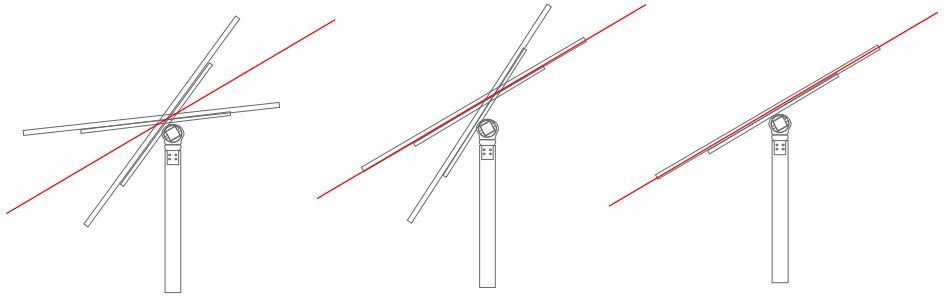
How to solve the reliability of the longer tracker? **Innovative Protection Atrategy**

Hail protection strategy

After the hail protection strategy is turned on manually, the tracker will rotate to the leeward direction to ensure that the module direction and the hail fall direction are parallel as far as possible to reduce the vertical contact area between the module and the hail.



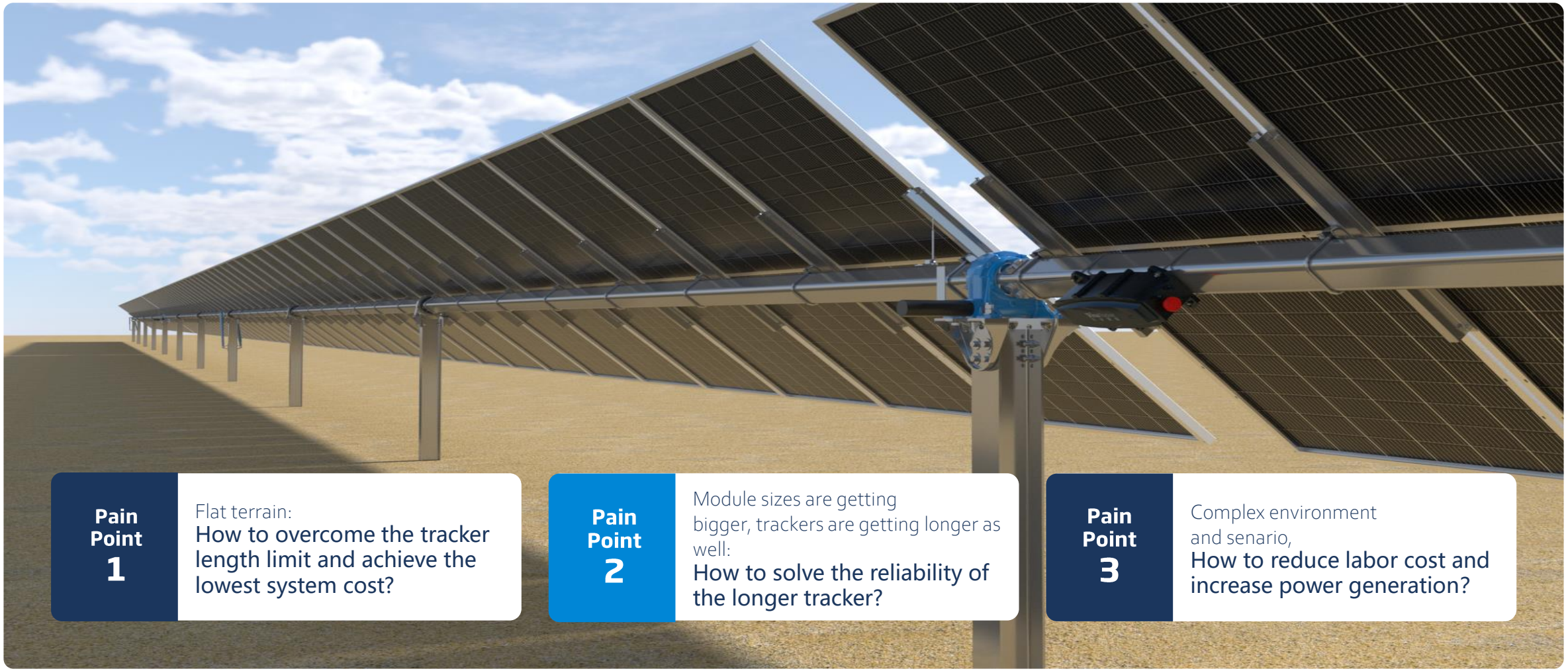
Upgraded Vg1P wind protect strategy		
Level	Wind speed (3s)	Stow position
1(low)	14m/s – 16m/s	+15 to +60° or -15 to -60°
2(medium)	16m/s – 18m/s	+30 to +60° or -30 to -60°
3(high)	＞18m/s	±30°



Low wind Medium wind High wind

By limiting the tracking angle, we can reduce the time it takes to enter the protection state.

Upgraded Vg1P- Fully solves scenario pain points



Pain Point 1

Flat terrain:
How to overcome the tracker length limit and achieve the lowest system cost?

Pain Point 2

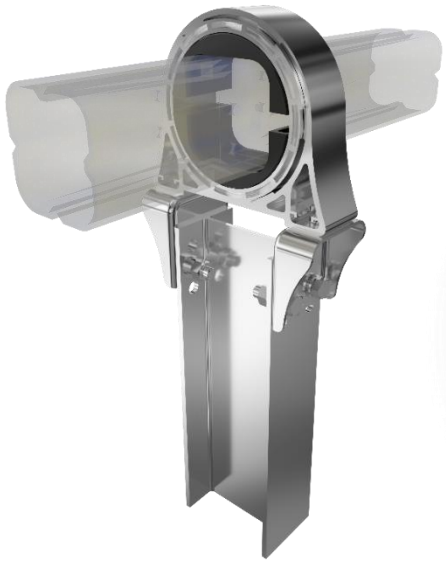
Module sizes are getting bigger, trackers are getting longer as well:
How to solve the reliability of the longer tracker?

Pain Point 3

Complex environment and senario,
How to reduce labor cost and increase power generation?

How to reduce labor cost?
Fast Installation Solution

New Spherical Bearing



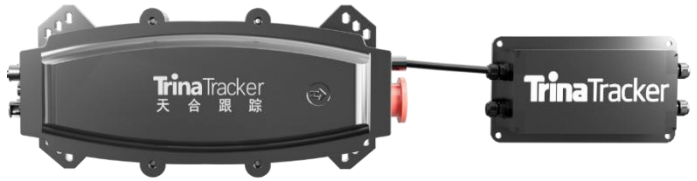
Spherical bearing design - no installation calibration required

Compared with the traditional mechanical multi-drive tracker

34%

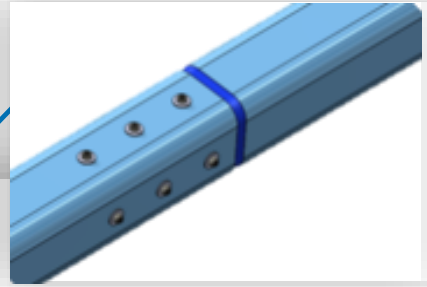
fewer parts

Multi-point drive system without mechanical transmission



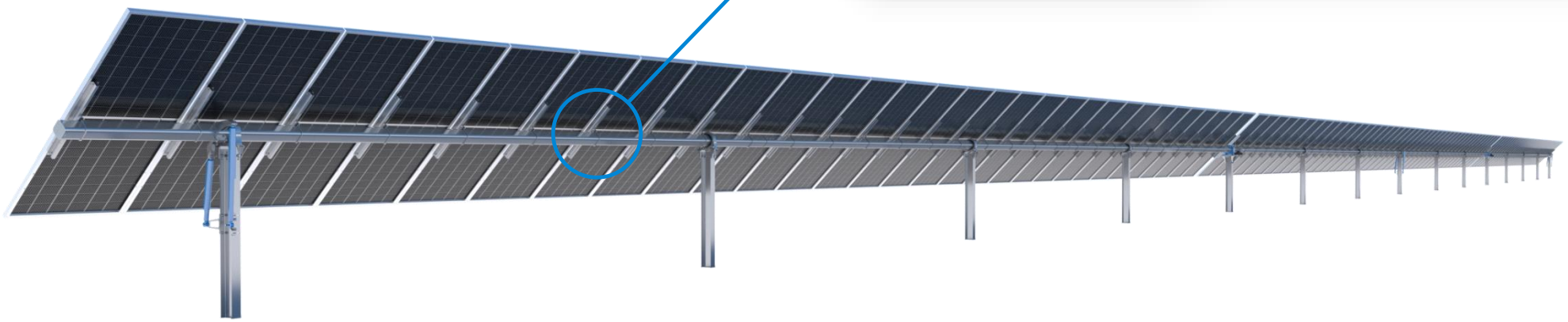
Spherical bearing design - no installation calibration required

How to reduce labor cost?
Fast Installation Solution



Shrink tube

Save 50% tube connection time



Without components positioning

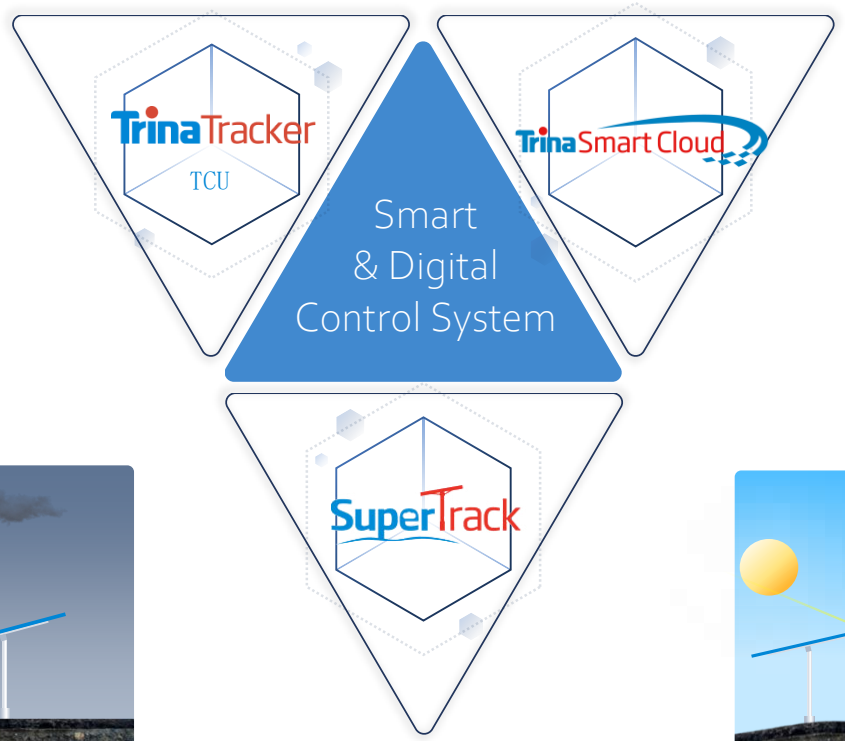
Rivet connection

Connectors are highly integrated with tubes

Device adaptability-Smart control system

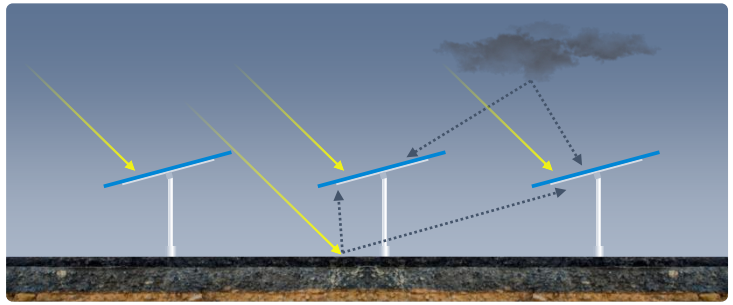
Compared with the conventional tracking algorithm, the power generation gain is up to 8%; Ship 3GW with the Vg 1P

High reliability

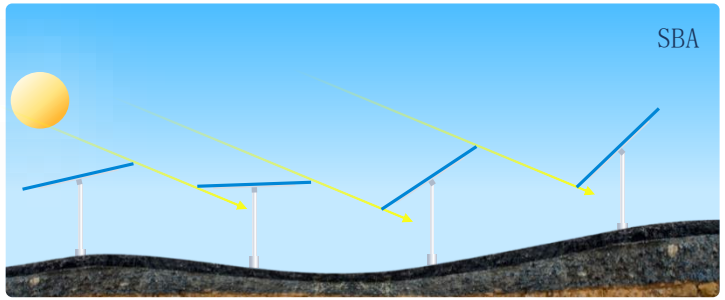


High efficiency

High performance



High power generation



Device adaptability-Smart control system

State-of-the-art solar trackers

Vanguard™ 1P

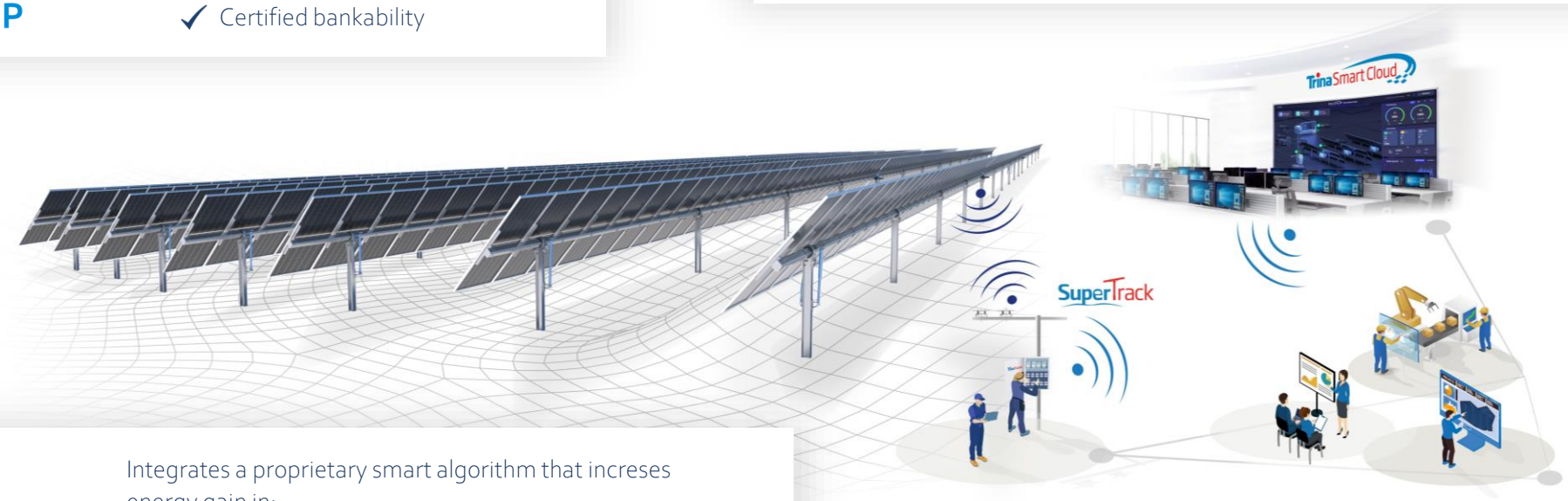
Vanguard™ 2P

Agile™ 1P

- ✓ Adaptable to any kind of complex terrains
- ✓ Validated reliability in extreme weather conditions
- ✓ Compatible with all modules available in the market
- ✓ Certified bankability

Trina Smart Cloud (SCADA)

- ✓ Gathers real-time wheather information and installation peformace
- ✓ Analyses data online
- ✓ Forecasts and reports failures in real time
- ✓ Provides O&M recommendations
- ✓ Works remotely
- ✓ Leads to energy production loss minimization and smart O&M management



SuperTrack

Integrates a proprietary smart algorithm that increses energy gain in:

- Periods of highly diffused radiation
- Overcast days
- Terrains with múltiples slopes

PV plant Achilles heel

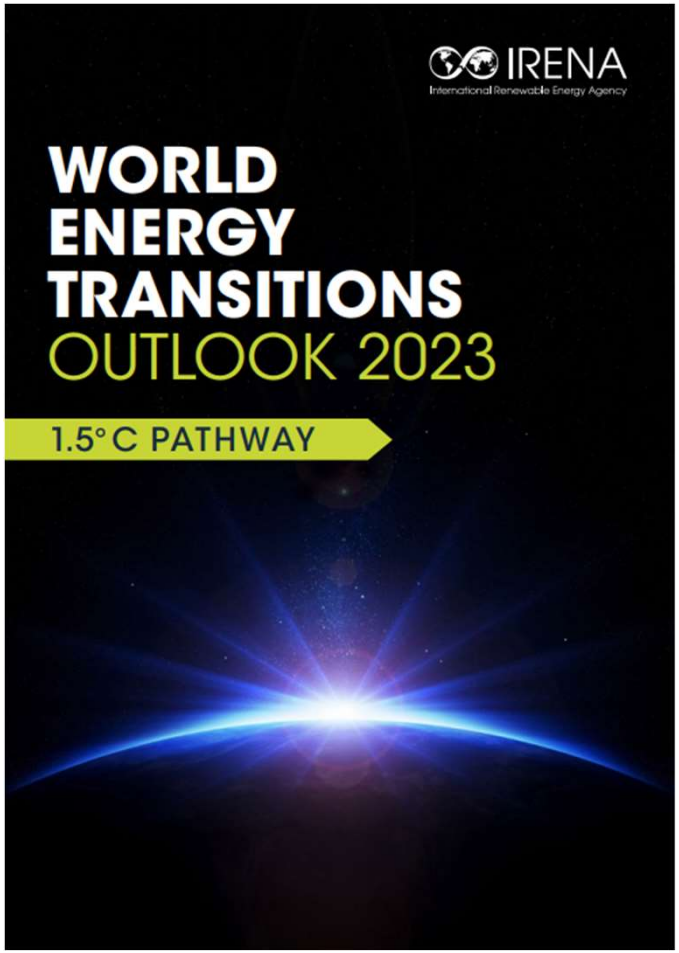
THANK YOU

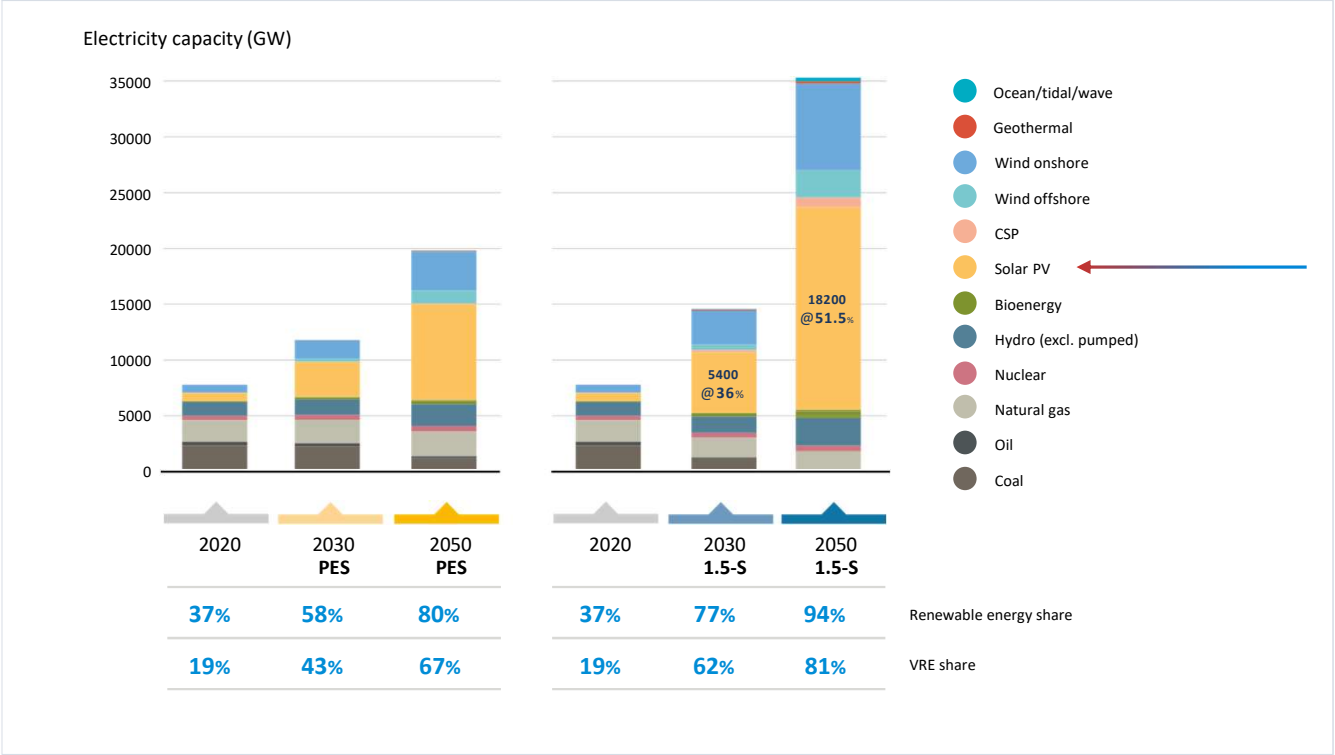
Trinasolar


Trinasolar
Vertex N
FULLY UPGRADED
700W+
FUTURE FORWARD

Global Energy Transition & Photovoltaic Energy Trends

As the world commits to carbon neutrality, a high proportion of renewable energy structure is the major trend in energy transformation.



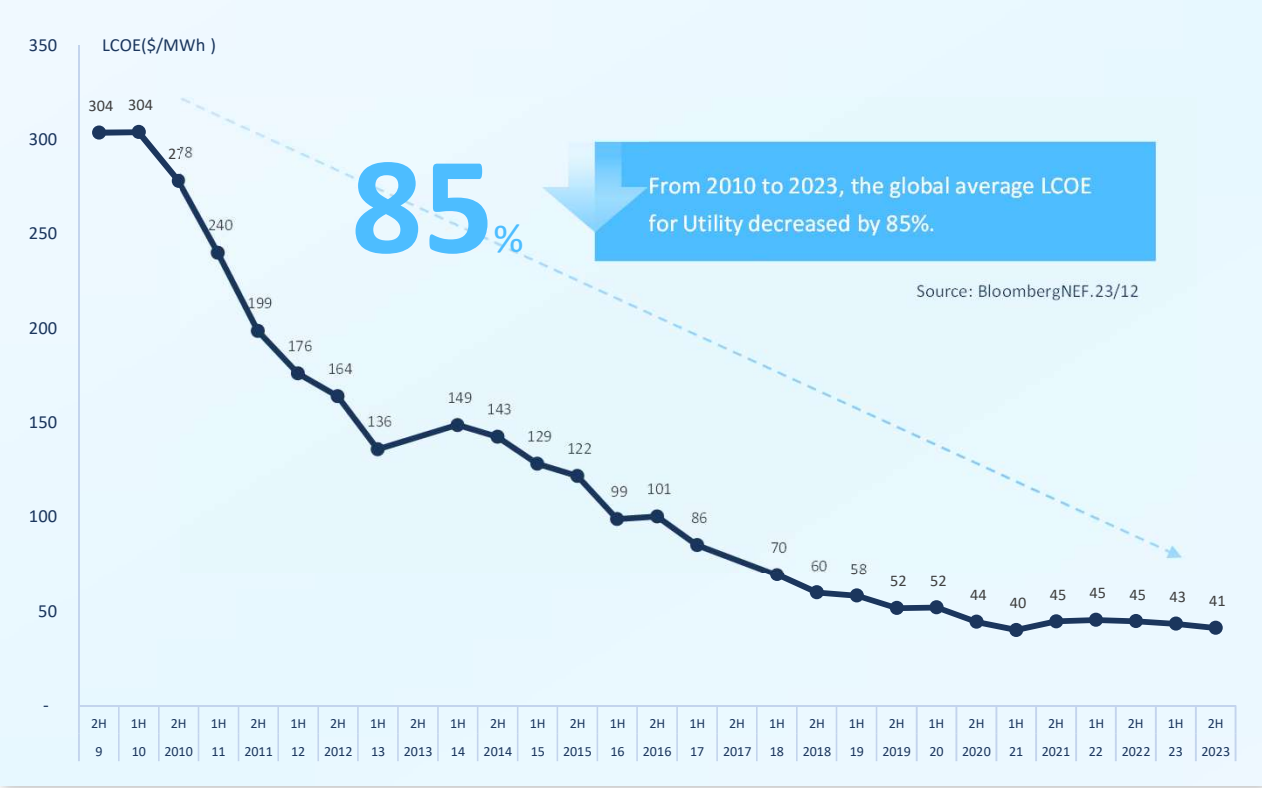


The International Renewable Energy Agency (IRENA) (June, 2023):

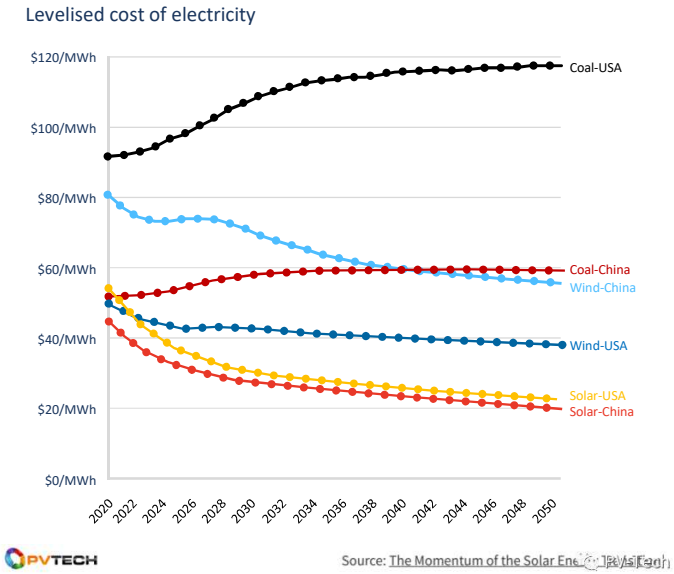
Solar power is a strong booster for achieving carbon neutrality, with global solar power capacity expected to exceed **18,000GW by 2050.**

Notes: PES: Planned Energy Scenario/ 1.5-S = 1.5°C Scenario/ VRE: Variable Renewable Energy

Main Energy Source Transformation Node

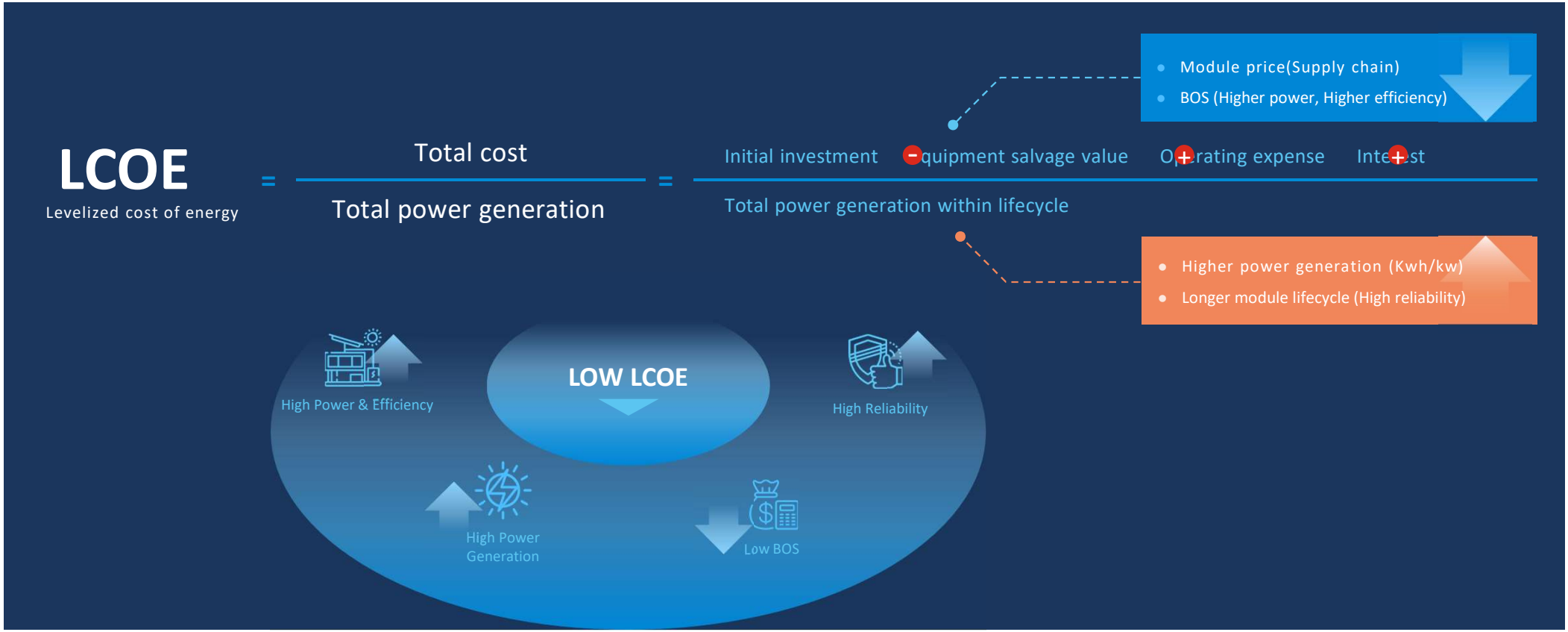


Solar is forecast to be the cheapest form of electricity production by 2050



To accelerate the replacement of fossil fuels such as coal and crude oil,
the LCOE for photovoltaics needs to continue to decline!

The Way to Lower LCOE



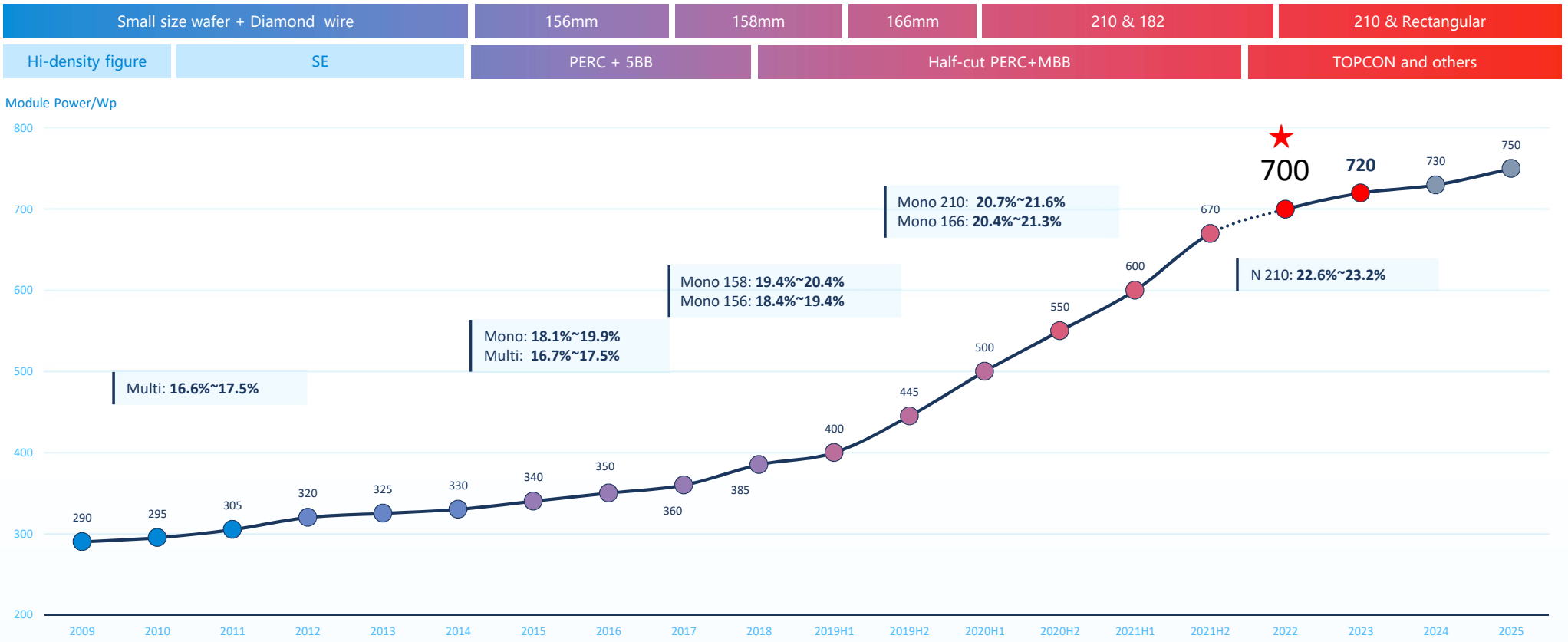
- Low voltage design + Higher power & efficiency -> Higher string power -> Saving on BOS (Investment)
- Lower Temperature Coefficient + Lower Power Degradation -> Higher power generation
- High Reliability -> stable high performance in the 30 years

700W

A Milestone in the PV Industry's Development

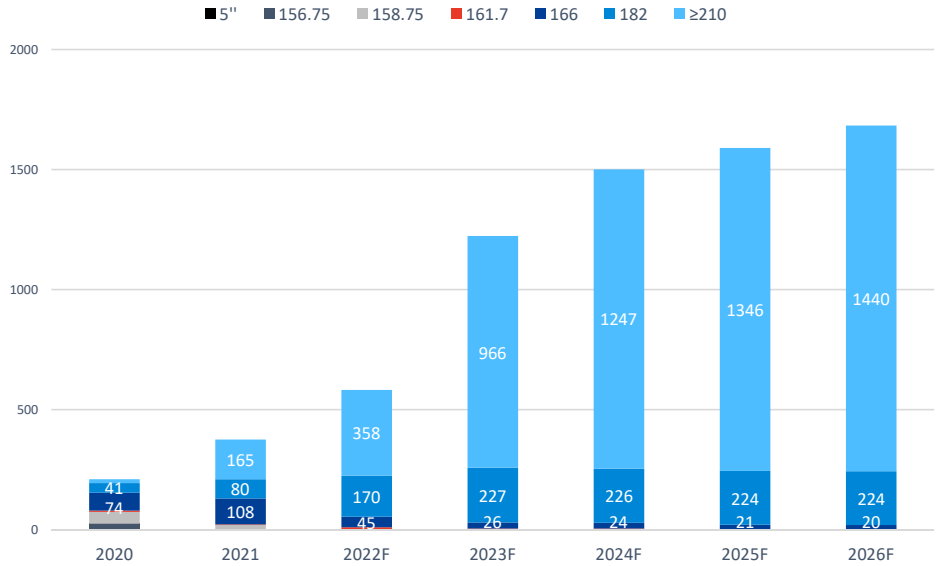
Trina Solar leads the commercialization of multiple key technologies:

Selective emitters, PERC, TOPCon, dual-glass, MBB, high density packaging, rectangular cells, etc., driving innovative development in the industry.



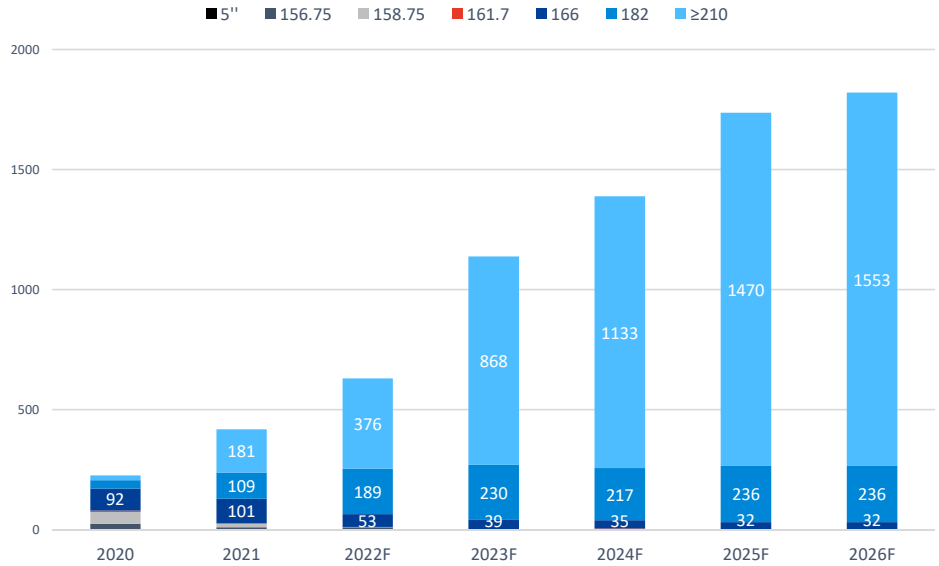
Development Trend and Law:
210 Technology -Long Life Cycle Technology

Changes in Cell Output Capacity of Various Sizes, Unit: GW



Source: 光伏技术趋势报告，November .2023, PV InfoLink

Changes in Module Output Capacity of Various Sizes, Unit: GW



Source: 光伏技术趋势报告，November.2023, PV InfoLink

- M6 and smaller wafer: Had been completely replaced by 210 and 182 technology
- PERC M10 evolution: 183.75 micro rectangle wafer replaced 182x182 cell quickly.
- TOPCON revolution: 80% or more new Topcon capacity is rectangle cell, 210R is the dominant technology.
- Long life cycle: The 210 large wafer technology covers the PERC, TOPCON and the main technical pathway of HJT.

Forging Consensus, Shaping the Future

700W+

Industry Consensus to Build 700W+ Ecosystem

As a major player in solar industry , Trina Solar joined hands with industry partners to accelerate the industrialization of 700W+ and elevate the industry ecosystem.

Pioneer to Launch 700W+ TOPCon Modules in the Industry

Trinasolar

May 2023

Global Launch of new generation i-TOPCon Advanced technology

August 2023

Officially announced mass production of Vertex N 700W+ TOPCon modules

December 2023

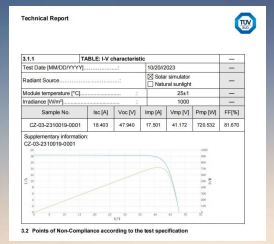
Vertex N 700W+ surged to 720W due to upgrade of i-TOPCon Advanced technology

Vertex N 700W+

Trina Solar takes lead in the

N ERA OF SOLAR ENERGY

TUV Certified



Vertex N 700W+

Trinasolar

210+N

VERTEX DNA

210

Innovative Technology Platform

210/210R
Most advanced wafer products in mass production

Half-cut technology
High shadow tolerance and reduced risk of hot spots

Non-destructive cutting
Lower risk of hidden cracks, higher product reliability

MBB (multi-busbar)
Perfect balance of efficiency and reliability

High density packaging
Reduced risk of hidden cracks, higher reliability

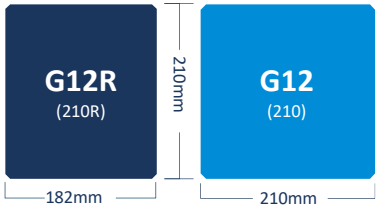
N

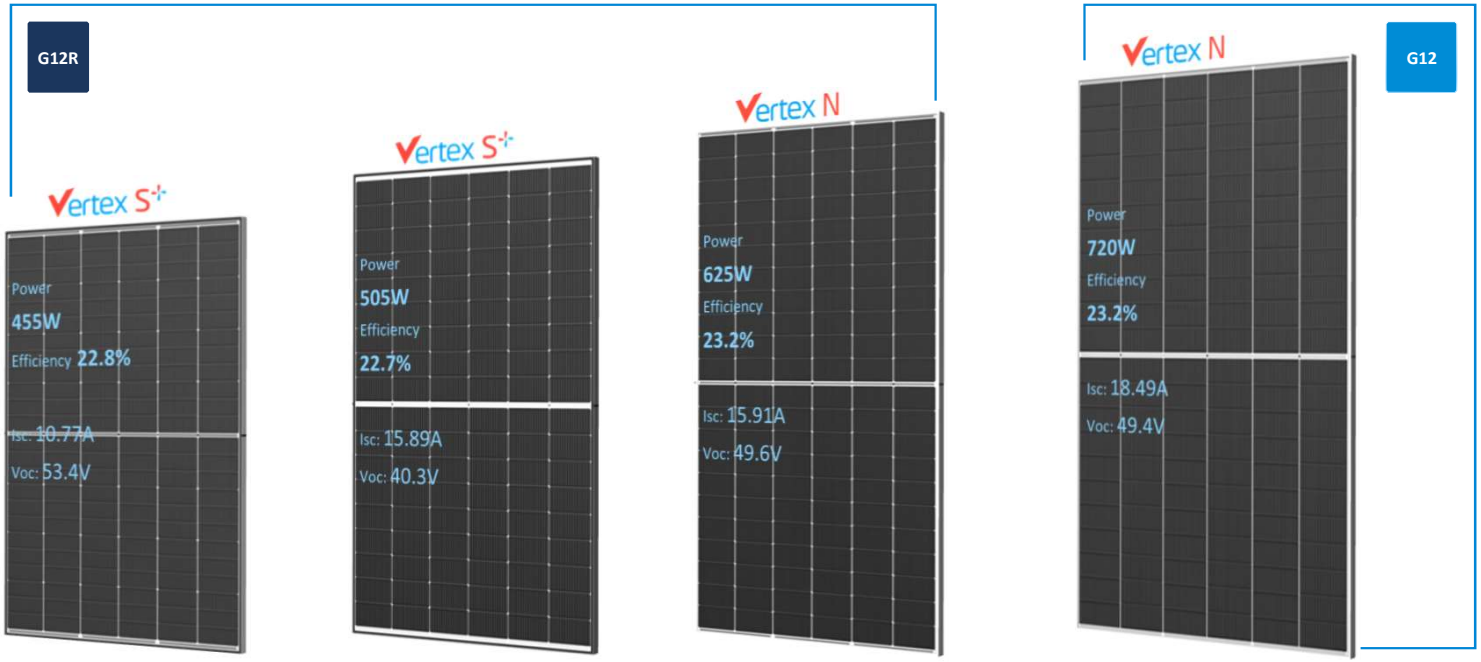
Trinasolar i-TOPCon

i-TOPCon Advanced technology upgrade drives continuous efficiency improvement.
Laser induced Firing , Rear planar reflector, Highly low rear TOPCon structure, Edge Passivation Technology

TOPCon core patent group, globally Risk-free
Stand at the forefront of the industry with over a hundred patents in the TOPCon field.

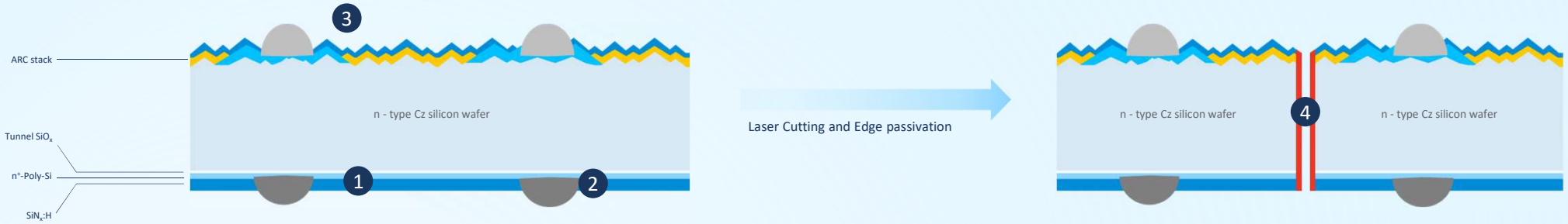
210N All Scenarios Vertex Family





- Small format module: **2m² extreme design** , leading power and efficiency.
- Medium format module: excellent installation and electrical compatibility, **best partner for tracker**.
- Large format module: ultra high power, **"designed for optimal LCOE".**

Vertex N 700W+ i-TOPCon Advanced Technology



1 Rear planar reflector

2 Highly low rear TOPCon structure

3 Laser induced Firing

4 Edge Passivation Technology

Vertex N 700W+

Trinasolar

Leading Performance & Continuous Advancement

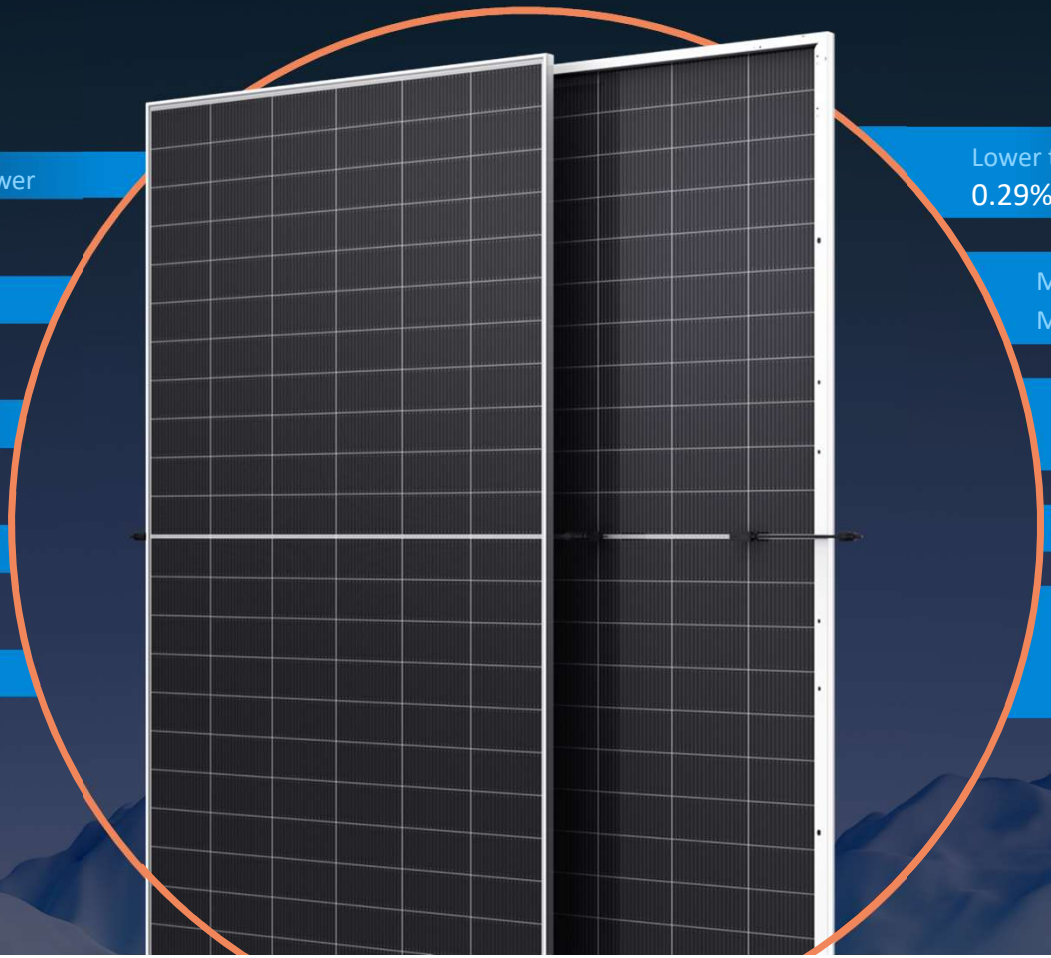
720W High Power

23.2% High efficiency

Voc 49.4V, Impp 17.44A

30 years Power warranty

80%±5 High bifaciality



Lower temperature coefficient - 0.29%/℃

Module Size: 2384*1303*33mm
Module Weight: 38.3kg

Excellent low irradiance performance

Anti-PID

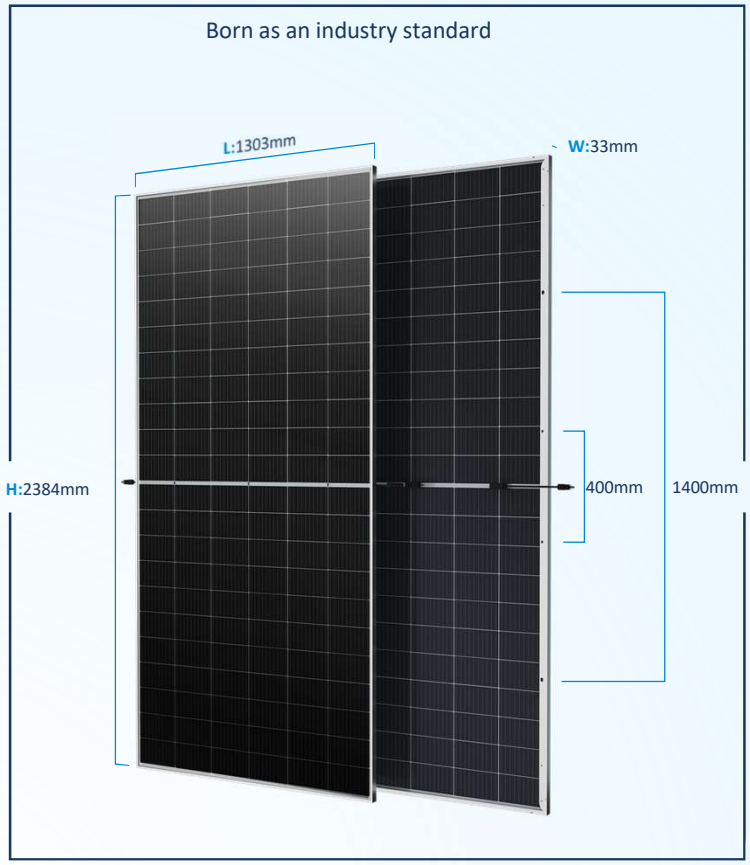
Lower degradation, 1% first year degradation, 0.4% annual power attenuation

Vertex N 700W+ Maximizes Container Capacity

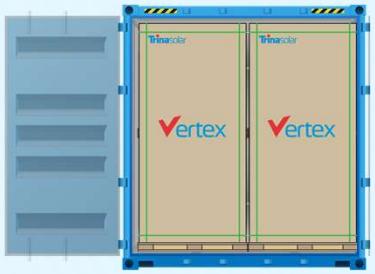
Trinasolar

Golden-sized design

Born as an industry standard



Nearly 98%
Container utilization



Product Name	Vertex N	182-78pcs N
Module Size (mm)	2384x1303x33	2465x1134x30
Module Design	210-66 half cut cell 2+2 bifacial dual glass	182 half cut glass Bificial
Cell Technology	i-TOPCon advanced	182 TOPCon
Module Power	720W (+13.9%)	620W (BL)
Container Utilization Rate	97.6%	81.4%
Container capacity/power	594 pcs = 427,680(+16.5%)	576 pcs = 357,120(BL)

Vertex N 700W+ Maximizes Reduction in BOS and LCOE

Project Information

Scenario	Ground-mounted
Location	Rio Verde, Brazil
DC capacity	125 MW
Type of inverter	String inverter
Mounting	Trina Tracker Vanguard 1P
Type of module	Bifacial module

PV System Configuration

Item	Module type	NEG21C.20	182N-72pcs	182N-78pcs
Module	Module power	700W	580W	625W
	Module size (mm)	2384×1303×33	2278×1134×30	2465×1134×30
Mounting	Installation		Trina Tracker Vanguard 1P	
	Pitch	6.8 m	6.5 m	7.0 m
Inverter	Inverter type		SUN2000-330KTL-H1	
	Inverter power (AC)		330 kW	
	Inverter number	334	334	334
Layout	Module/string	31	30	28
	String power	21,700W (19.3%)	17,400W	17,500W (BL)
	Tracker configuration	1P	1P	1P
	String number	5760	7184	7142
	Module number	178560	215520	199976
Capacity	DC capacity (MW)	125	125	125
	AC capacity (MW)	100.2	100.2	100.2
	DC/AC ratio	1.25	1.25	1.25

Vertex N 700W+ Maximizes Reduction in BOS and LCOE

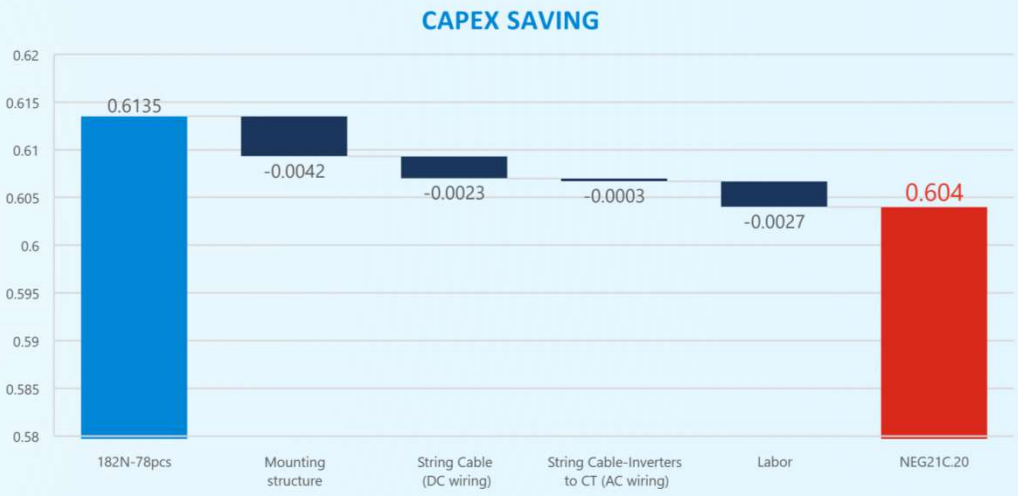
Module type	NEG21C.20	182N-72pcs	182N-78pcs
PV Modules	0.2006	0.2006	0.2006
Inverters	0.0395	0.0395	0.0395
Mounting structure	0.1052	0.1095	0.1094
String Cable (DC wiring)	0.0080	0.0098	0.0103
String Cable - Inverters to CT (AC wiring)	0.0077	0.0079	0.0080
AC BoP Equipment	0.0605	0.0605	0.0605
Civil Works	0.0665	0.0666	0.0666
Labor	0.0672	0.0700	0.0699
Design & Engineering	0.0153	0.0153	0.0153
Development Cost (Land, interconnection, etc)	0.0330	0.0333	0.0334
Total CAPEX	0.6036 (1.6% Saving)	0.6130	0.6135(BL)

TS4 connector

PV cable

LV cable

LV cable trench



Vertex N 700W+ Maximizes Reduction in BOS and LCOE

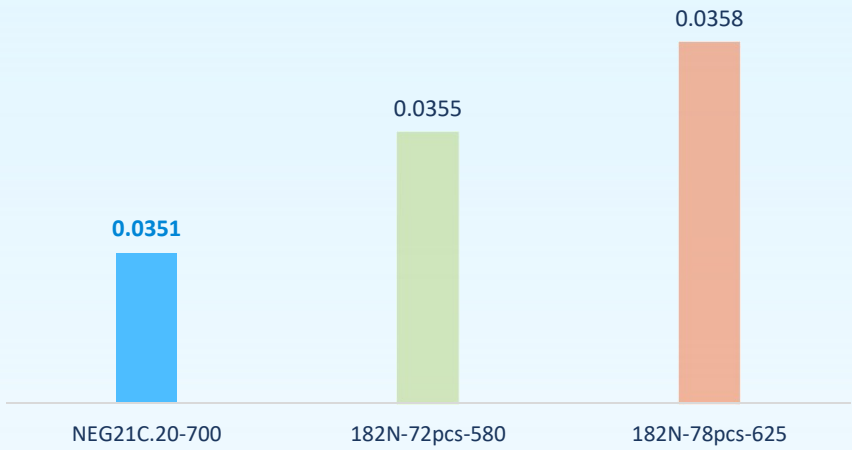
Input Data and Assumptions

Module type	NEG21C.20-700	182N-72pcs-580	182N-78pcs-625
Project capacity (MW)	125	125	125
Global horizontal irradiation (kWh/m2/yr)	1,944	1,944	1,944
PR Ratio	88.6%	88.5%	87.7%
BOS* ($ /W)	0.4030	0.4123	0.4129
Other cost ($ /W)	0.2006	0.2006	0.2006
CAPEX ($ /W)	0.6036	0.6130	0.6135
CAPEX Gap (%)	-1.6%	-0.8%	BL
Designed life time (year)	30	30	30
O &M cost ($ /kW/year)	21	21	21
Annual escalation rate	4.8%	4.8%	4.8%
Debt fraction	30%	30%	30%
Tax rate	34%	34%	34%
LCOE ($ /kWh)	0.0351 (1.8%Saving)	0.0355	0.0358(BL)

*includes only the components which make difference with modules.

LCOE Results

Unit: $/kWh



The result shows that the Vertex 210-66N 700W module performs the best, with a reduction of 1.6% in CAPEX and 1.8% in LCOE than 182-78N 625W.

1.6% In CAPEX

1.8% In LCOE

Vertex N 700W+ Compatible with Mainstream Inverters

Trinasolar

HUAWEI · SUNGROW Clean power for all · GOODWE · SINENG · Growatt · SMA · KEHUA TECH

solis · Ingeteam · Fronius · KACO new energy · AISWEI · TBEA · SOFAR · FIMER · KSTAR

Commercial and Industry Roof

610W or 710W Vertex + String Inverter

Hundreds MW Utility

710W Vertex N + Central Inverter

Mountain and Hilly Land Utility

Medium size 610W Vertex + String Inverter

Reliability Recognized by

Authoritative Third-party

TC600 | DH2000

SML+DML+TC50+HF30

LeTID | PID 192

鉴衡认证
CHINA GENERAL CERTIFICATION

DH200+(UV60+TC50+hf10)*3+UV6.5

SML+DML+TC50+HF10 | TC600 | DH2000

9

Trina Solar has been awarded PVEL "Best Performer" for **9** consecutive years, ranking first in the industry

Vertex N 700W+ Reliability Verification at -43℃ Extreme Cold

Testing Site: CTC -Mohe Extreme Cold Test Park

Test modules: Vertex N 700W modules

Test Period: September 2023 - present

Power generation monthly

276KWh

System energy efficiency ratio

100%

(backside power gain included)

Vertex N 700W+ High Value Recognized by Customers Globally

88MW , China

45MW Saudi Arabia

800MW, China

500MW, China

0.962MW, China

6.6MW Cambara, Brazil

700W+

High power/efficiency

Launched Vertex N 700W TOPCon modules , leading the industry into 700W+ high power era

700W+

High reliability

RETC, CGC, CTC and other third-party reliability certificates

700W+

High power generation

0.96% higher than industry average level

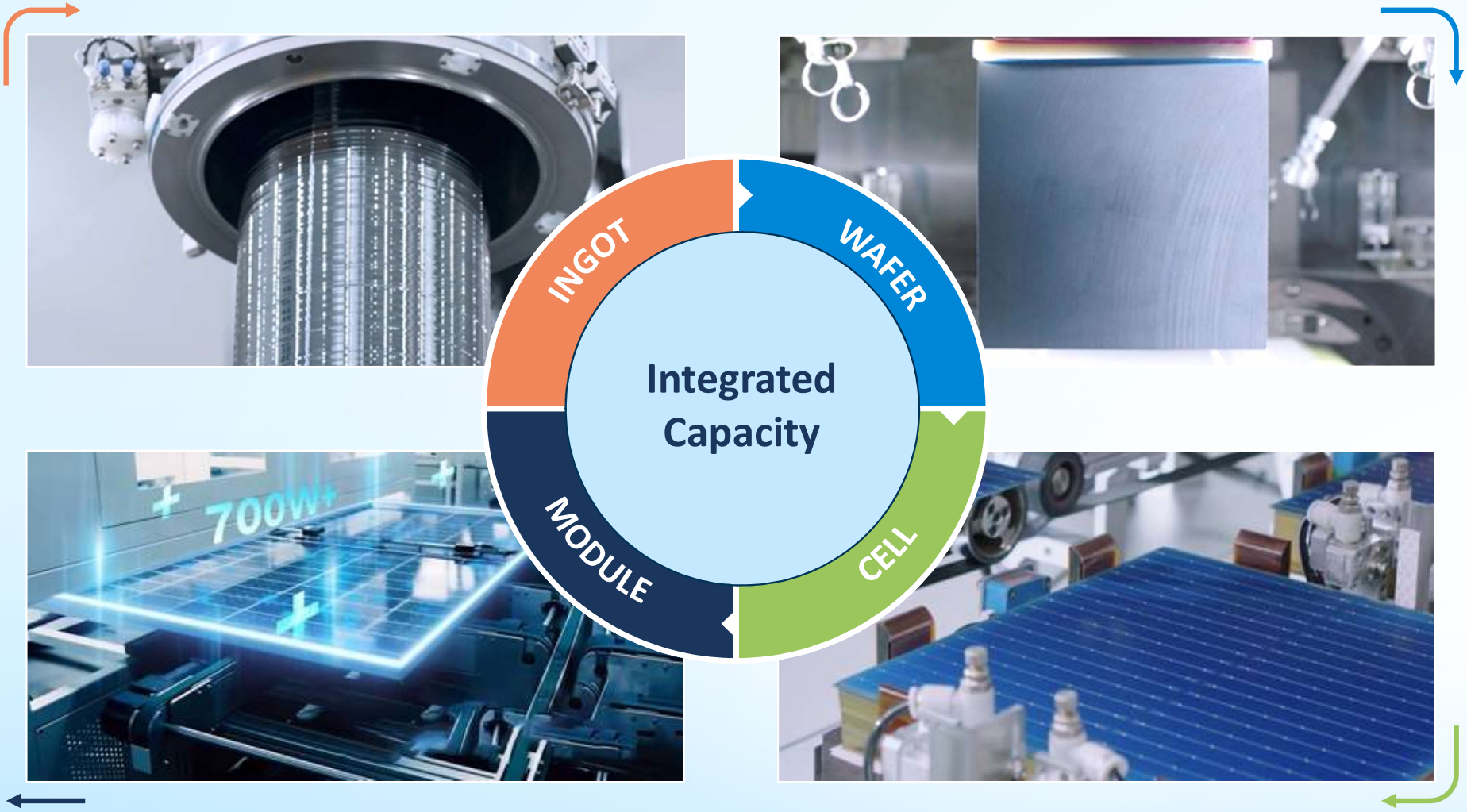
700W+

Low LCOE

1.8% lower than industry average level

Vertex N 700W+ N-type Integration Production Capacity

Trinasolar



Vertex N 700W+ Global Vertically Integrated Production Chains

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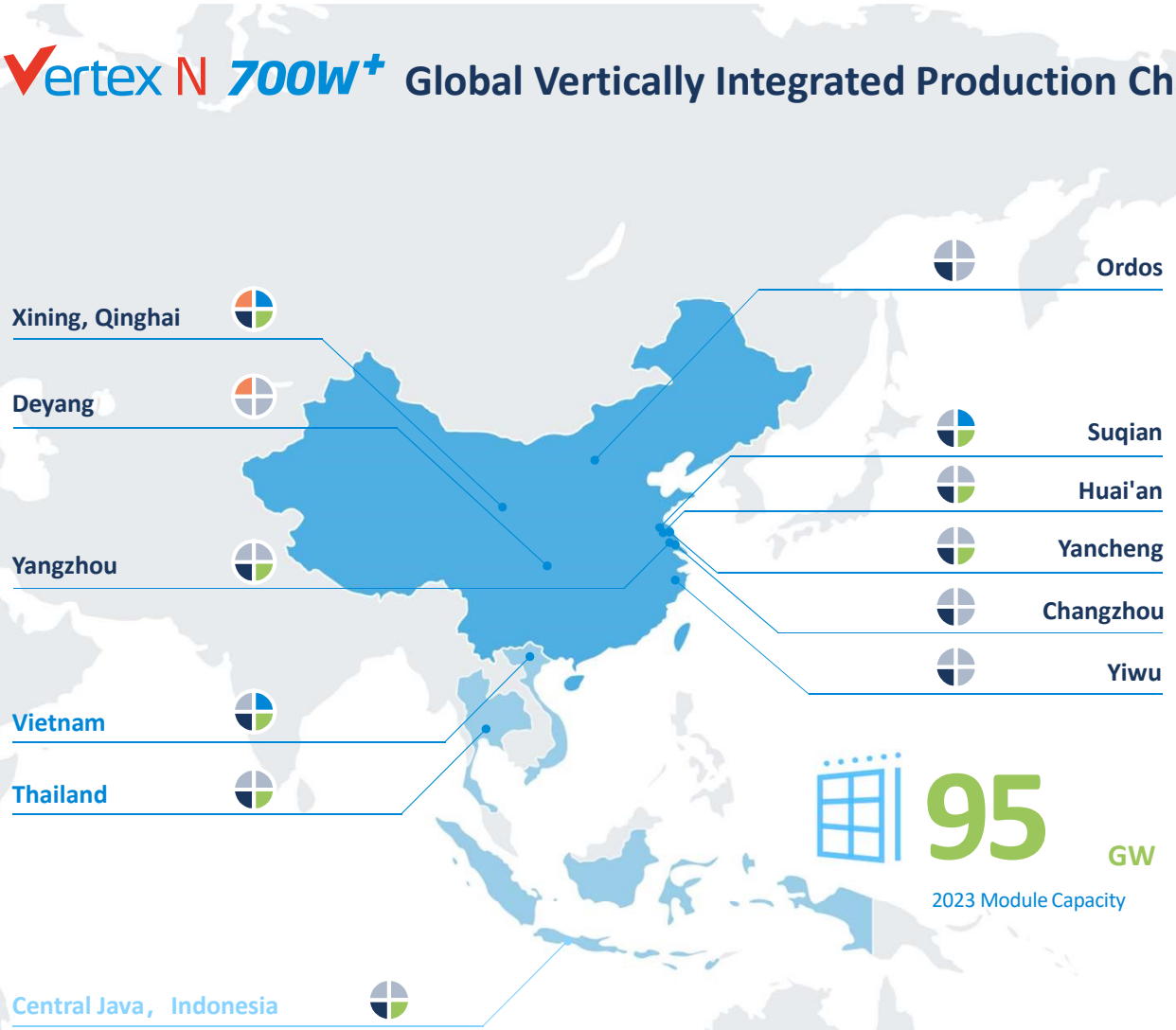

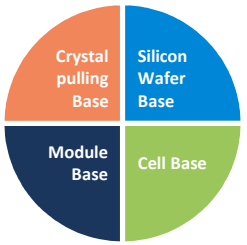

Vermeer, Texas, USA

95 GW
2023 Module Capacity

75 GW
2023 Cell Capacity
N TOPCon 40 GW

50 GW
2023 Silicon Wafer Capacity


Trinasolar
Trinasolar
Leading the way in Smart PV and Energy Storage Solutions