



SERAPHIM®



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Seraphim and SMA Solar: Small changes, big accomplishments for utility-scale PV projects

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Moderated by



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PV Tech



Small Changes, Big Accomplishments

Seraphim Solar 2021.1



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- 1. About Seraphim**
- 2. Downward LCOE & Upward Efficiency**
- 3. Seraphim S4 Series Half-cell Module**

A large red graphic of a stylized human figure, consisting of a solid red circle for the head and a solid red vertical bar for the body, positioned to the left of the page number.

01

About Seraphim

A Global Leading Solar Module Manufacturer



**Tier 1 Solar Module Maker
Listed by BNEF**



**Top Performer
Listed by PVEL**



**5GW
Global Capacity**



**40+ Destination Countries
8 GW + Shipment**



**1500+
Global Employees**



**100+ R&D
Technicians**

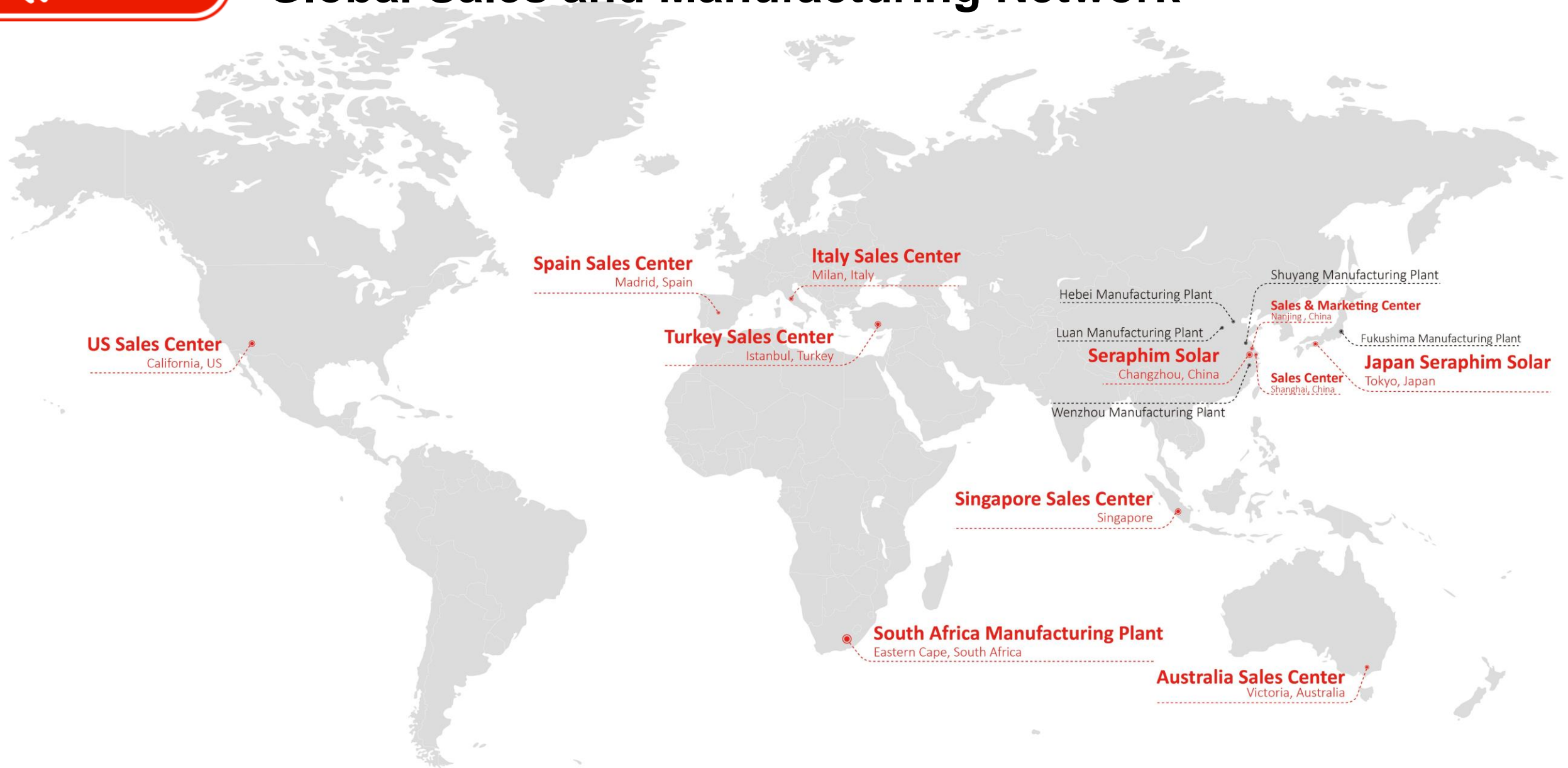



**100+
Technical Patents**



**50+ Global
Financial Partners**

Global Sales and Manufacturing Network



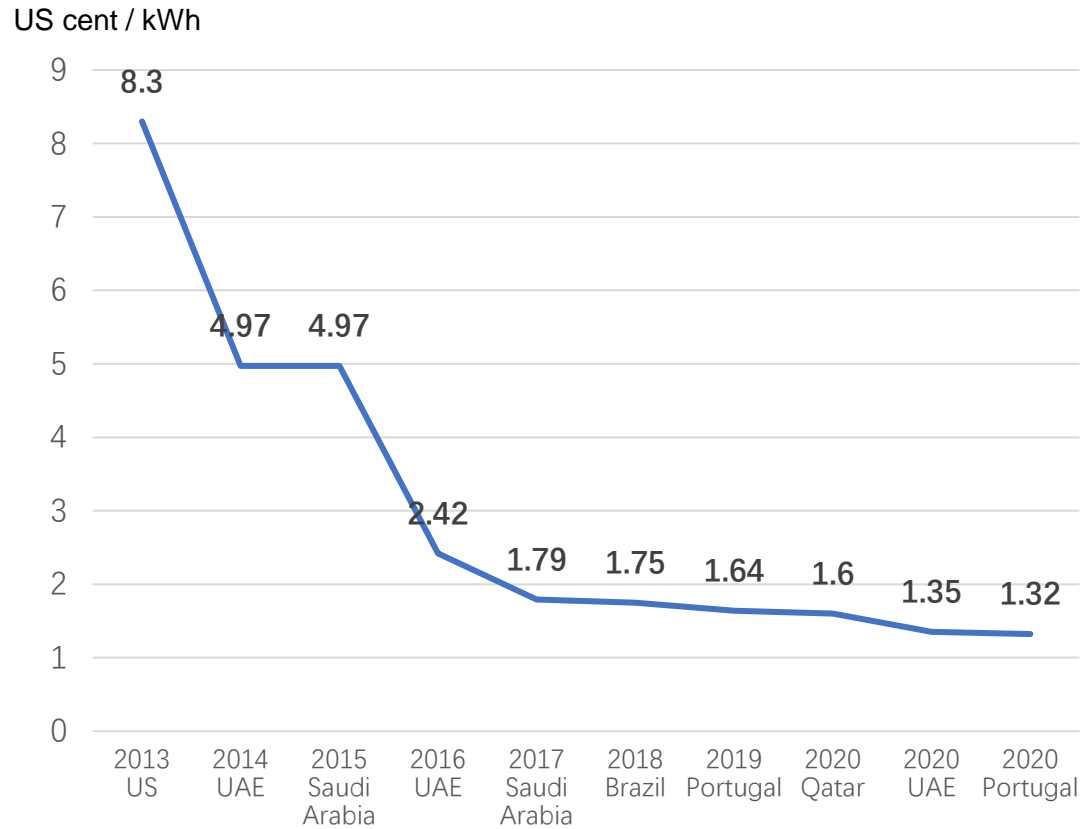
A large, red, stylized graphic of the letter 'i' on the left side of the slide. It consists of a solid red circle for the dot and a solid red vertical bar for the stem.

02

Downward LCOE & Upward Efficiency

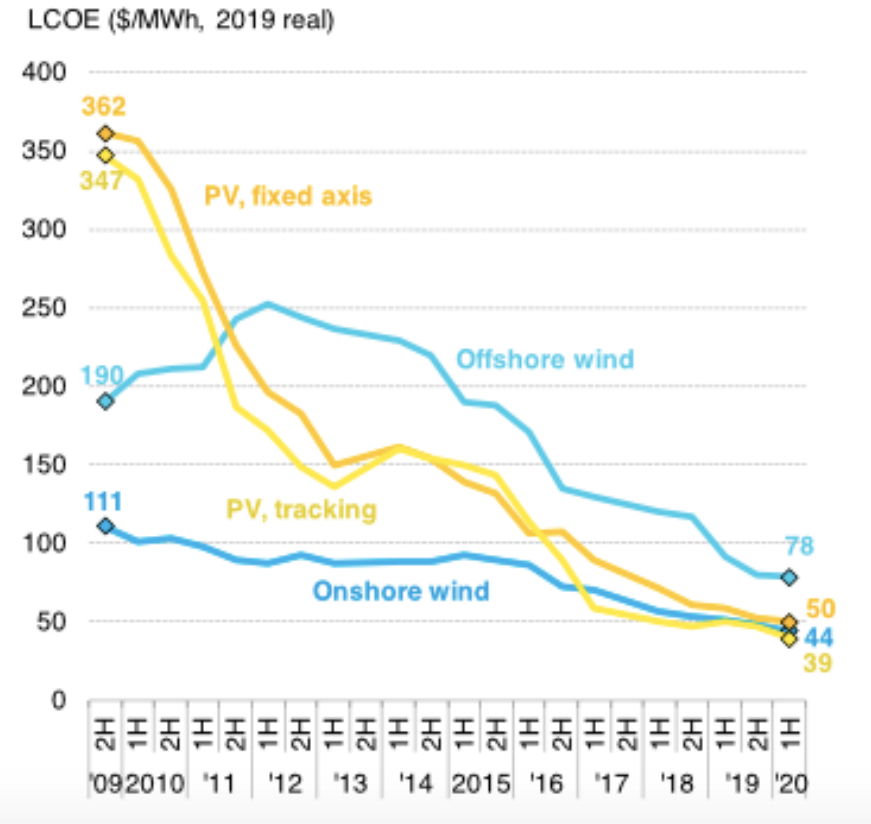
Downward Global LCOE

Global Bidding Price



The lowest global PV project bidding price dropped drastically between 2013 and 2017, and kept going down smoothly thereafter.

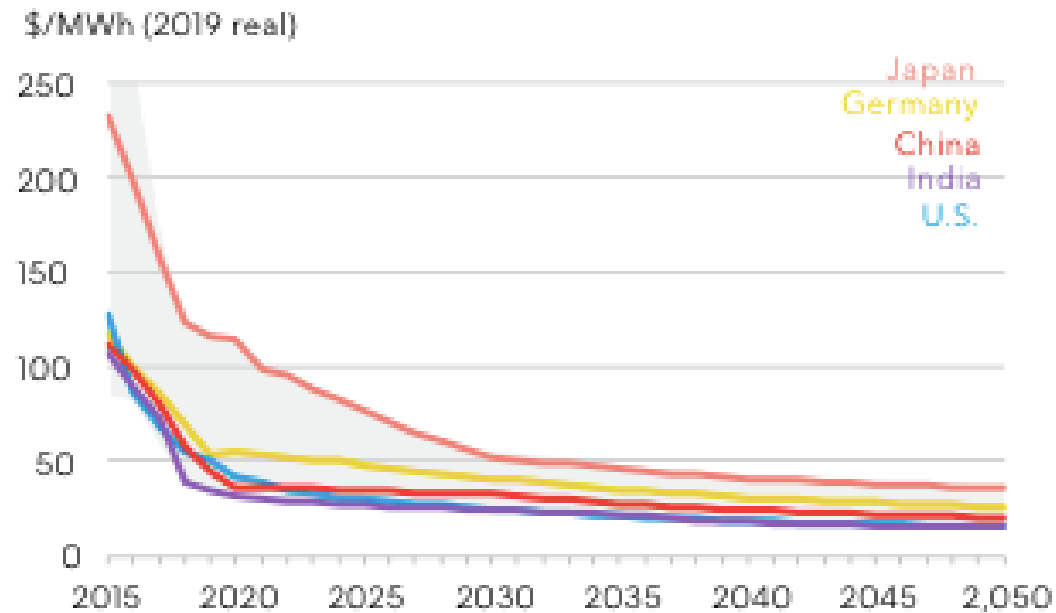
PV & Wind LCOE Global Benchmarks



This learning curve has been made possible by a combination of technology innovation, economies of scale and manufacturing experience.

Upward Efficiency

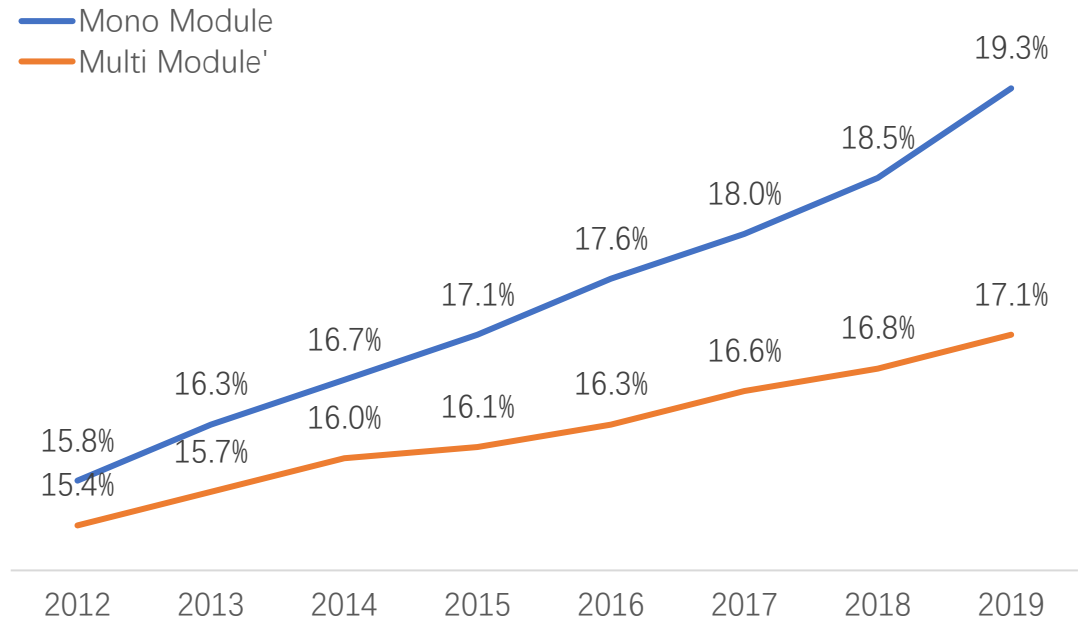
Utility-scale PV LCOE forecasts



Source: BNEF

Ongoing reductions in equipment costs, improving efficiency and declining financing and development costs are expected to further cut the global benchmark LCOE.

Technologies Push Up Module Efficiency

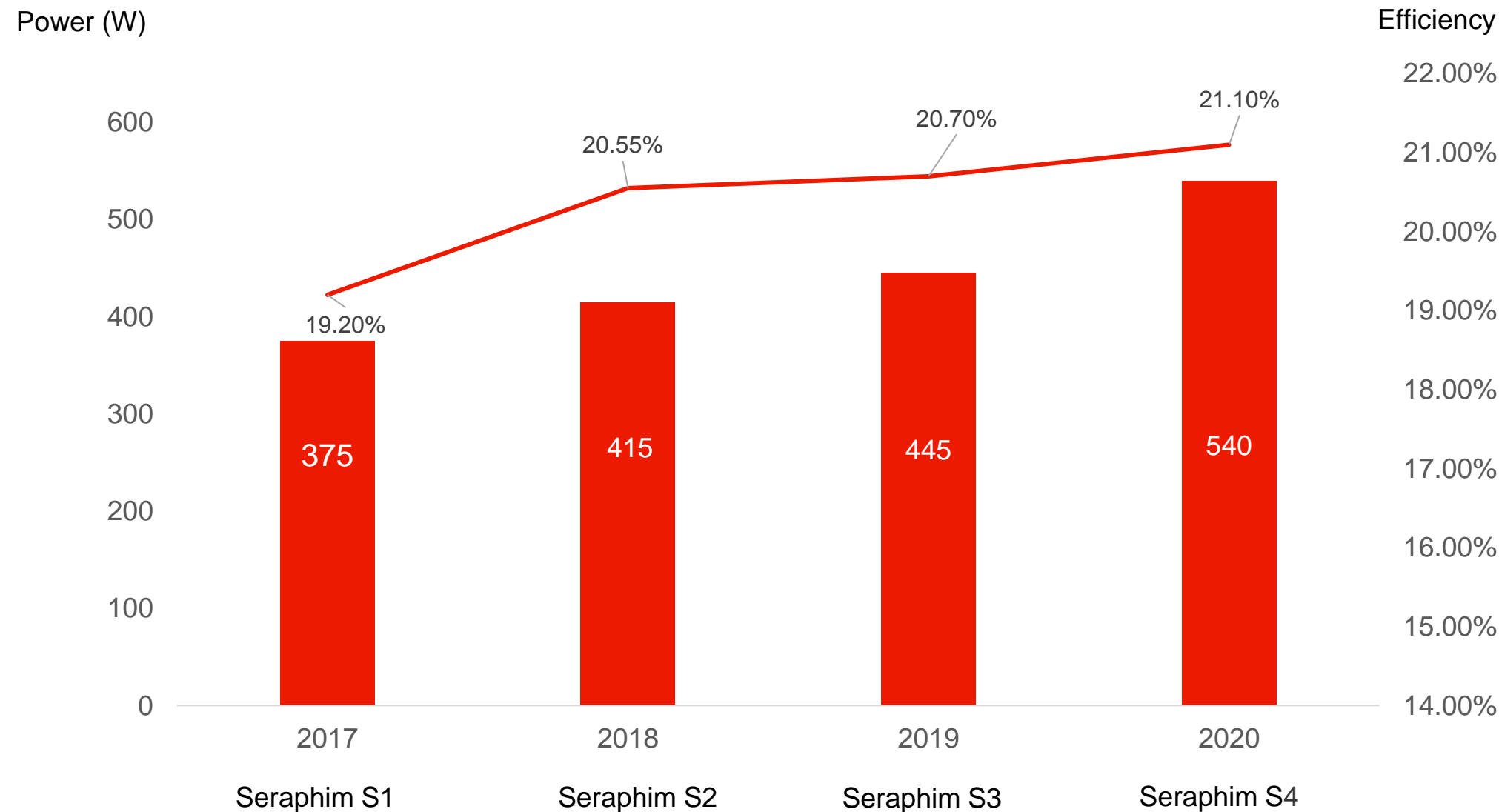


Source: BNEF

Module efficiency continues to improve year-on-year, driven by manufacturing innovation and a shift towards new PERC (passive emitter rear contact), half-cut cell designs, and larger wafers etc.



Advancing Seraphim S Series Module





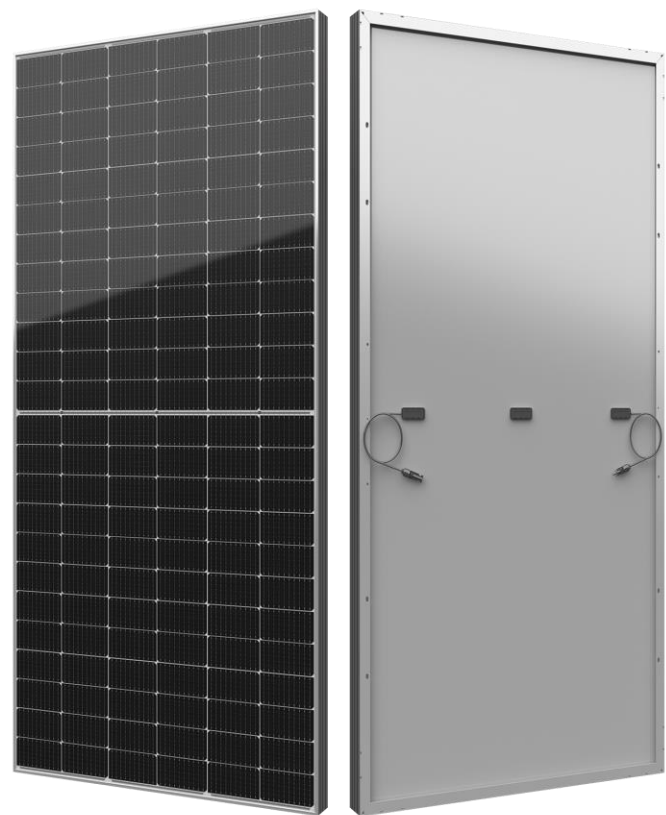
03

Seraphim **S4** Series Half-cell Module





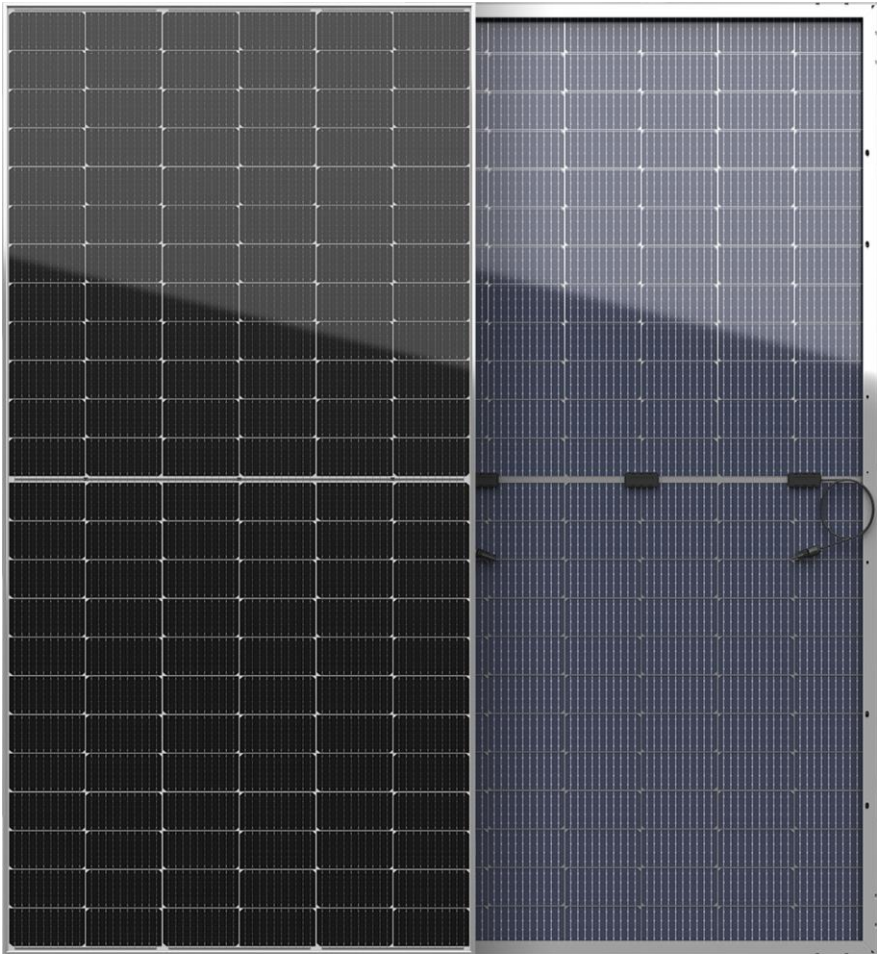
Seraphim S4 Series Half-cell Module



Module Type	144 Cells Module (525-540W, 182mm, 10BB)
Module Power (Wp)	525-540
External Dimensions (mm)	2256×1133×35
Weight (kg)	28
Front Glass	3.2 mm AR coating tempered glass, low iron
Mechanical Load (Pa)	Front 5400 Pa/Back 2400 Pa



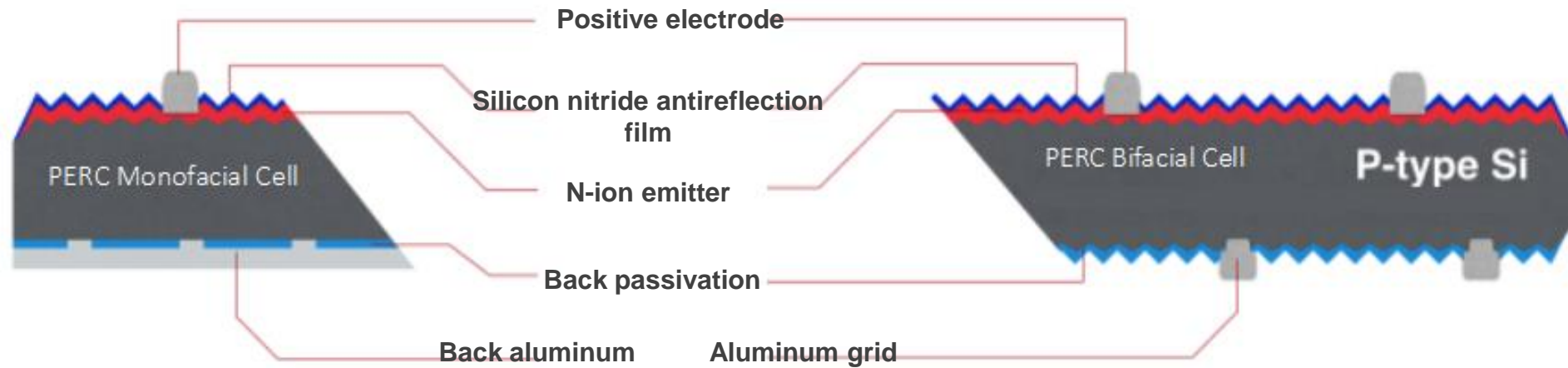
Seraphim S4 Bifacial Series Half-cell Module



10-30% Additional Power Output from Rear Side

Module Type	144 Cells Module (525-540W, 182mm, 10BB)	
Module Power (Wp)	Front	Back
	525-540	395-410
External Dimensions (mm)	2256×1133×30	
Weight (kg)	32	
Front/Back Glass	2.0 mm AR coating semi-tempered glass, low iron	
Mechanical Load (Pa)	Front 5400 Pa/Back 2400 Pa	

Seraphim S4 Series Bifacial Module



We managed to improve the module bifaciality rate up to $70 \pm 5\%$.

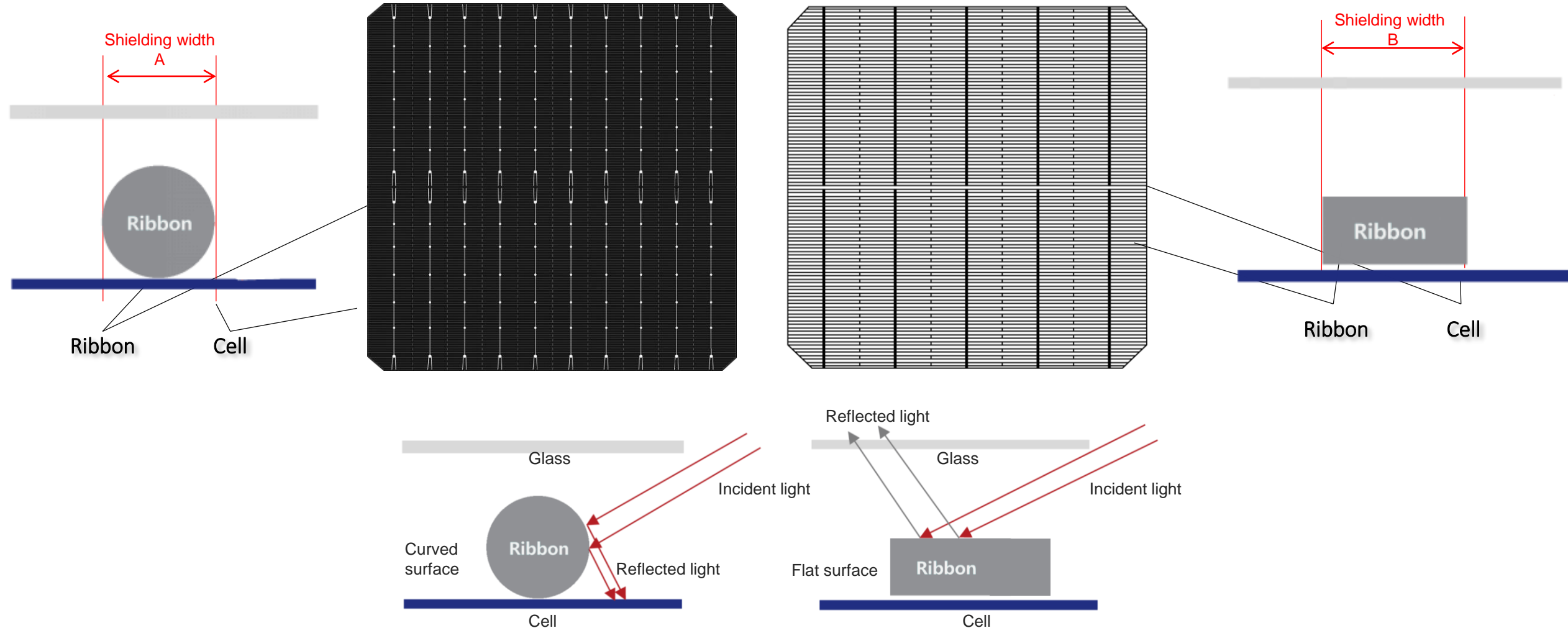
Scene 1	Asphalt Ground	Scene 2	Grass	Scene 3	Snow
Surface Reflectance	10%	Surface Reflectance	30%	Surface Reflectance	45%
Power Generation Gain	7%	Power Generation Gain	10%	Power Generation Gain	15%

Seraphim S4 series half-cell module will have a back gain of 10% to 30% in different installation environments. Ideally, this module can reach a maximum output power of 700W from both sides.

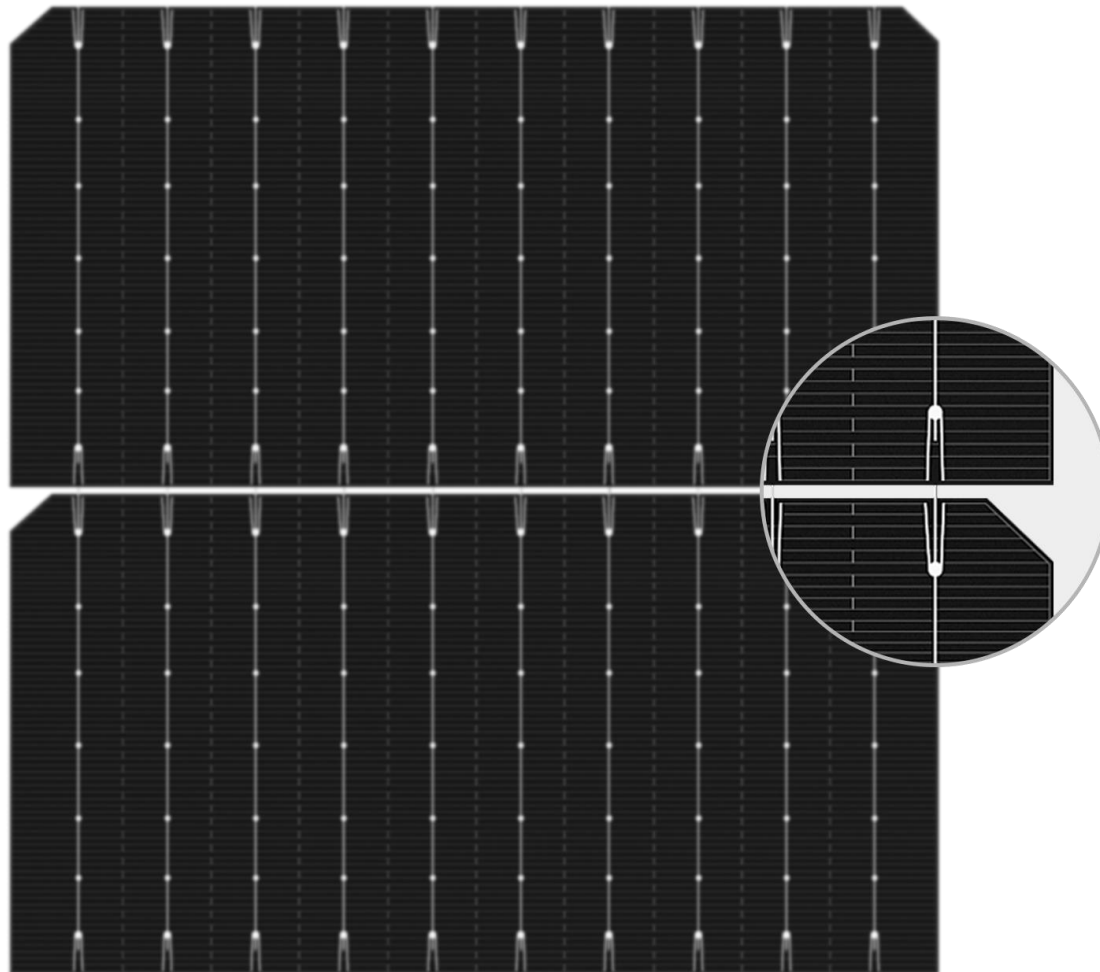
Optical Advantages Of MBB

10BB increases the effective light receiving area of the cell. The optical utilization rate of the ribbon area is increased from less than 5% to more than 45%.

$$10 \cdot A < 5 \cdot B$$



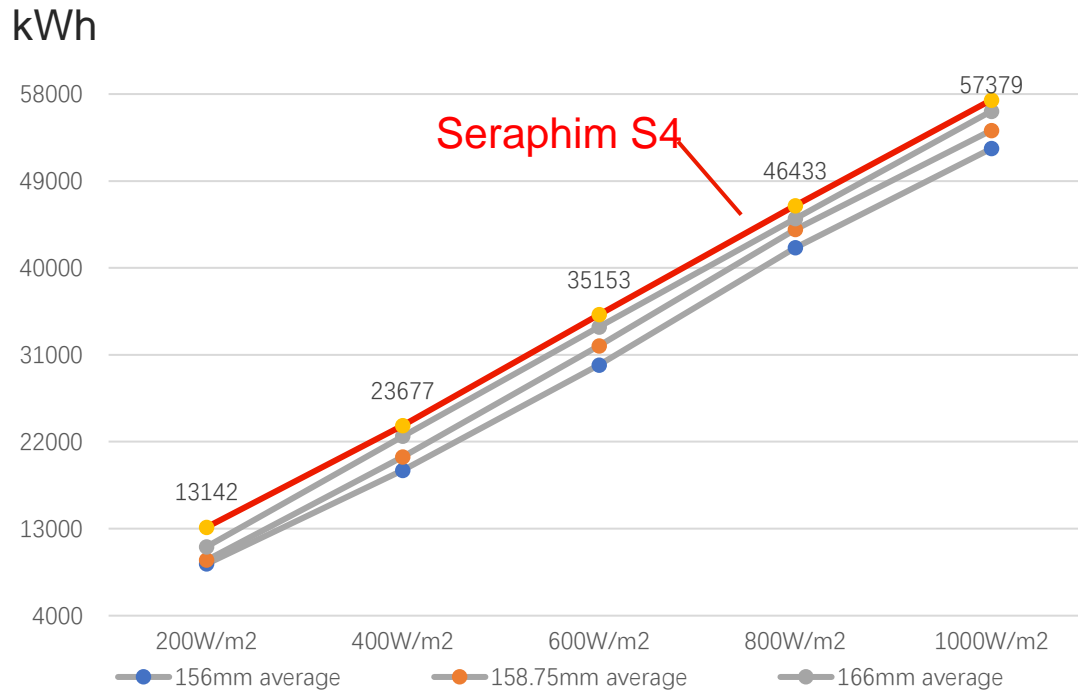
Minimized Cell Gap



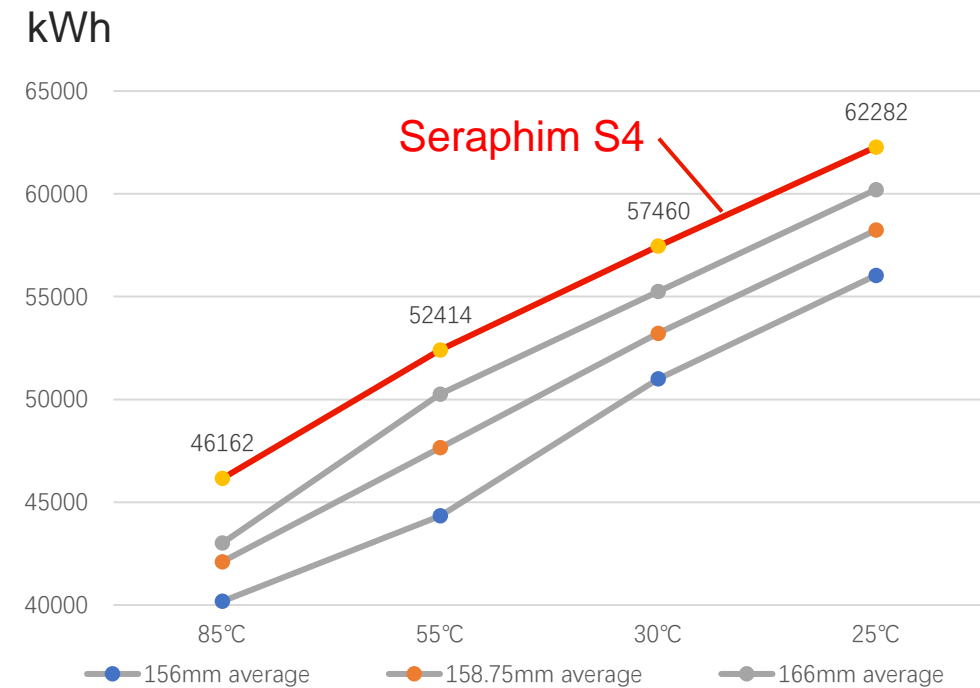
0.5mm

High density encapsulation
with 0.5mm only cell gap

Excellent performance at low irradiation



Extraordinary low temperature co-efficiency



Seraphim S4 series solar modules are more actively responding to low irradiation and remained functional at low temperature environment, resulting higher power generation. This is due to constant improvements in solar cell surface texturing like sueded structures to facilitate the absorption and reuse of sunlight.

Optimal Design, High Compatibility



Inverters

Compatibility with mainstream inverters



Tracker

Compatible with mainstream 1P & 2P horizontal tracking system



Transportation

Compatible with the existing packaging scheme, container space and logistics methods



Installation feasibility

Provide for two installation methods according to field conditions: by rails and clamps

BoS Analysis – Qinghai, China

Module Type	158mm Half-cell Module	166mm Half-cell Module	Seraphim S4
Module Power	410W	450W	540W
Module Efficiency	19.6%	20.7%	21.1%
Extra Output	Reference	+1.2%	+1.4%
Mounting System	Reference	-8.8%	-14.5%
BoS	Land	Reference	-7.0%
	Cable	Reference	-4.6%
	Labor	Reference	-7.5%
	Total BoS	Reference	-5.8%
LCOE	Reference	-2.5%	-4.0%

- 4.0% LCOE

+1.4% Life Cycle Performance Improvement

- 100MW G-mounted plant
- 3.13MW centralized inverter (1500V)
- 1.2 capacity ratio
- Fixed-tilt mounting system
- Double row vertical installation

Mass Production

2021 Q1 Mass Production

3 GW Annual Capacity (2021)

Additional 54 pcs for rooftop



THANK YOU

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SHIFTING • THE FUTURE

Sunny Central UP, SHP, Medium Voltage Platform

SMA Solar LS & BS Solution

Charles Wang





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AGENDA



SMA Solar Technology

1

Why SMA Solar Technology?

Milestone

2

Bi-facial Panels – Inverter Selection

What needs to be checked at the inverter side

3

182 mm Solar Panels Compatibility

Specification deep dive

4

Solution from SMA Solar Technology

Sunny Central UP, SHP PEAK3, STP CORE2

A pioneer in PV and storage system technology for 39 years...



1987

SMA develops the first transistor inverter for photovoltaics.



2002

First Central inverter.



1999

First transformer-less string inverter



2009

The world's largest carbon-neutral inverter factory begins operations.

2015

For the first time, the Sunny Home Manager integrates household appliances into the energy management system via EEBUS.



2017

Sunny Tripower CORE1 is the first free-standing string inverter.



2019

Sunny Central UP delivers 50% more power than its predecessor and integrates large storage systems.



2020

SMA 360° is the most comprehensive installer App on the market.



1981

SMA Founded

2001

Sunny Island delivers an autonomous electricity supply to off-grid areas.



2008

SMA achieves the year's largest IPO.



2011

Sunny Tripower is the first inverter to achieve 99% efficiency.



2016

Sunny Boy Storage is the first AC-coupled system to integrate high-voltage batteries.



2018

With ennexOS, SMA establishes the first IoT platform for cross-sector energy management.



2020

110kw inverter, Up to 12 MPPT



SMA Solar Technology Worldwide



#1 European PV inverter manufacturer brand

German Engineering and Design.



> 95 GW of installed SMA inverter power

in more than 190 countries worldwide



> 3,000 SMA employees

in 18 countries, more than 650 sales and service teams



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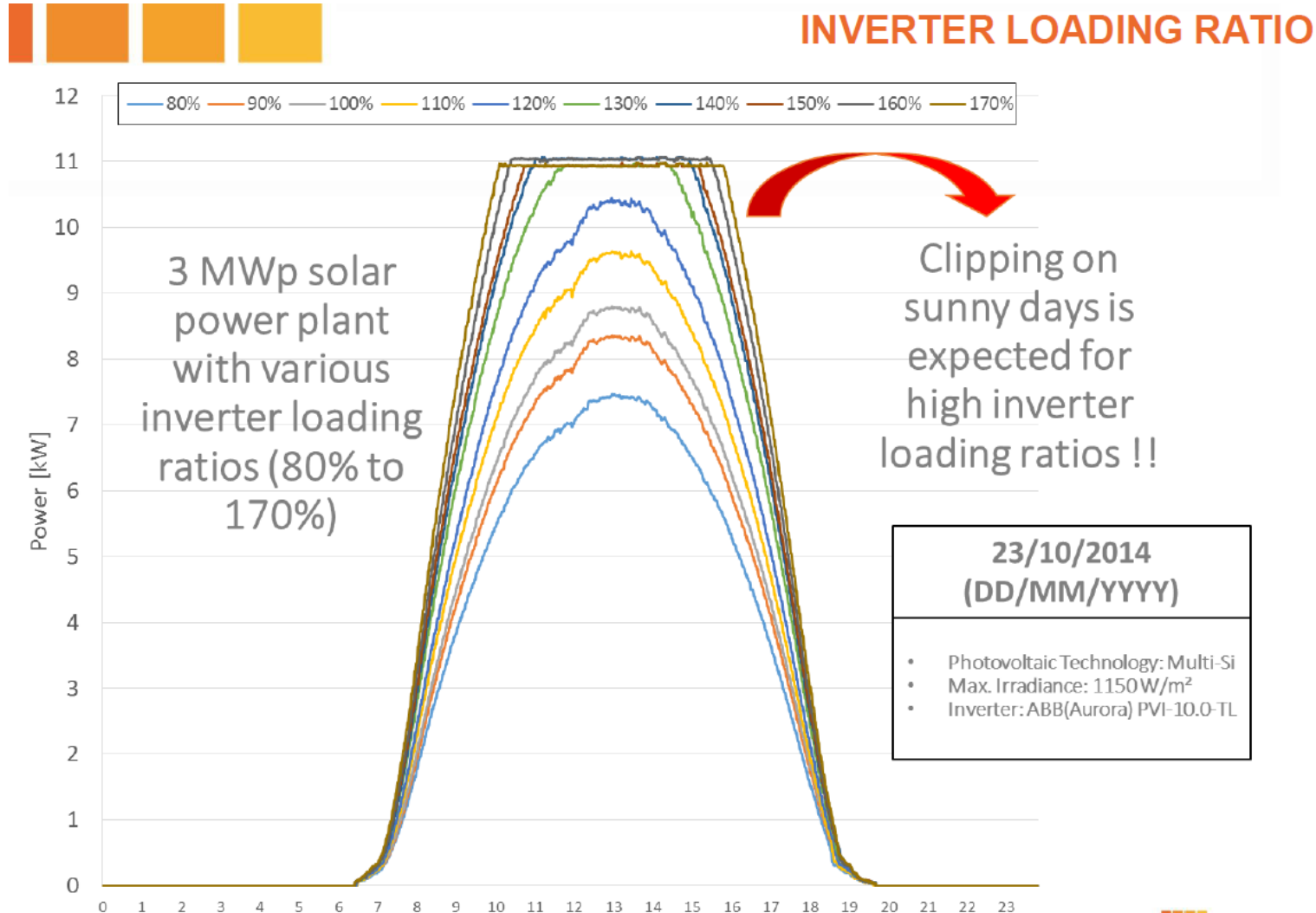
Bi-facial Solar Panels



Bifacial solar panels have their backs covered with either a transparent sheet or a have a double glass panel. This makes reflection possible, hence, there is energy production from both sides, increasing the total power output.

Surface Type	Reflection Rate	Back side additional Gain
Water	10~20%	4~7%
Grass	15~25%	7~10%
Concrete	25~35%	8~12%
Sand	35~45%	10~15%
Snow	40~70%	15~22%
Reflecting Coating	80~90%	23~25%
Roof		
Newly accumulated snow	80~95%	25~30%

Bi-facial Solar Panels – DC/AC Sizing Ratio



- A Case Study in 2016 by Solar Energy Research Laboratory at Universidade Federal de Santa Catarina – Brazil
- In order to achieve the optimal LCOE, PV inverter should be able to maintain its reliability under **high DC/AC ratio**.

Bi-facial Solar Panels – Inverter Selection



The additional output of bi-facial solar panel will increase the DC power at the inverter input. For inverter manufacturer this will be specified at the Input (DC) section – Max. PV array power.

For SMA inverters, this DC/AC ratio can go up to **150%** to ensure it can cover the max. gain from the bi-facial panels.

Technical Data	Sunny Highpower 100-20	Sunny Highpower 150-20
Input (DC)		
Max. PV array power	150000 W _p	225000 W _p
Max. input voltage	1000 V	1500 V
MPP voltage range / rated input voltage	590 V to 1000 V / 590 V	880 V to 1450 V / 880 V
Max. input current / max. short-circuit current	180 A / 325 A	180 A / 325 A
Number of independent MPP trackers	1	1
Number of inputs	1 or 2 (optional) for external PV array junction boxes	



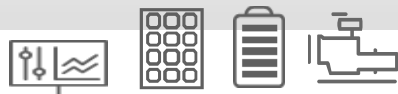
Hybrid Energy Supply – Antarctica, 2009/19

Princess Elisabeth Antarctica Station



Project

- Location: Antarctica
- Commissioning: 2009/2019



Plant information

Energy generation

- 12%: 22 m² of thermal PV modules
- 40%: 380 m² of photovoltaic PV modules
- 48%: 9 wind turbine systems

SMA System Technology

- 15 Sunny Boy / 12 Sunny Mini Central
- 1 SMA Data Manager M
- Update: 5 Sunny Tripower 5.0
- 12 Sunny Island (4 clusters)
- 192 Hoppecke Sun Power batteries
- Kyocera PVmodules/upd. **bifacial LG modules**

The Belgian polar base Princess Elisabeth Antarctica is the first emissions-free research station in Antarctica. A hybrid system that intelligently combines the renewable energy sources of the sun and wind provides the energy to supply the station, making electricity and heating available to the researchers on-site.

The system is now to be expanded and optimized for future operations. The first step in this endeavor was to install a Data Manager M.

AGENDA



- 1 Why SMA Solar Technology?**
Milestone
- 2 Bi-facial Panels – Inverter Selection**
What needs to be checked at the inverter side
- 3 182 mm Solar Panels Compatibility**
Specification deep dive
- 4 Solution from SMA Solar Technology**
Sunny Central UP, SHP PEAK3, STP CORE2



182mm Solar Panels Compatibility – Higher rated Power, voltage and current

Ultra-high-power modules come with lower LCOE and BOS costs, aiming to deliver high power performance and long-term reliability.

Higher maximum power, current and voltage - need to be compatible with inverters

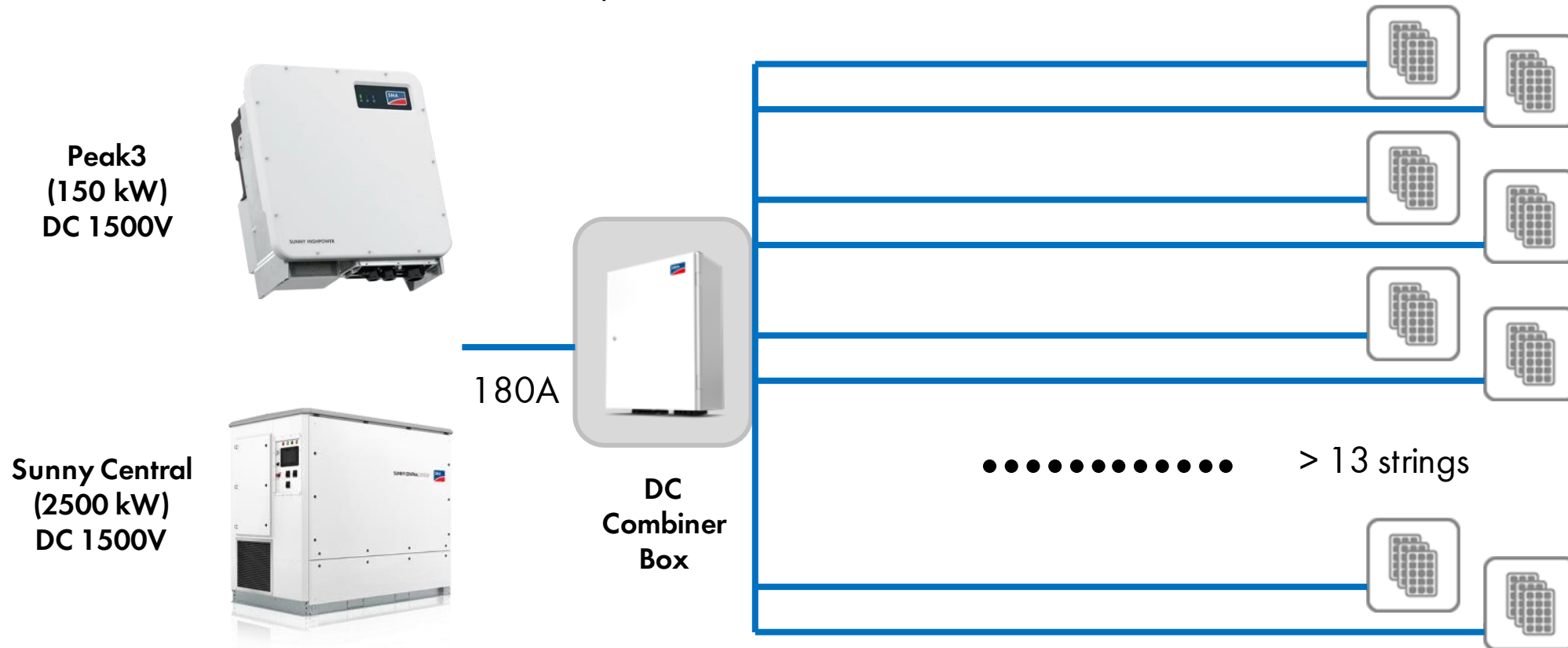
Electrical Characteristics

Module Type	SRP-525-BMA-BG		SRP-530-BMA-BG		SRP-535-BMA-BG		SRP-540-BMA-BG	
STC	Front	Back	Front	Back	Front	Back	Front	Back
Maximum Power -P _{mp} (W)	525	391	530	395	535	399	540	403
Open Circuit Voltage -V _{oc} (V)	49.41	49.38	49.51	49.48	49.64	49.61	49.77	49.74
Short Circuit Current -I _{sc} (A)	13.43	10.01	13.54	10.07	13.63	10.14	13.72	10.21
Maximum Power Voltage -V _{mp} (V)	41.60	41.57	41.76	41.73	41.91	41.88	42.03	42.01
Maximum Power Current -I _{mp} (A)	12.63	9.41	12.70	9.47	12.77	9.53	12.85	9.60
Module Efficiency STC-η _m (%)	20.2		20.4		20.6		20.8	
Power Tolerance (W)	(0, +4.99)							
Pmax Temperature Coefficient	-0.36 %/°C							
Voc Temperature Coefficient	-0.28 %/°C							
Isc Temperature Coefficient	+0.05 %/°C							



182mm Solar Panels Compatibility - High compatibility with wide adaptability for SMA inverters

The Sunny High Power PEAK3 String Inverter with 1 MPPT can easily manage the total combined current with 182mm - 210mm solar panels

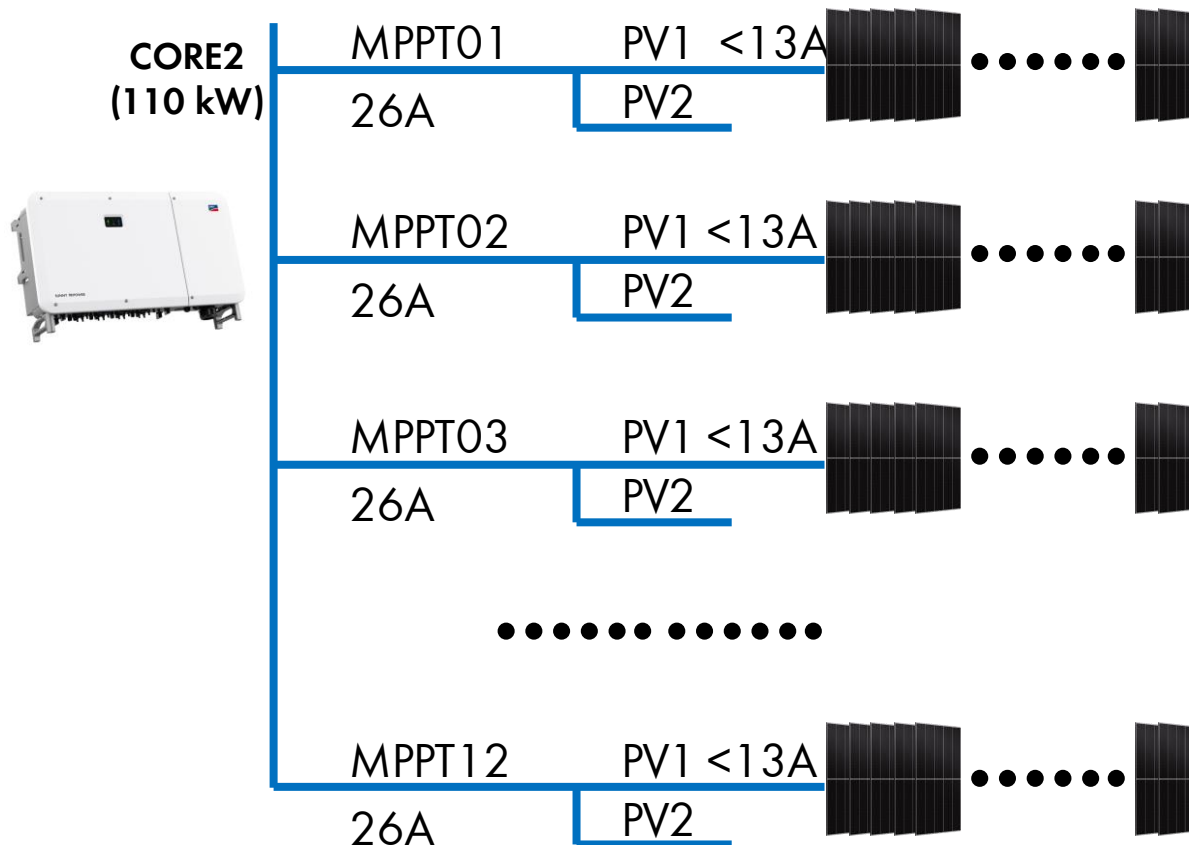




182mm Solar Panels Compatibility

SMA Core2 with 12 MPPT is also compatible for 182mm-210mm PV module

182mm PV module



Module Type	SRP-525-BMA-HV	SRP-530-BMA-HV	SRP-535-BMA-HV	SRP-540-BMA-HV
	STC	STC	STC	STC
Maximum Power at STC (Pmp)	525	530	535	540
Open Circuit Voltage (Voc)	49.41	49.51	49.64	49.77
Short Circuit Current (Isc)	13.43	13.54	13.63	13.72
Maximum Power Voltage (Vmp)	41.60	41.76	41.91	42.03
Maximum Power Current (Imp)	12.63	12.70	12.77	12.85
Module Efficiency at STC(η_m)	20.2	20.4	20.6	20.8
Power Tolerance	(0,+4.99W)			
Maximum System Voltage	1500V DC			
Maximum Series Fuse Rating	20A			

STC: Irradiance 1000 W/m² module temperature 25°C AM=1.5

* sourced from Seraphim Solar System Co., Ltd

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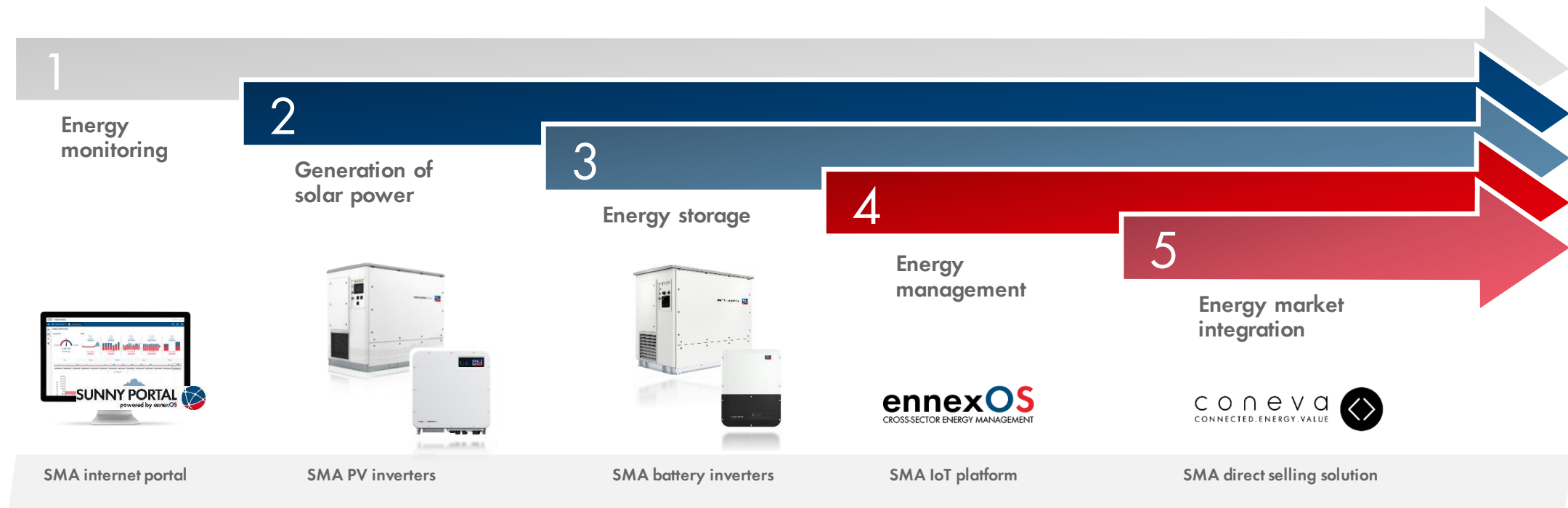
Specification deep dive

4

Solution from SMA Solar Technology

Sunny Central UP, SHP PEAK3, STP CORE2

The SMA Solar Portfolio Covers All Stages of Energy Integration



LARGE SCALE & PROJECT SOLUTIONS

True Turnkey solutions

2,500 – 6000kW

MVPS 20 ft.



MVPS 40 ft.



- Tailored power conversion systems as **true turnkey container solution** (MVPS)

PV / Storage Inverters

2,500 – 3,000kW



- SC2500-EV(-US),
- SC2750-EV(-US),
- SC3000-EV

PV / Storage Inverters

4,000 – 4,600kW



- SC UP 4000- 4600
- SCS UP 3000 - 3600

System components



- Power Plant Manager

Service



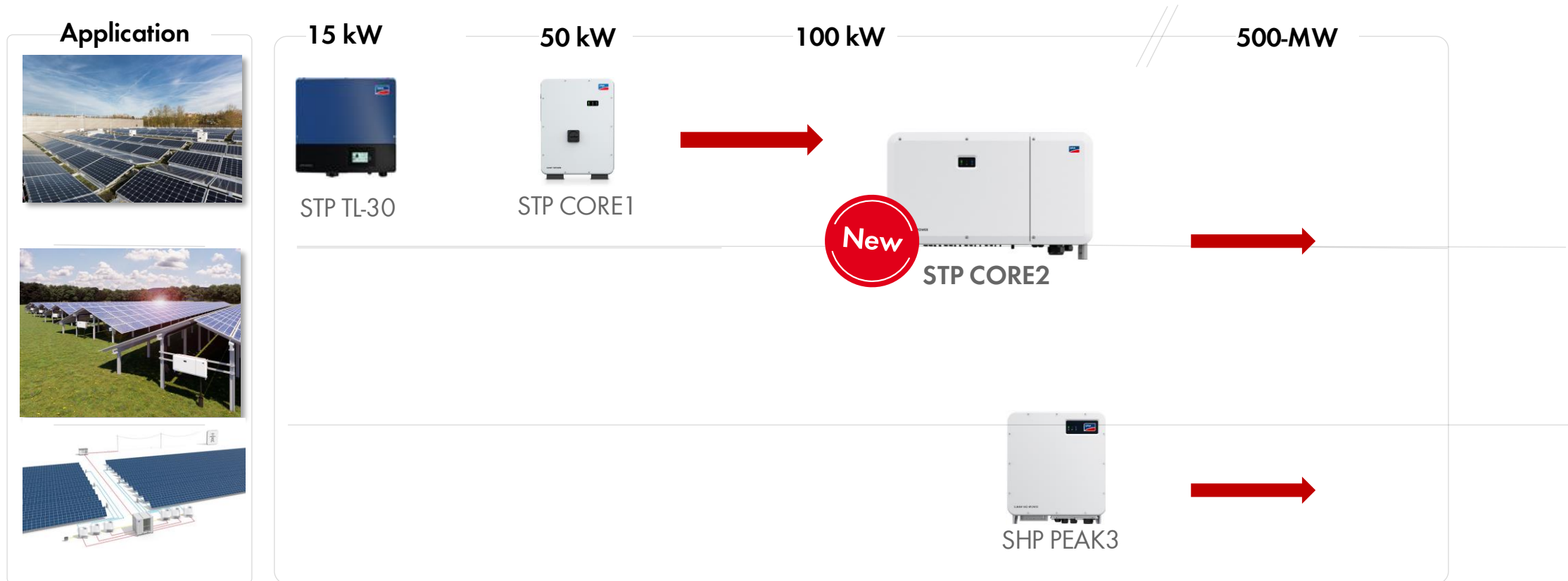
- Warranty support
- EW support
- Engineering Service

- **SMA offers solutions for the entire value chain from DC to the MV grid worldwide.**



Commercial & Large Commercial Solution

A product for all commercial project sizes.





PEAK3. Our technology.



Powerful 150 KW

- 1500 VDC
- 99.1% Max Efficiency
- Full-loading output @50°C



Quick & safe installation

- Easy step by step widget for installation
- Ergonomic grip and hooks
- fast and simple mounting



Central commissioning & monitoring

- ennexOS ready
- SMA Data Manager & Sunny Portal compatible
- Single point control



Highly flexible & future proof

- Ethernet connection
- Open Modbus / TCP interface
- Strict internal IT security



Thank you!

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