2020

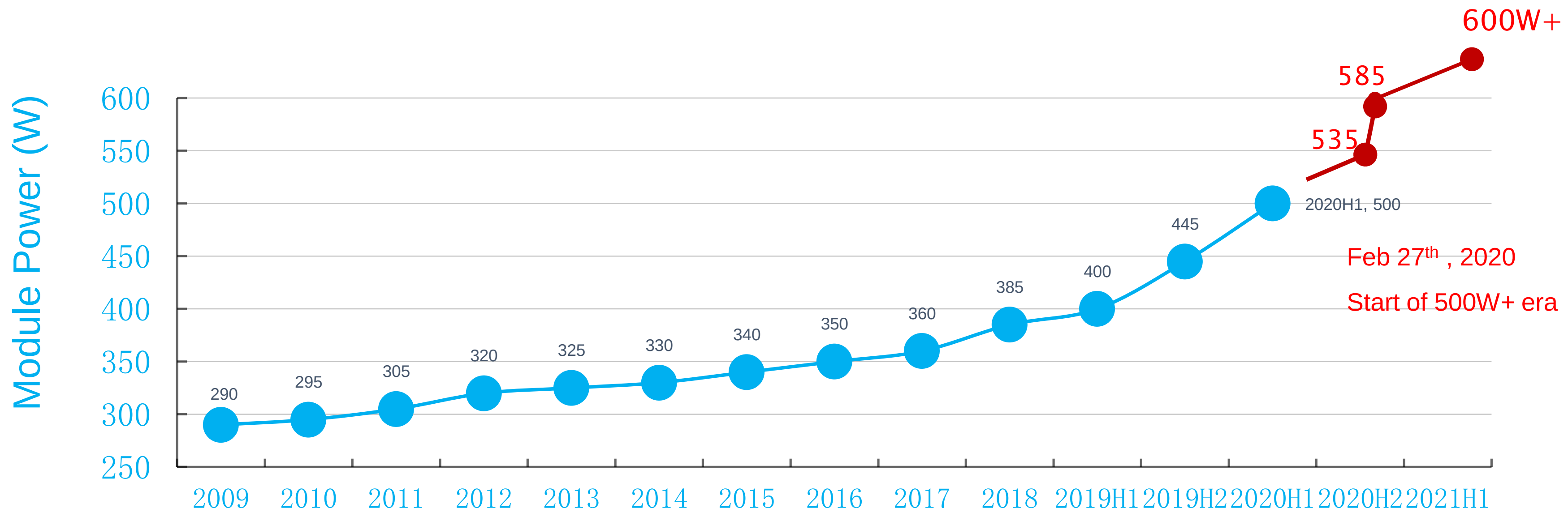
New TrinaTracker

For Vertex Module

Power beyond solar

Trina Vertex module 600W module background

- Review from 2009 – 2019, module power bin increased annually between 5~10W
- Since 2019, module power bin increased by ~100W, in the 500W+ era
- The Wp increase in last year is more than the cumulative in the last 10 years



600W+ era

Jul 16th 2020

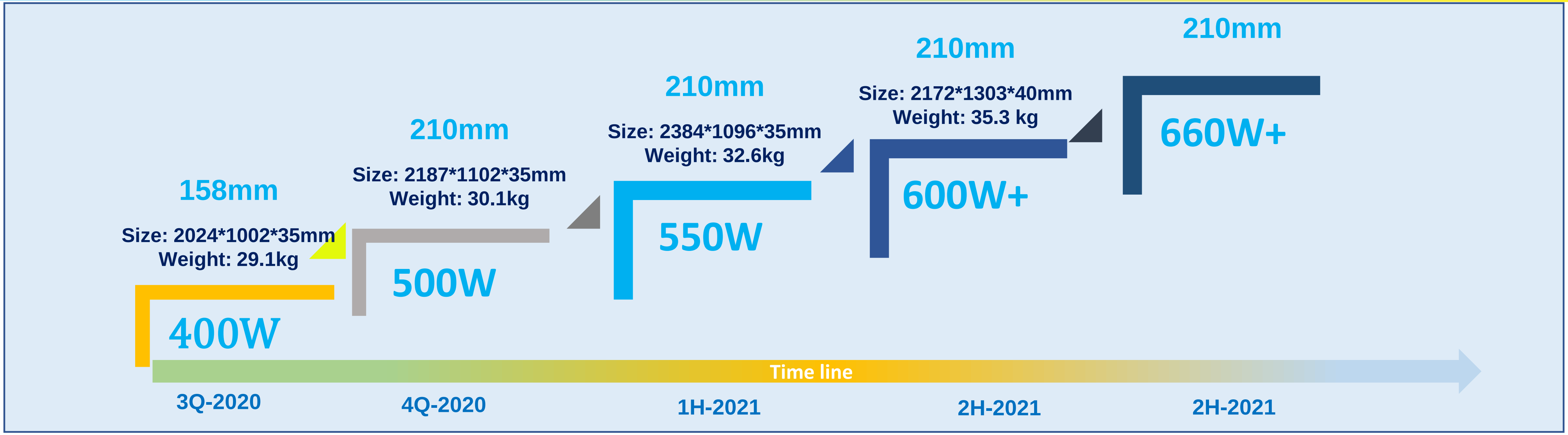
600W+ Vertex module paves the way for further lowered LCOE

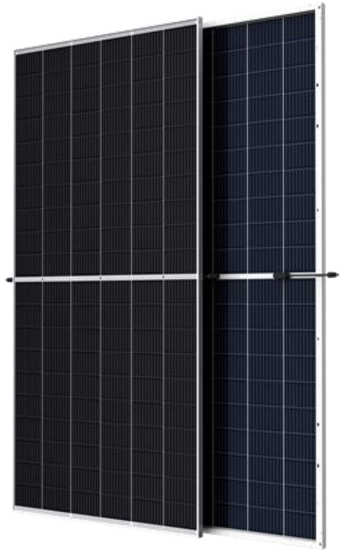
1. Module cost
2. BOS→ Module power, Module efficiency

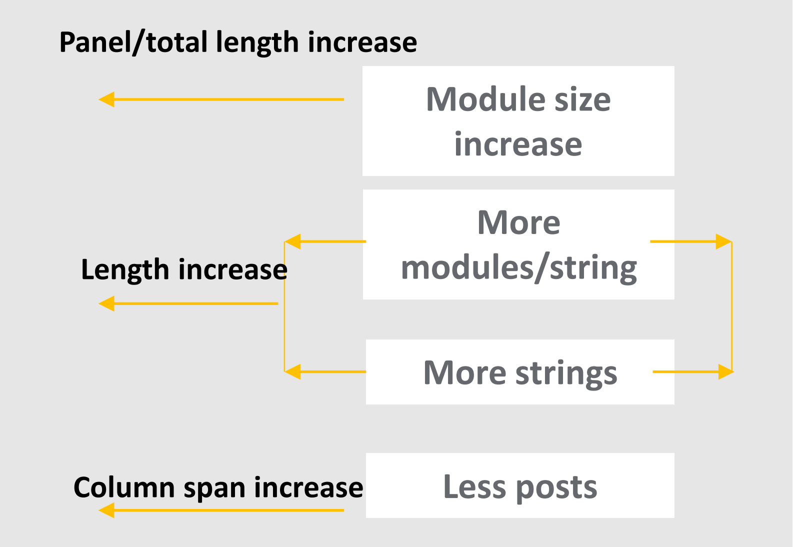
$$\text{LCOE} = \frac{\text{Total cost}}{\text{Total power generation}} = \frac{\text{Initial investment + total O\&M cost + other costs − system residual}}{\text{Total power generation}}$$

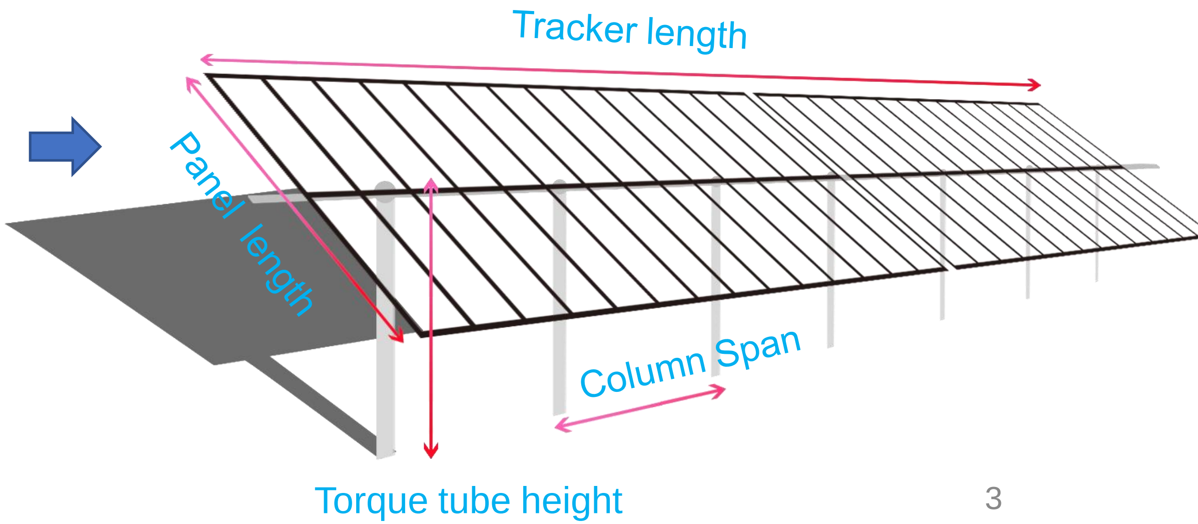
Module power generation per watt

How will Trina's Vertex module impacts tracker design?

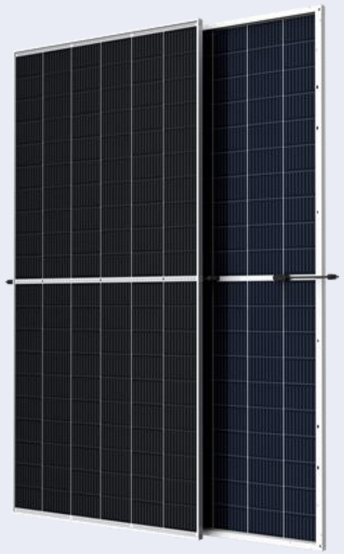
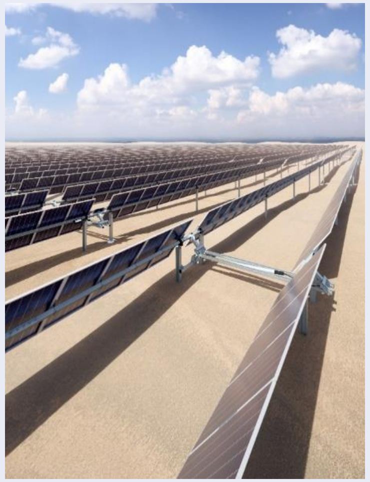








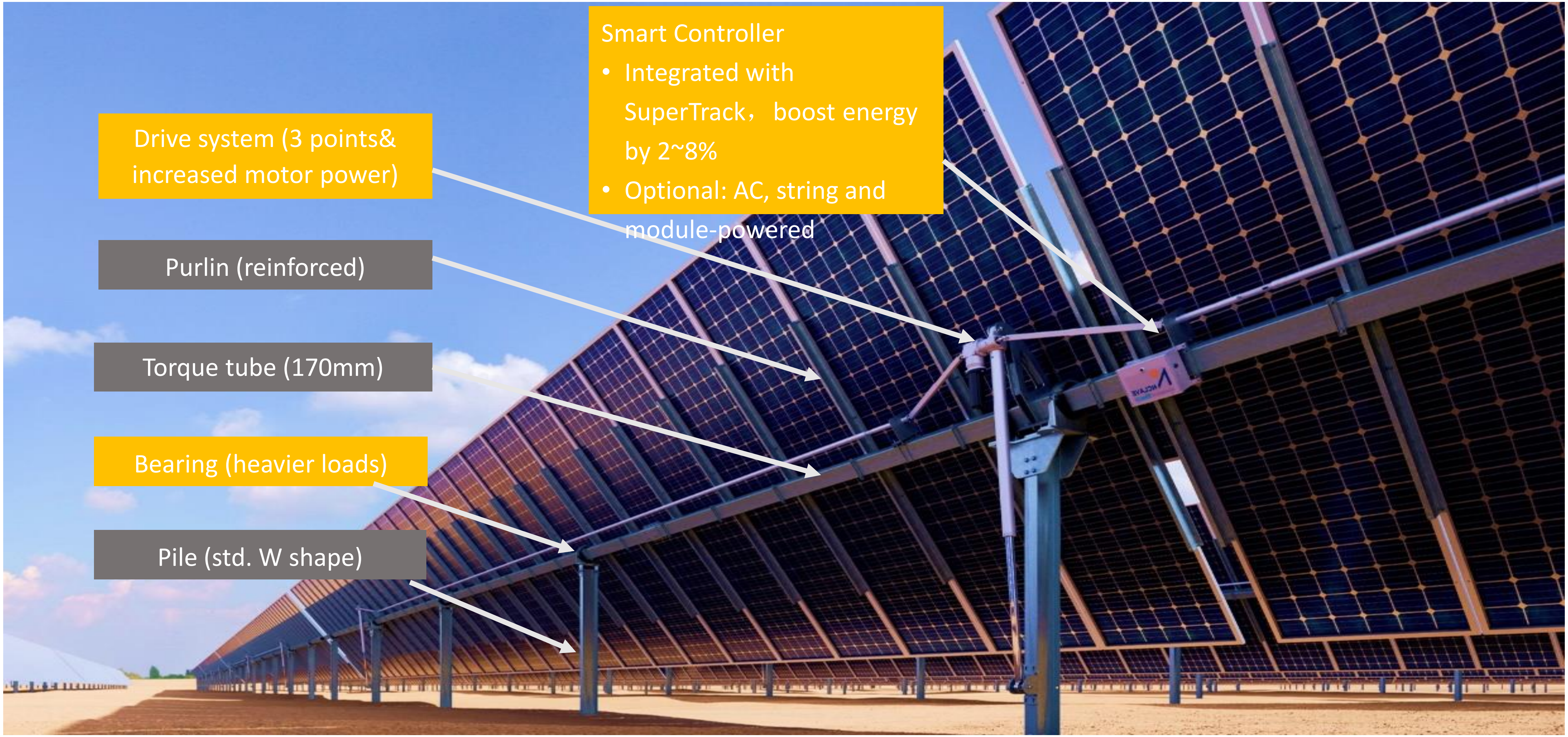
Different Trina Solar Modules & Trackers

	Vanguard™ 550		Agile™ 550
Vertex Module 550W	Vanguard 550-2P	Vanguard 550-1P	Agile 550-1P
			
Increased size & bifacial feature	• Vanguard is suitable for complex terrains • Independent tows can adapt to uneven ground mounted conditions		• Agile is robust and easy install • Protects against wind issue dynamics • Dual rows adapt to ground mounted conditions

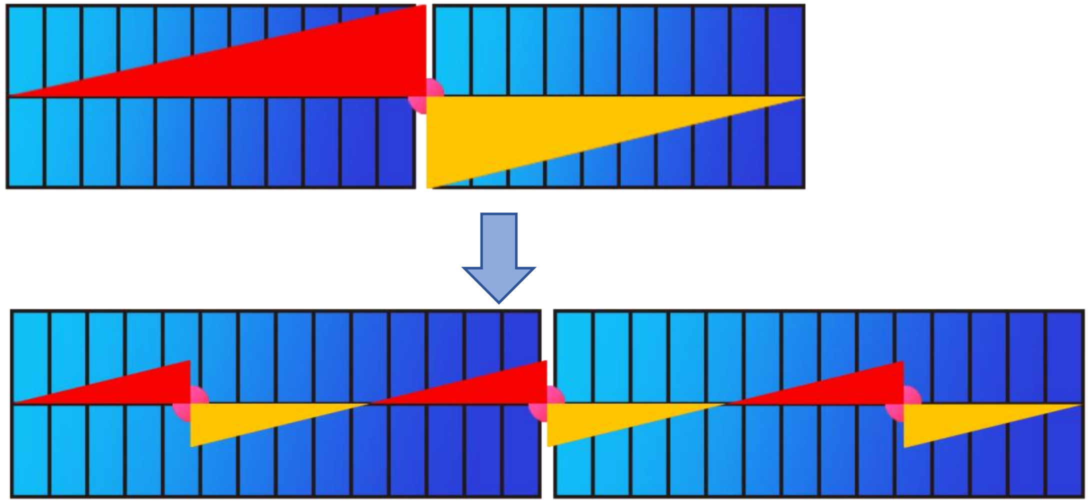
TrinaTracker Vanguard 550-2P product update

2P Product			
		Trina 2020	Trina 2019
Tracker Type		Vanguard 550 2P	SP160 (2V*45) 400W
Row size (modules number per row)		120 pcs	90 pcs
Rows per tracker		1	1
TCU unit （/MW）		1	1
Wind tunnel test	Length of tracker	65m-》68m	45 m
	Width of tracker	4.73m -》 5m	4.73m
Tracking range		±55°	±55°
environment temperature range		-30℃~60℃	-30℃~60℃
Terrain adaptation		Up to 15% N-S -》20%	Up to 15% N-S
Allowable wind speed		135mph（3s）	100mph（3s）
Piles per tracker（/MW）500W		7 (117 piles/MW)	9 (Slew driver:195 piles/MW)/ (Linear actuator:222 pile/MW)
Communications		ZigBee、LoRa wireless/ RS485	ZigBee / RS485
Power supply		AC powered/ Self powered/	AC powered/ Self powered

TrinaTracker Vanguard 550-2P Design Overview



TrinaTracker product update: multi-drive system



High Stability and accuracy

- **Torque transfer length 50% shorter, transfer efficiency improved, single motor drive, consistency improved, tracking accuracy reaches 1°**

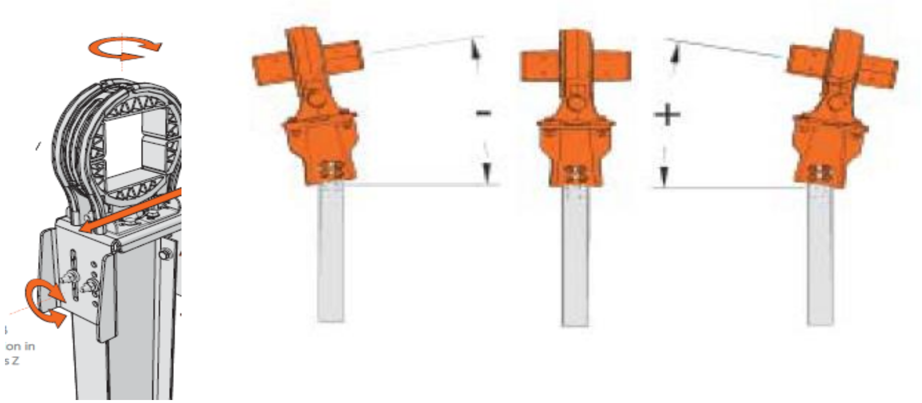
High Safety

- **Multi-point drive has self-locking function for maximum wind stability**

High reliability

- **Cooperate with authoritative wind tunnel firm RWDI**
- **20+ weeks testing period Passed static test/dynamic test /aero instability test**

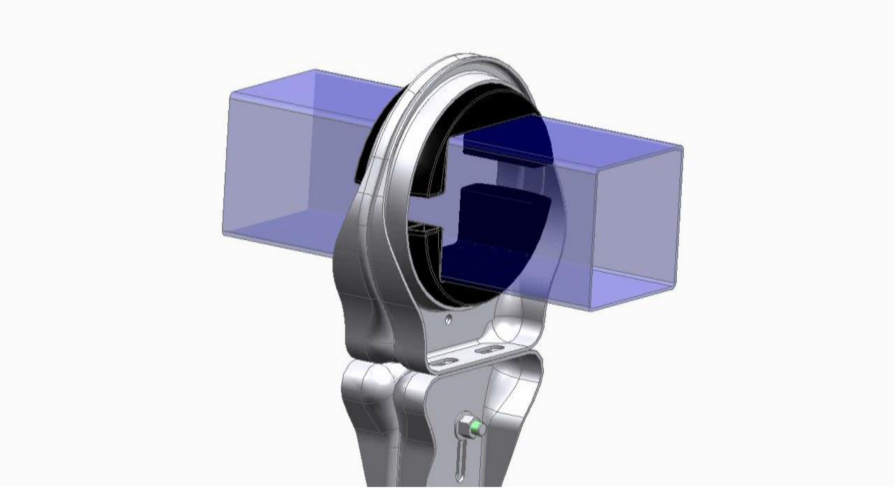
TrinaTracker product: global patented spherical bearing



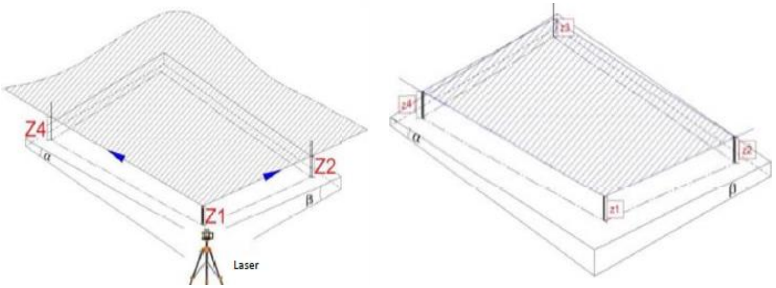
Cylindrical bearing

- Conventional tracker bearing: Non-Adjustable rigid design makes the system unstable and causes significant stress

Trina tracker bearing:
Global Patented Spherical Bearing: Up to 30% Angle Adjustability to minimize stress



Spherical bearing



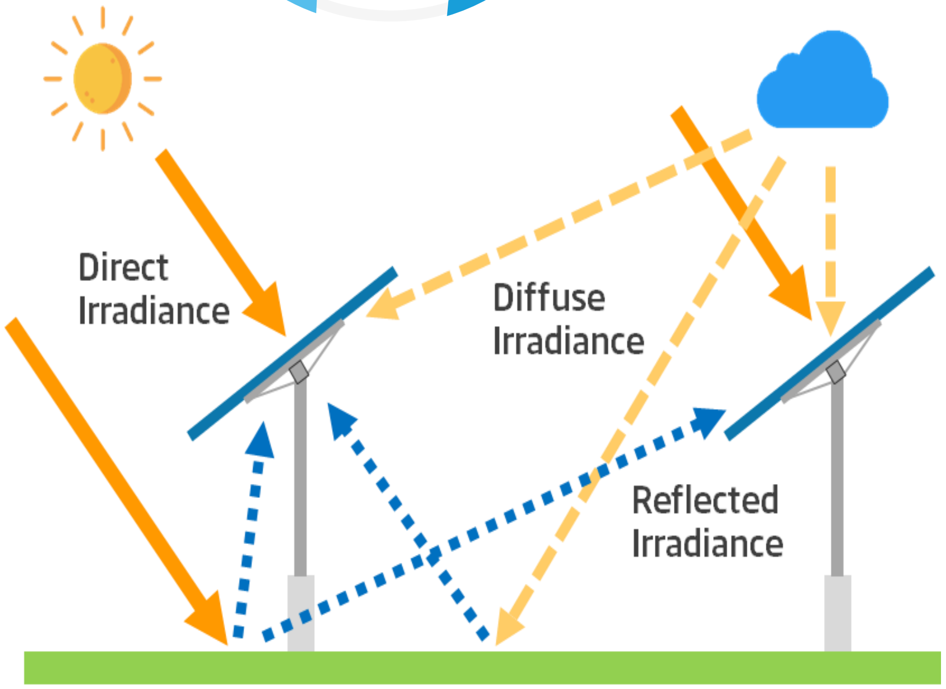
- Tracker contained in the plane
- Matches ground
- Minimizes stress

Highlights & features of SuperTrack

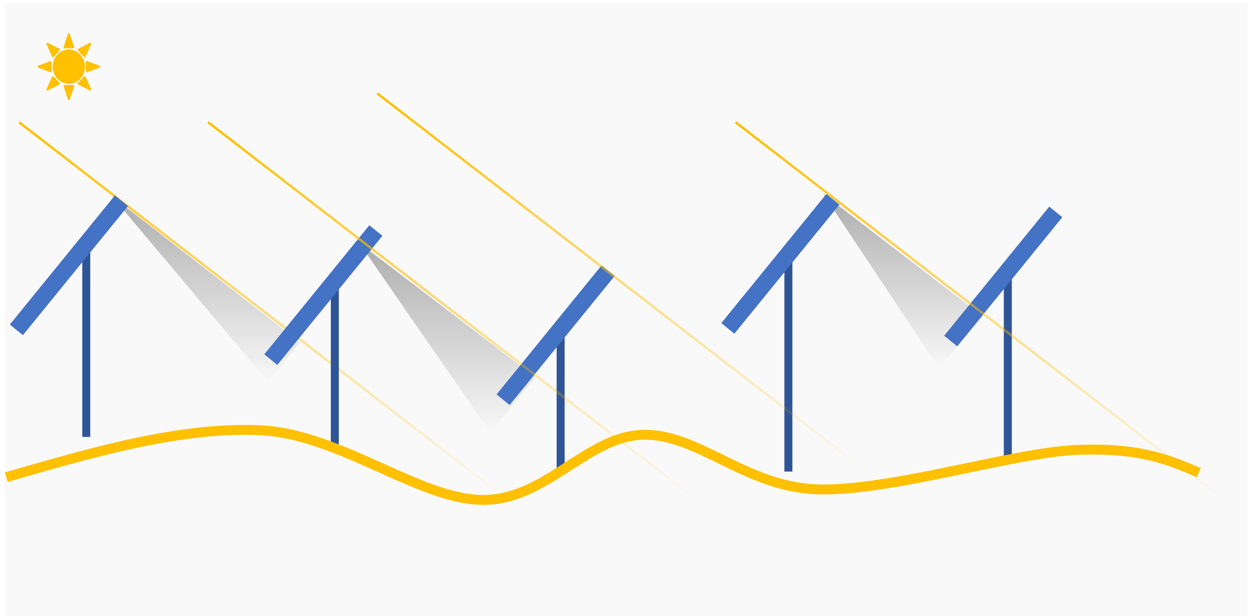
SuperTrack

Trina Solar Patented Algorithm

Third Party Certification



Smart Tracking Algorithm



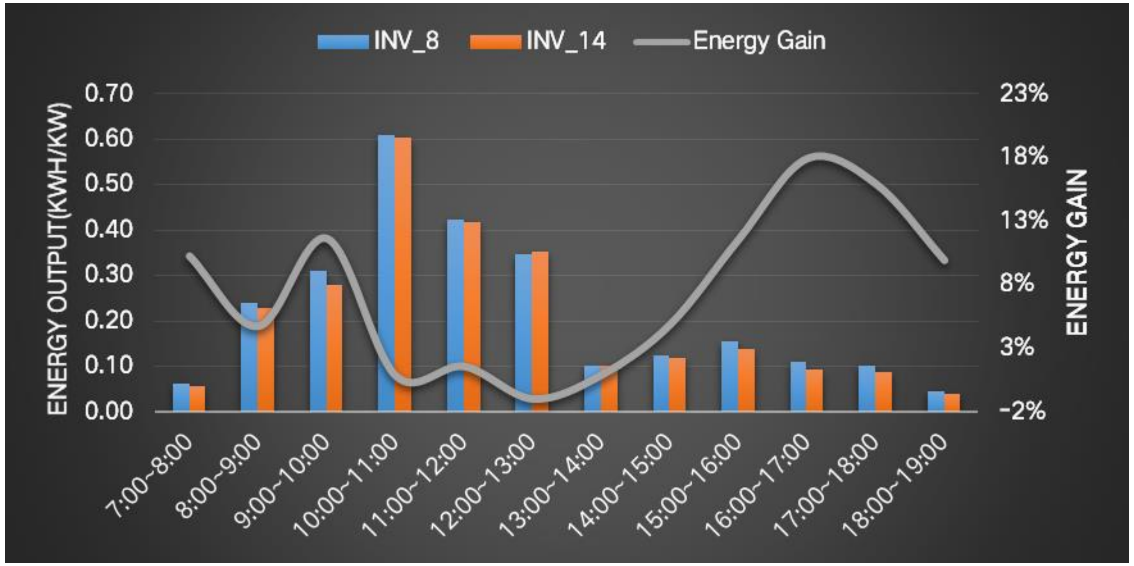
Smart Backtracking Algorithm

SuperTrack™ is featured with two patented technologies. Smart Tracking Algorithm (STA) is to optimize for high diffuse irradiation and 'Smart Backtracking Algorithm' (SBA) for undulating terrains.

More Yield Gain: Third party certification with CGC

Energy Gains of SuperTrack (8/19~9/17)

Inverter	8	13	14
Algorithm Type	SuperTrack	SuperTrack	Conventional Algorithm
Cumulative Energy Gain (Inverter Level-9 Trackers)	3.8%	3.2%	BL
Maximum Energy Gain (MPPT Level-Single Tracker)	6.4%	5.0%	BL



Energy gains of SuperTrack during cloudy and sunny time

China General Certification Center: Independent 3rd party data

* Tongchuan, China project

2.4%~4.5%

Compared with the conventional algorithm the LCOE is lower

Summary

More Reliable Tracker
- Multi-drive system
- Reinforced structure design
- Patented Spherical bearing

More Energy Yield
- Bifacial tracking algorithm
- Optimal back tracking under uneven terrain and cloudy days
- SCADA smart monitoring and O&M advice

Lower Capex
- Lower BOS cost compared to old generation
- Lower installation and O&M cost due to quick mount solution and standardized pile design

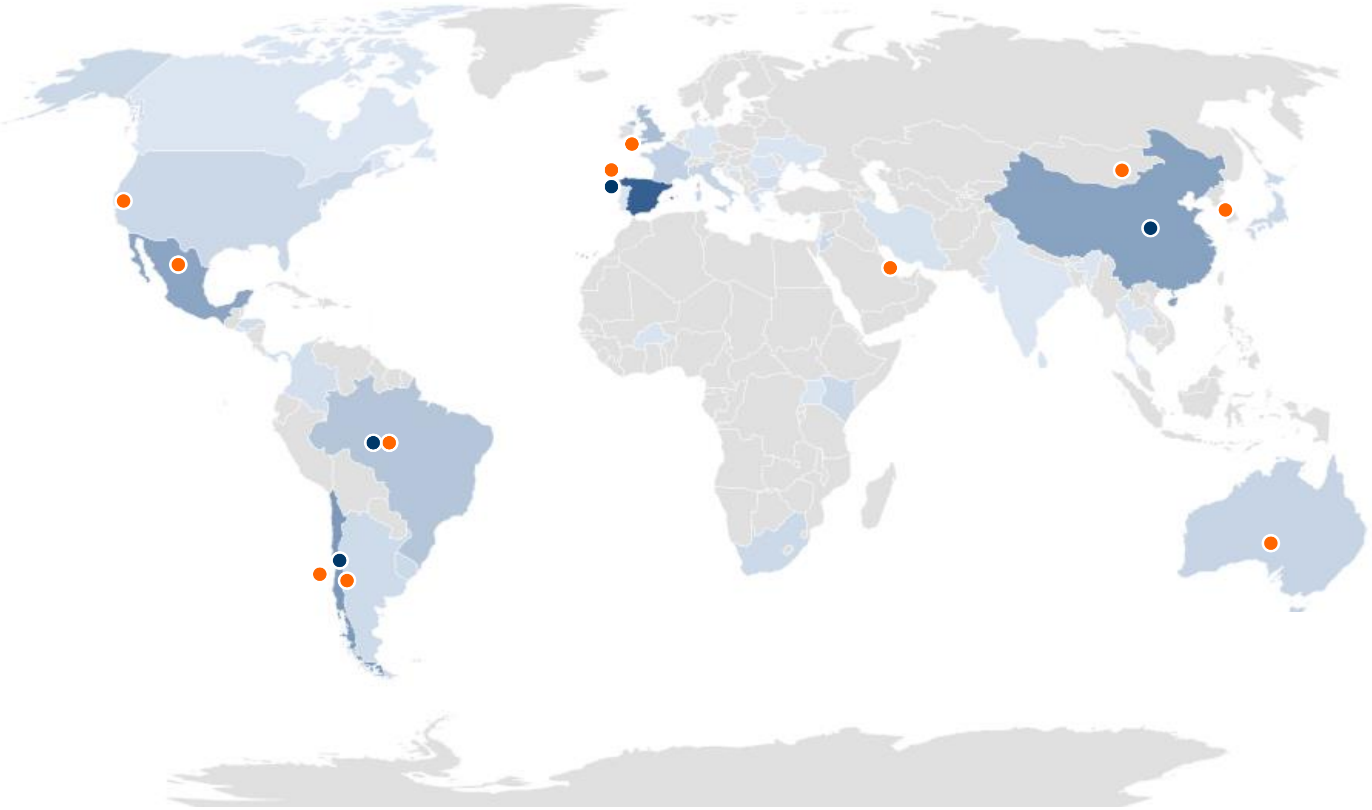
TrinaTracker Global Presence

PVTECH TECHTalk Trinasolar

5GW+ deployed worldwide

Offices & Branches
Spain
France
USA
Mexico
Brazil
Chile
Argentina
Japan
Australia
China

Production Centers
Spain
Brazil
Argentina
China



12+ years of experience

5GW+ installed capacity worldwide

25+ countries in the 5 continents

4GW+ Production capacity worldwide

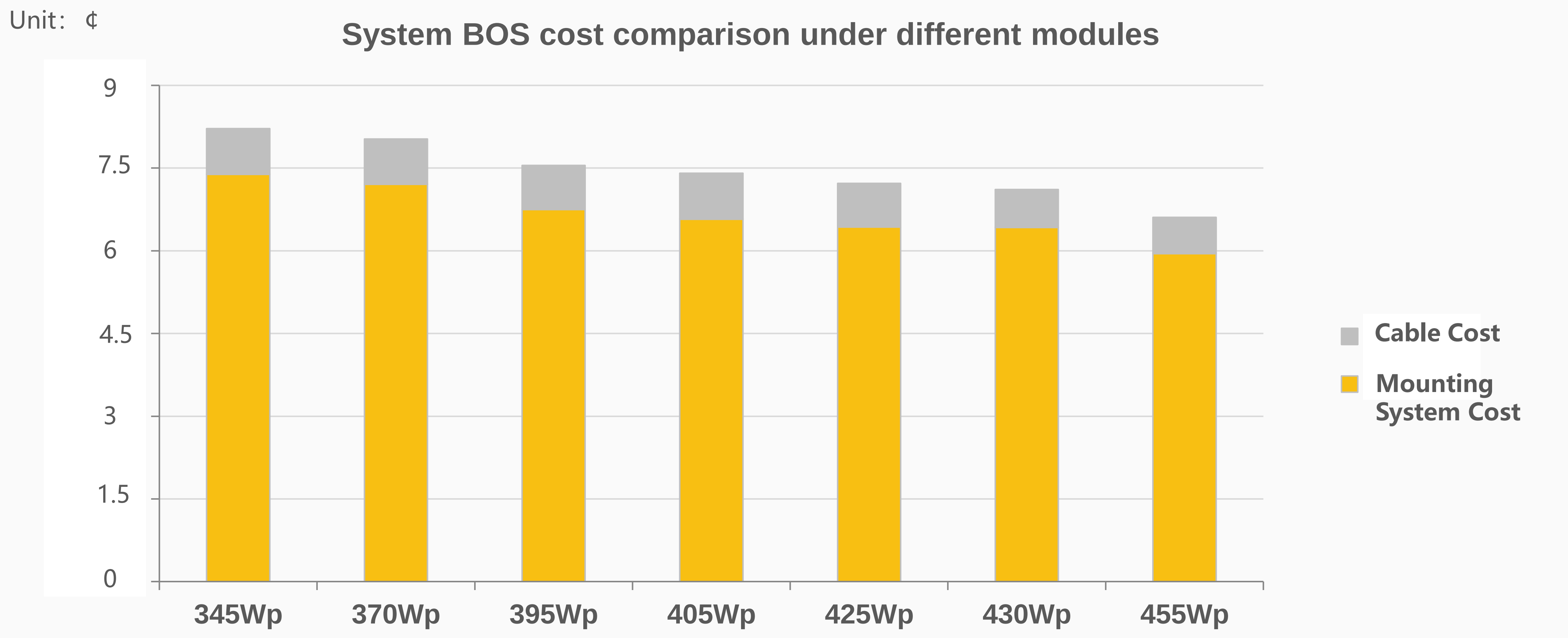
Thank You

www.trinasolar.com

Adapting PV inverters to the new era of 500Wp+ PV modules

Higher PV module power leads to lower system cost

- **Compared to 345Wp, 455Wp modules save cable and mounting system cost 1.6 ¢ /Wp**



Note: The cost of Combiner Box excluded; Unit price refers to China market.

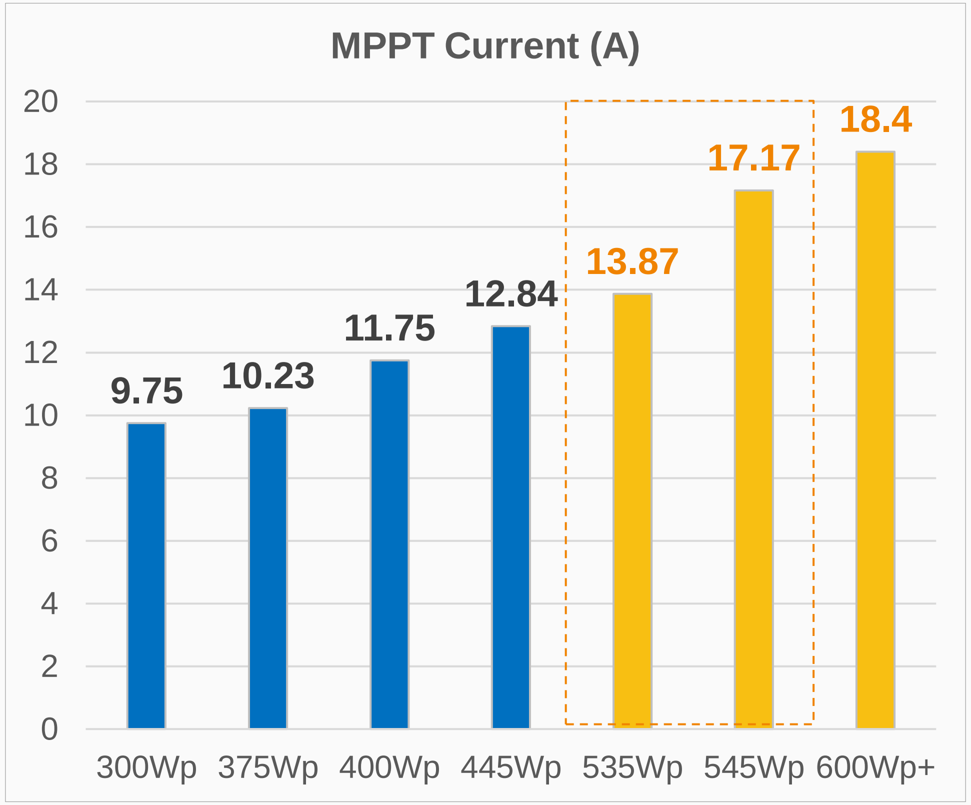
P=V*I: 500W+ PV module means higher voltage or current

Higher Voltage

- Shorter string, more strings, mounting cost increased
- Higher system voltage, need to update system devices and amend standard

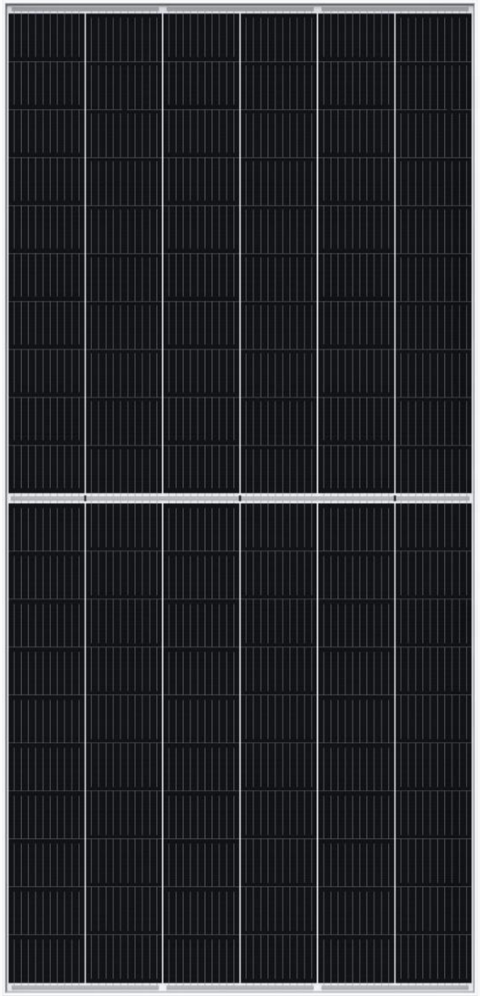
Higher Current

- Longer string, less strings, mounting and cable cost decreased
- Higher string current, higher cable loss, need to updated DC combiner and inverters



1500V system, higher current PV module is more competitive

Inverter solutions for 500W+ PV module era



Central Solution

- For all 500W+ module, fuse **25A/30A** optional
- Combiner 16/20/24 inputs optional, lower DC cable cost

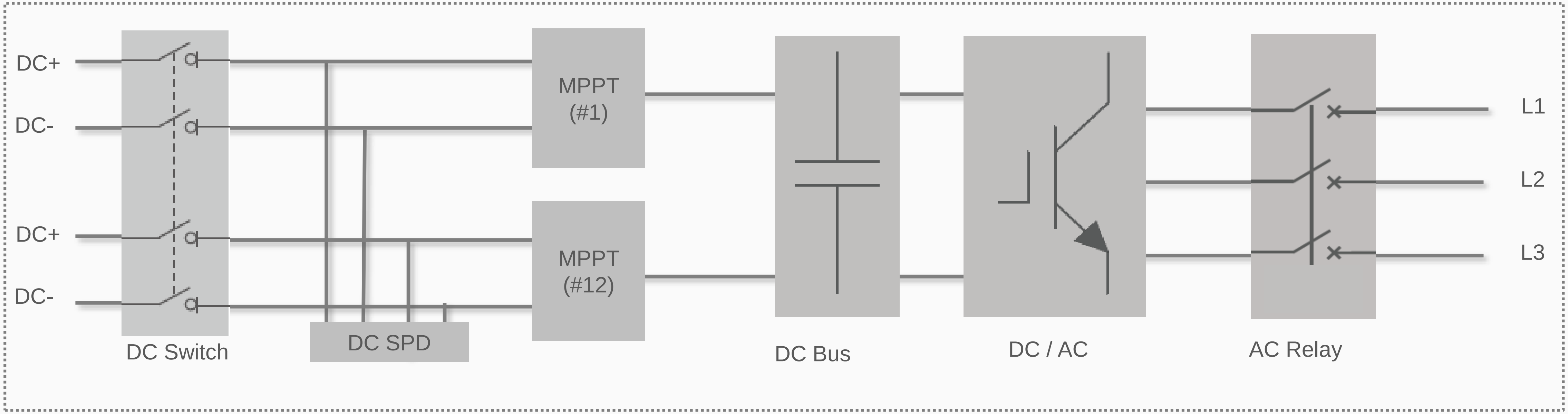
- Inverter 16/18/22 inputs optional, support 1.8 DC/AC ratio

String Solution

- Current inverter can handle **15A** PV string, next is **20A**

- DC / AC ratio up to 1.6, decrease LCOE dramatically

How string inverters match 500W+ PV module era



1

Input Current

Upgrade Max. input current

Wider current detection range

2

MPPT Circuit

IGBT module upgrade

Thermal design of boost module

3

Overall Inverter

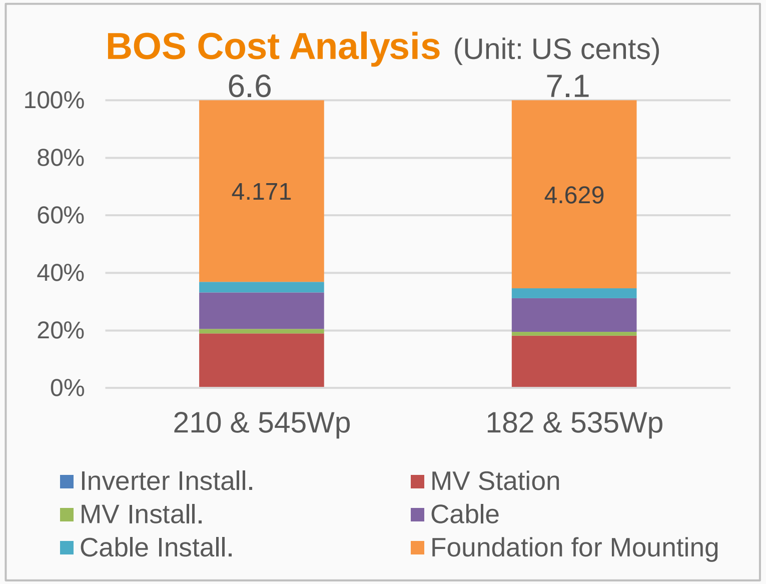
Algorithm and reliability

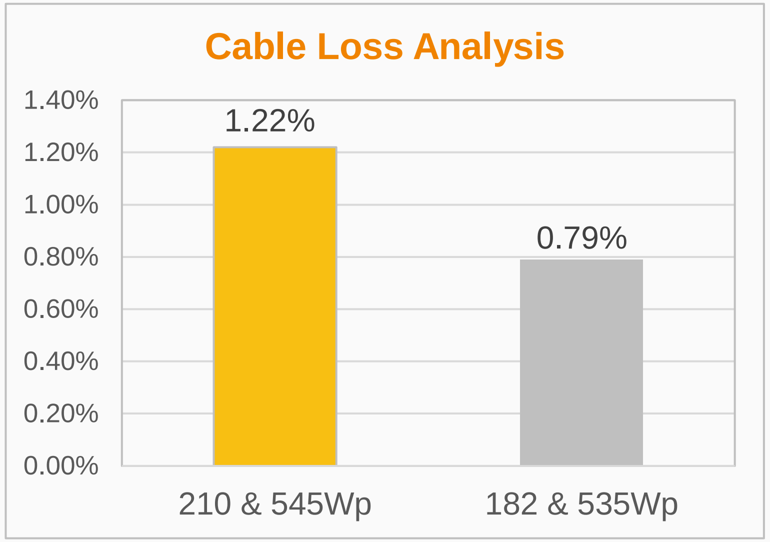
Tests and certification update

Why 500W+ PV modules benefit total PV system

- Lower system cost benefit from high current module
- Lower DC cable loss benefit from high voltage module
- Need to do the balance between cost, efficiency and local conditions

Module	210 & 545Wp	182 & 535Wp
Open Circuit Voltage（V）	38.1	49.35
Short Circuit Current （A）	18.47	13.78
Voltage for Pn（V）	31.7	41.5
Current for Pn（A）	17.17	12.9
Dimensions（mm）	2389*1102	2256*1133
String Design	36 pcs / string	28 pcs / string
Fixed Mounting	2*36 portrait	2*28 portrait
Tracker	2p	2p
Max. DC Voltage（V）	1500V	1500V

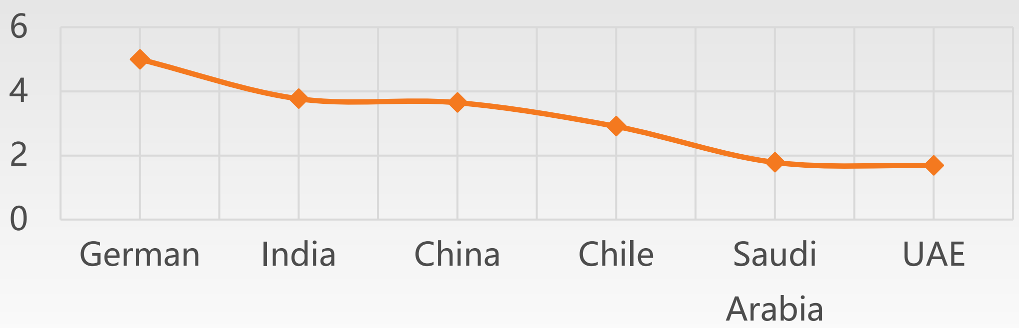




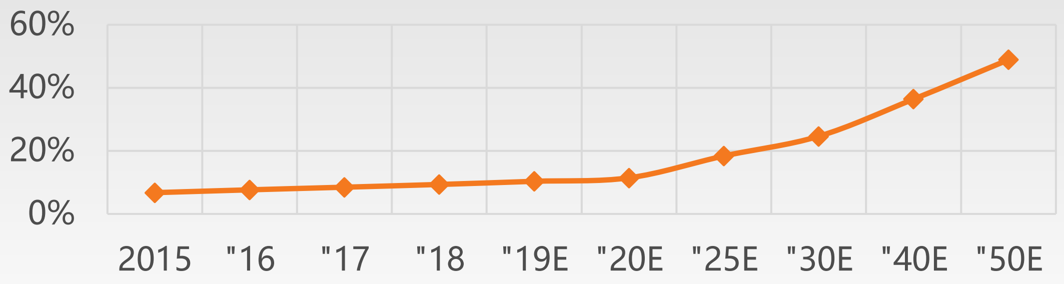
Innovation trends of PV inverters

Two Key-point for System Innovation

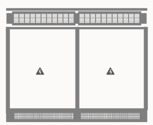
DC Side：Lower LCOE



AC Side：Grid Support, Reliable Connection



- High DC/AC Ratio, Large Capacity
- High Efficiency， High yielding
- All-in-one， Low O&M Cost



- Larger inverter capacity，Less equipment quantity
- Centralized layout, fast delivery
- PV & ESS，Support Grid

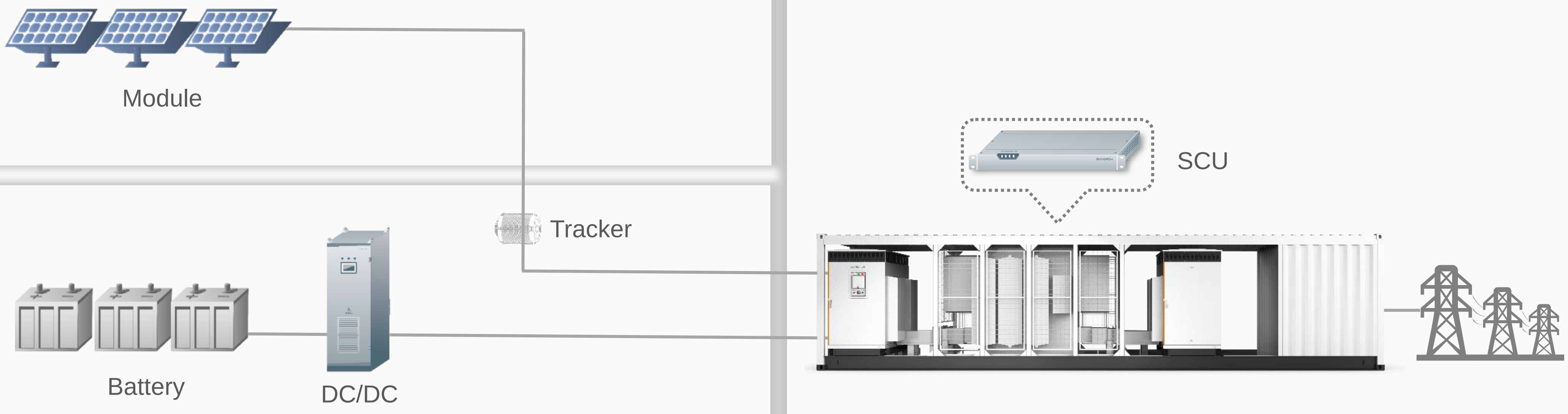
Higher integration and compatibility

1 High Yield

- Advanced three-level technology, max. efficiency 99 %
- Built-in PID solution, 100% repair degradation PV module

3 Safe & Efficient

- Integrated SCU, unified interface, easy O&M
- 24h AC insulation monitoring



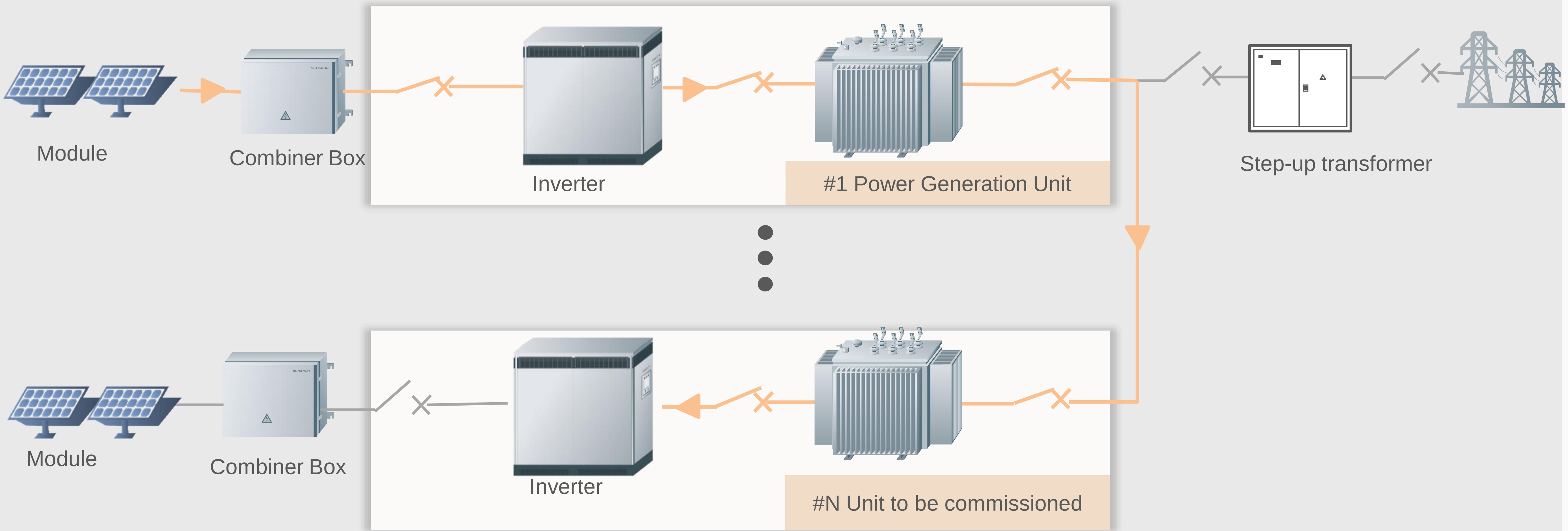
2 Low Cost

- Integrated Aux. Power, supply for tracker system
- DC ESS interface, support reverse charging at half nominal power

4 Grid Support

- Fast power dispatch, Q response time < 30ms
- Stable operation in SCR≥1.2 weak grid

Self-constructed grid for pre-commissioning



- **Self constructed grid for equipment hot-commission before connecting to grid.**

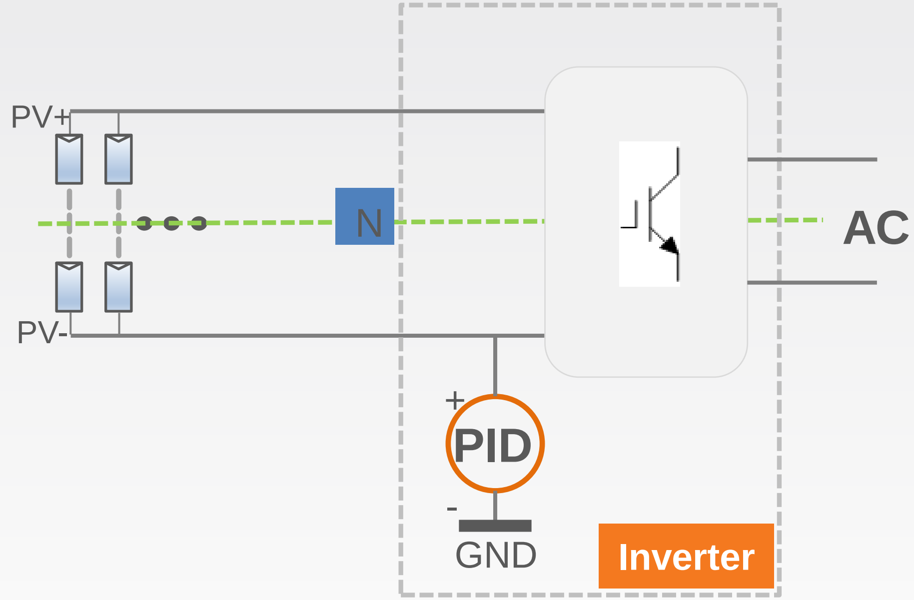
Technical innovation of SG250HX

String Inverter

- Grid parity era is coming, the optimal LCOE is the best choice for PV Plant
- Renewable energy is continuously connected to the power grid, and grid friendliness has become an essential feature of the inverter

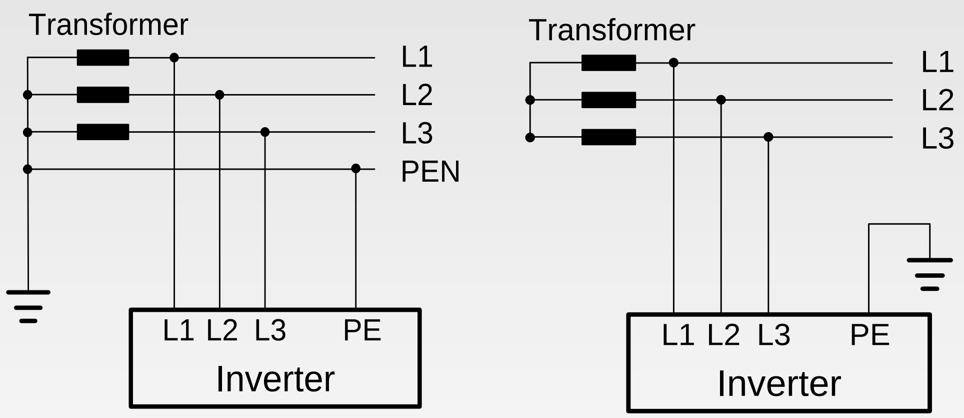
PID 3.0 technology: Higher yield and lower cost

- **DC side PID Lifting**
- Integrated PID recovery function, 10% yield more



- Applied to both **TN** and **IT system**
- **Saving 25% AC cable cost for TN system**

TN: Neutral-grounding **IT: Neutral-floating**

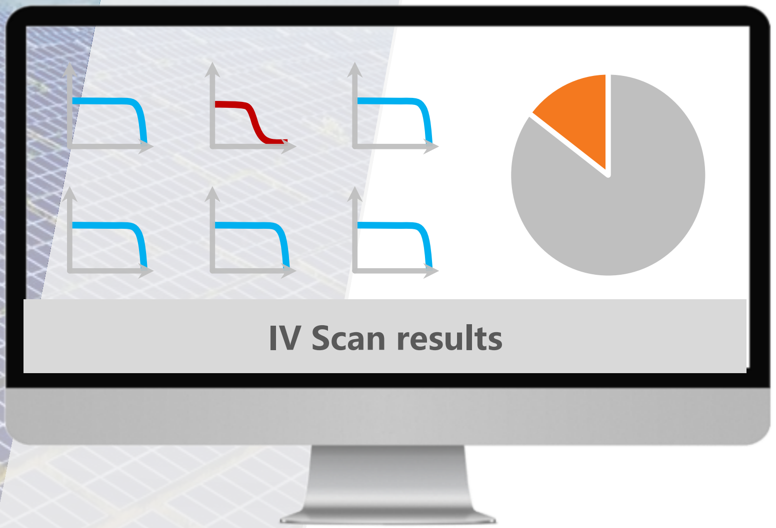


0.6/1.0kV AC cable

1.8/3kV AC cable

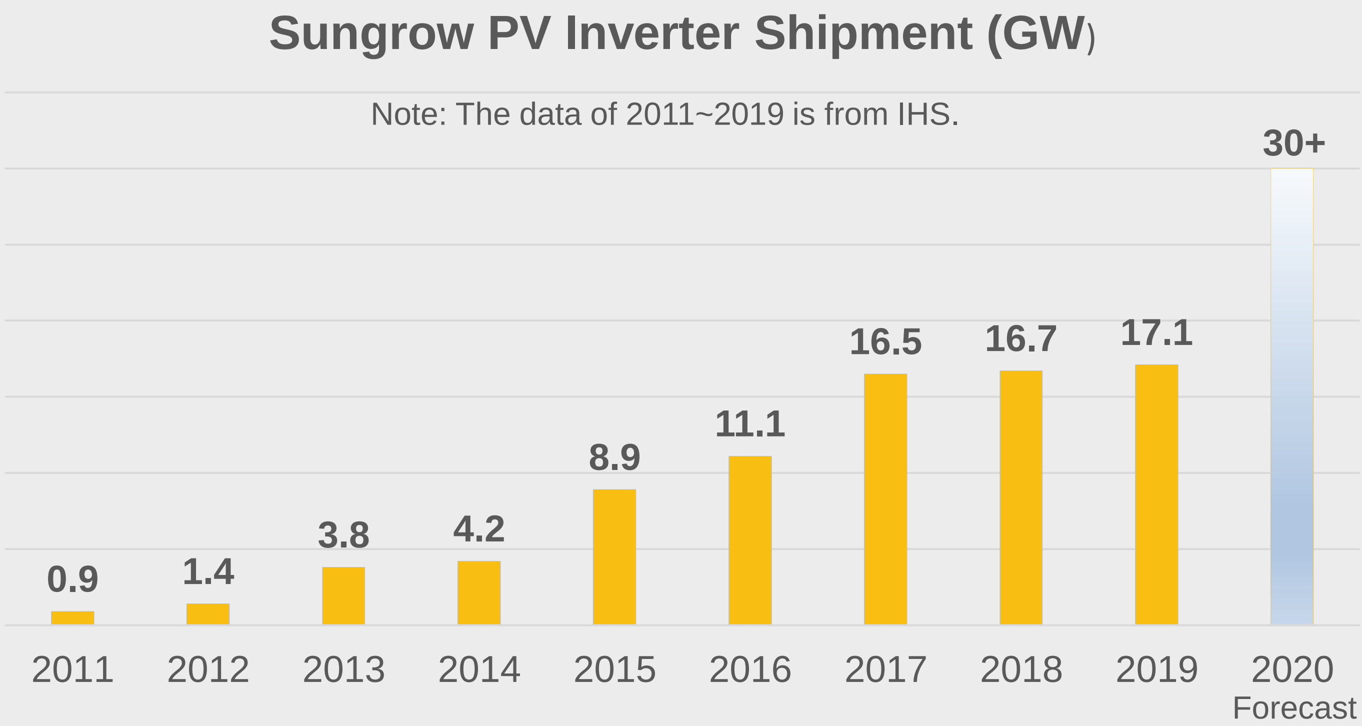
Smart online IV curve Scanning, 100MW in 10-mins


光伏电站测试报告
PV Plant Test Report
阳光云 iSolarCloud 系统 IV 曲线在线诊断功能验证
Sungrow iSolarCloud System Use in PV Plant Monitoring Function Acceptance



17 Fault Categories

Global Leading Inverter Supplier 2015 ~ 2020




SUNGROW
Clean power for all

Trina Vertex module LCOE comparison

MinWah Leung

DNV GL Energy USA, Inc - Solar

17 November 2020

System configuration

Module power	450 W	535 W	545 W
Module		Trina bifacial	
Dimensions L x W [mm]	2111 x 1046	2256 x 1131	2384 x 1096 ↑
Modules/string	27	27	35
# modules	244,350	205,389	201,600 ↓
Inverter		Sungrow SG250HX (string inverter)	
Inverter capacity		225 kWdc	
# inverters		445	
Tracker		NexTracker (1 module portrait)	
Modules per tracker	81 (3 strings)	81 (3 strings)	70 (2 strings)
Tracker length [m]	85.1	92.2	77.4 ↓
# trackers	3,017	2,536	2,880 ↑
Transformers		44 x 2.5 MW 1 x 1.5 MW	
DC Capacity		110 MWdc	
AC Capacity		100 Mwac	
DC/AC ratio		1.1	
Pitch [m]	6.55	7.00	7.41
Ground cover ratio (GCR)		32%	

- 545 W Vertex module: low voltage, high current
  - More modules per string, fewer # of modules
  - Tracker can't support as many larger modules -> shorter trackers -> more trackers
- Same DC & AC system capacity
- Same GCR: maintain bifacial & shading impacts

Increase from prior module rating ↑

Decrease from prior module rating ↓

Vertex module considerations

Inverters

	450 W	535 W	545 W
Cell size	166mm	182mm	210mm
Cell cut	Half cut	Half cut	Third cut
Isc	11.4 A	12.9 A	18.4 A
Voc	49.5 V	51.5 V	37.9 V

Inverter string input now typically 15 A, future need to design for 20 A strings to be compatible with larger modules

Compared to 535W, <u>shorter DC homerun wiring</u> (each string has more modules), <u>longer AC wiring</u>

Item	450 Wp	535 Wp	545Wp
DC cabling length [m]	953,243	775,721	511,609
compare 535W			-34%
AC LV cabling length [m]	154,213	138,668	165,628
compare 535W			19%
AC MV cabling length [m]	35,382	33,740	36,283
compare 535W			8%

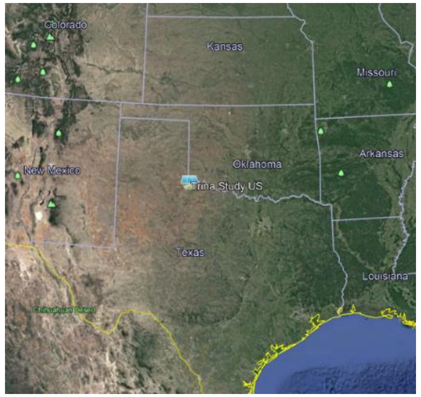
Wire length

PVTECH TECHTalk

Energy model

Seville, Spain (37.27°, -5.74°)

Texas, USA (34.36°, -99.89°)



	Seville, Spain			Texas, USA			
	450 W	535 W	545W	450 W	535 W	545 W	
Global horizontal irradiation		1,855 kWh/m²/yr			1,865 kWh/m²/yr		
Diffuse horizontal irradiation		605 kWh/m²/yr			567 kWh/m²/yr		
Ambient Temperature		18.9 °C			17.5 °C		
Global irradiation plane-of-array		2,506 kWh/m²/yr			2,540 kWh/m²/yr		
Soiling		-1.4%			-1.0%		2 washes / year
Ground reflection on front side		0.0%			0.0%		albedo 0.2
Bifacial energy gain	+5.8%	+5.6%	+5.4%	+5.5%	+5.4%	+5.3%	
Irradiance	-0.2%	+0.4%	0.3%	-0.2%	+0.3%	+0.2%	
Temperature	-6.0%	-5.9%	-5.8%	-5.9%	-5.8%	-5.6%	
Module quality	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	
Light induced degradation		-1.5%			-1.5%		
Mismatch		-0.5%			-0.5%		
Mismatch for back irradiance		-0.7%			-0.1%		
DC Ohmic	-0.5%	-0.6%	-0.8%	-0.6%	-0.7%	-0.9%	
Low irradiance efficiency fall off	-0.2%	+0.4%	+0.3%	-0.2%	+0.3%	+0.2%	
AC Ohmic	-0.8%	-0.7%	-0.5%	-0.8%	-0.7%	-0.5%	
Transformer losses		-2.1%			-2.1%		
Auxiliary losses		-0.3%			-0.3%		
System unavailability		-0.8%			-0.8%		
Yield Factor [kWh/kWp]	2,239	2,249	2,249	2,263	2,275	2,274	

Energy increase w/ module power

Energy decrease w/ module power

DC/AC wire losses balance out, similar energy yield factor

DNV·GL

LCOE comparison results

- EPC cost decrease for 545 W
  - Fewer modules, higher power rating for same module price
  - Overall 545 W has less tracker material
  - Less DC wiring and cost of DC cable lower
- OPEX, development fees same

Takeaways

- The LCOE cost for 545 W modules lower than 535 W.
- LCOE could be even lower when trackers optimized to fit 3 modules per string
- This calculation assumes inverters can have higher string input 20A, but product not available yet.

$$\text{LCOE} = \frac{Cost}{Energy}$$

	Seville, Spain Euro €/Wp			Texas, USA USD $/Wp		
	450 W	535 W	545 W	450 W	535 W	545 W
Module		0.1932			0.3200	
Inverter		0.0257			0.0279	
Tracker & mounting	0.1000	0.0896	0.0885	0.1260	0.1124	0.1115
EPC cost	0.5268	0.5079	0.5052	0.9533	0.9222	0.9132
Development		0.1138			0.1567	
CAPEX	0.6406	0.6217	0.6190	1.1099	1.0788	1.0699
Land		0.0017			0.0033	
O&M fee		0.0150			0.0082	
Asset management		0.0020			0.0015	
OPEX		0.0187			0.0130	
		Euro €/kWh			USD $/kWh	
LCOE	0.0366	0.0357	0.0356	0.0451	0.0437	0.0435
LCOE compare 450 W		-2.5%	-2.8%		-3.0%	-3.5%

[1] Cost estimations based on similar projects in Spain and USA. Tracker costs provided by NexTracker based on tracker estimated tracker dimension changes for similar 545 W modules

[2] Results comparable to industry reports system pricing. Wood Mackenzie, U.S. Solar PV System Cost Model, H1 2020

Questions?

MinWah Leung
minwah.leung@dnvgl.com

www.dnvgl.com

SAFER, SMARTER, GREENER