WEBINAR | PVTECH | February 1, 2024

TrinaTracker

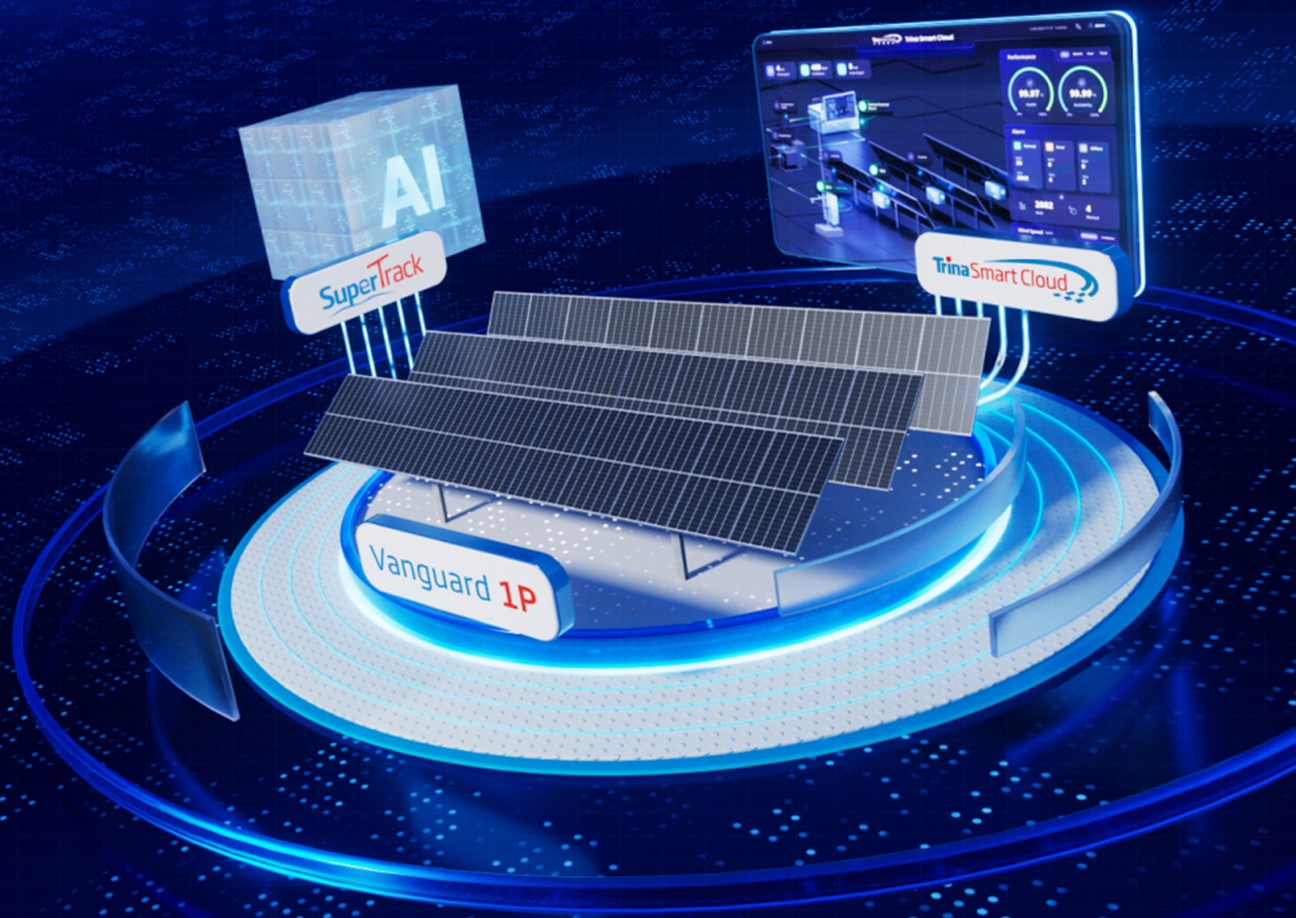
Maximising Solar Efficiency: Innovations in TrinaTracker's Smart Solution

Sun Kai
Head of Smart Tracking Technology
TrinaTracker

Daniel Tobalina
Senior R&D Mechanical Engineer
TrinaTracker

Parsa Enshaei
Senior Engineer
CPP WIND ENGINEERING CONSULTANTS

Moderated by Ben Willis
Editor in Chief
PVTECH SOLAR MEDIA



Trinasolar

TrinaTracker

Maximising Solar Efficiency:
Innovations in Trina Tracker's Smart Solution

February 1, 2024

Index

1 Upgraded Vanguard 1P Smart Tracking Solution

Global References & GloCal supply chain

Continual Sales	Delivered	Countries	Global Production Capability
19 years	9GW+	40+	10GW+

System Reliability & Bankability

Vanguard 1P

DNV

Bankability report

- Manufacturer capabilities and experience in the market
- Product evaluation
- Supply chain
- Quality process controls
- Reliability, warranty and contractual conditions

SGS

UL certification

- UL3703 certification

TÜV SÜD

IEC certification

- IEC62817 certification

cpp

WTT

- Pressure study
- Free vibration test
- Aeroelastic study
- 2D sectional model test
- Slope study

TrinaTracker

Empirical test

- European and China region full size tracker operation tightening test
- Installation, operation and maintenance construction convenience test
- The matching test of cleaning robot's obstacle crossing ability
- Intelligent tracking algorithm matching test

Tracker Application Scenarios

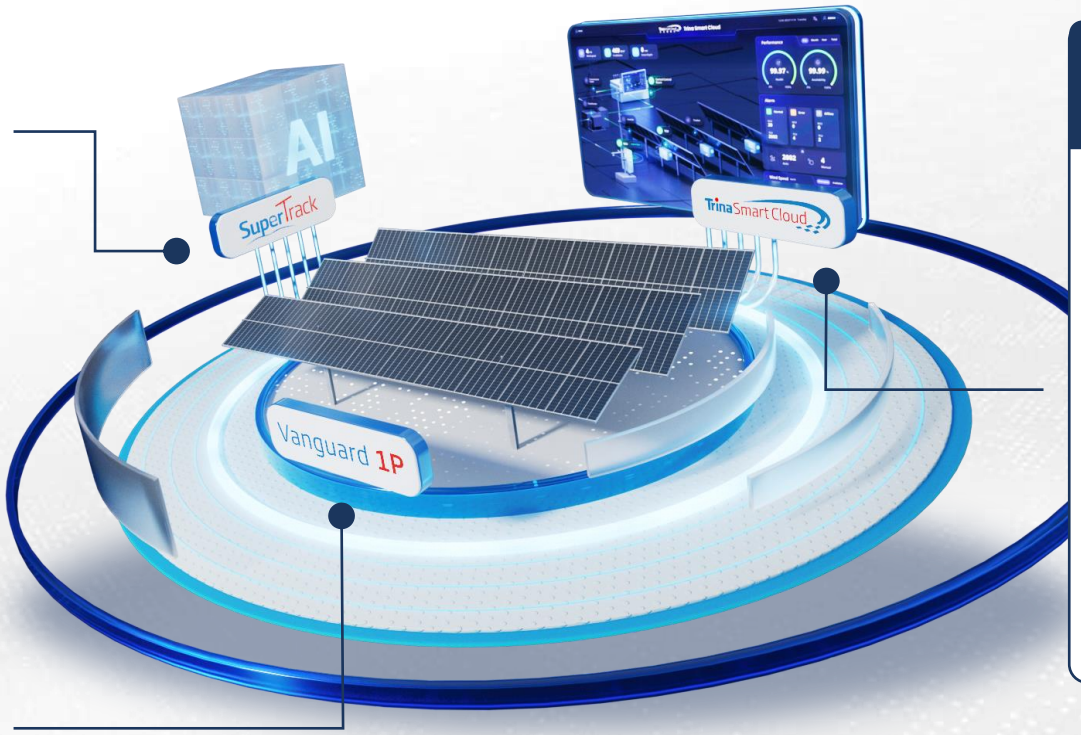
SuperTrack

Integrates a proprietary smart algorithm that increases energy gain in:

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

Upgraded Vanguard 1P

- Optimal adaptation to large, flat terrains
- Validated reliability in extreme weather conditions
- Compatible with all modules available in the market



Trina Smart Cloud (SCADA)

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


TrinaTracker
0:01 / 1:14
1x

2 Upgraded Vanguard 1P Enhances Tracker Performance

Upgraded Vanguard 1P- 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?

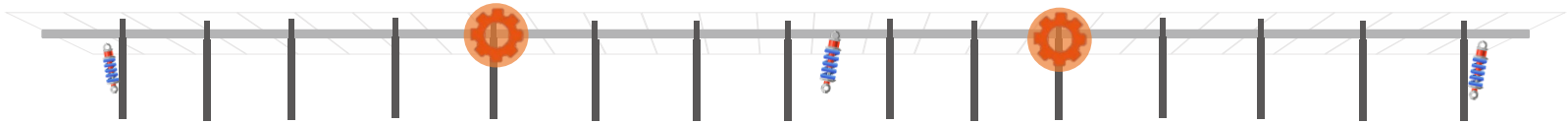
Tracker Scenario Pain Points

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?

Standard Vanguard 1P

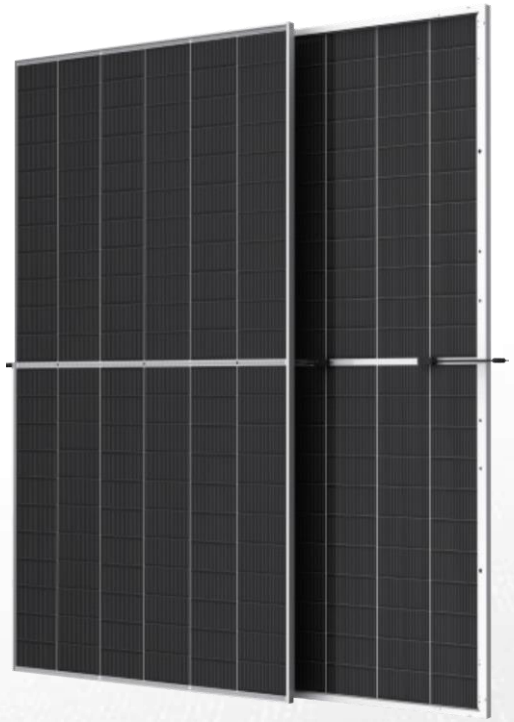
- 100 m
- 2 strings of Trina 210 modules & 3 strings 182 modules
- Single slewing drive + bi-damper system

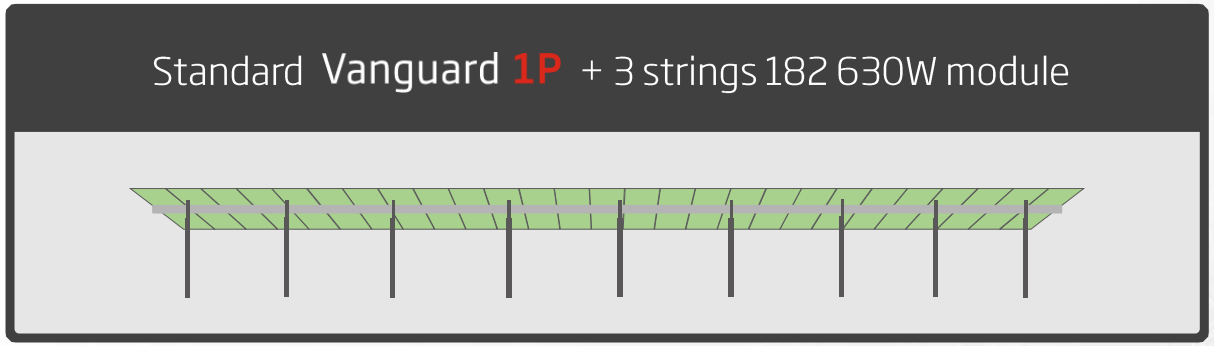


Upgraded Vanguard 1P

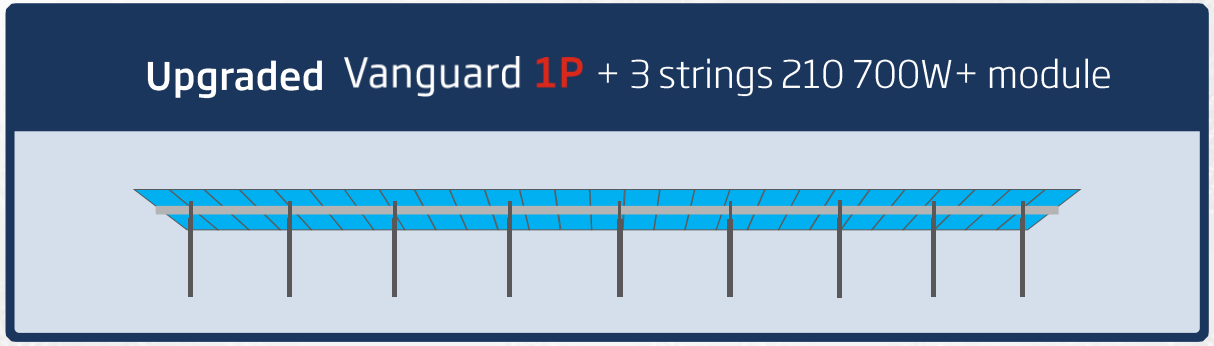
- 140 m
- 3 strings of Trina 210 modules & 4 strings 182 modules
- Multi-slewing drive + bi-damper system

Device Adaptability - Module Compatibility





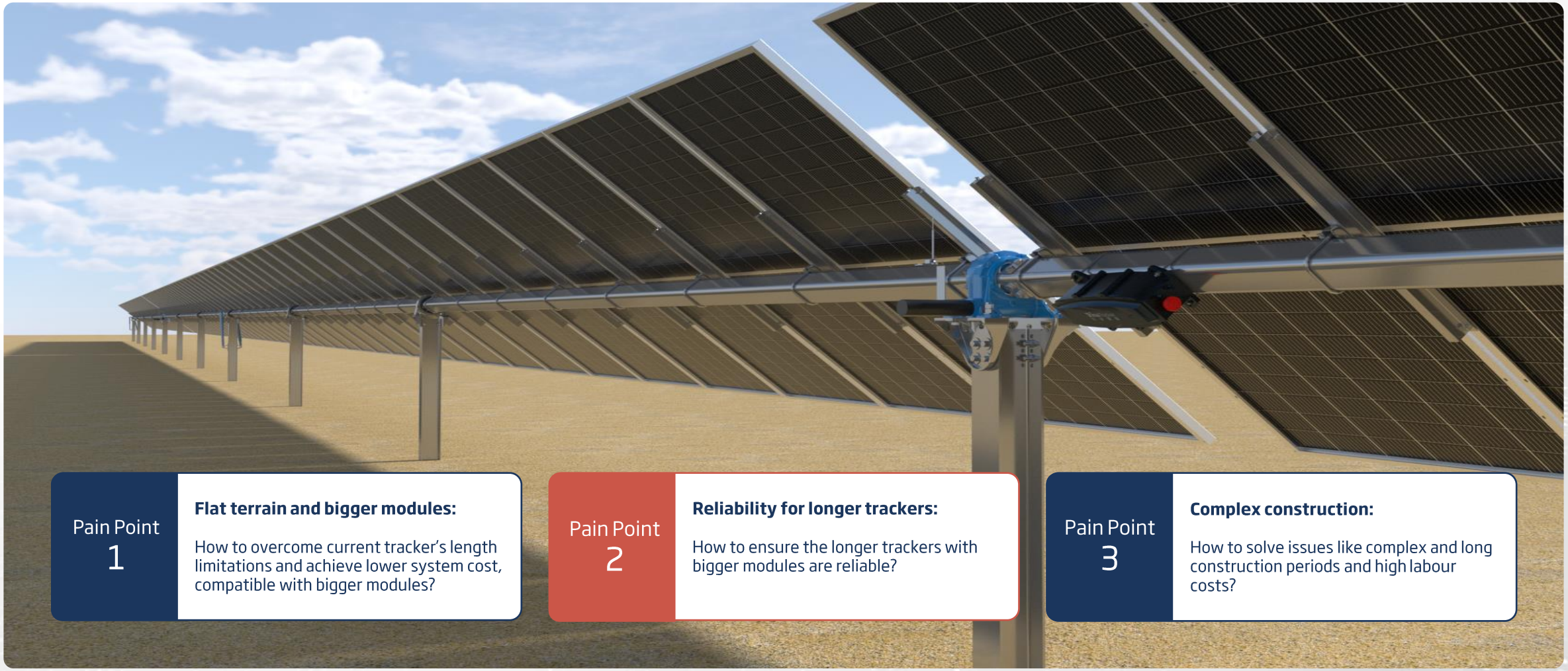
- 182 630W 26 modules/ string
- 1P tracker length: ~ 90m



- 210 700W+ 30 modules/ string
- 1P tracker length: ~ 119.0m

Configuration	Standard Vanguard 1P + 182 630W module	Upgraded Vanguard + 210 700W+ module
Length	90 m	119 m
Capacity/ Tracker	49140 W	63000 W
Tracker Cost	BL	-2%

Upgraded Vanguard 1P- Fully Solves Scenario Pain Points

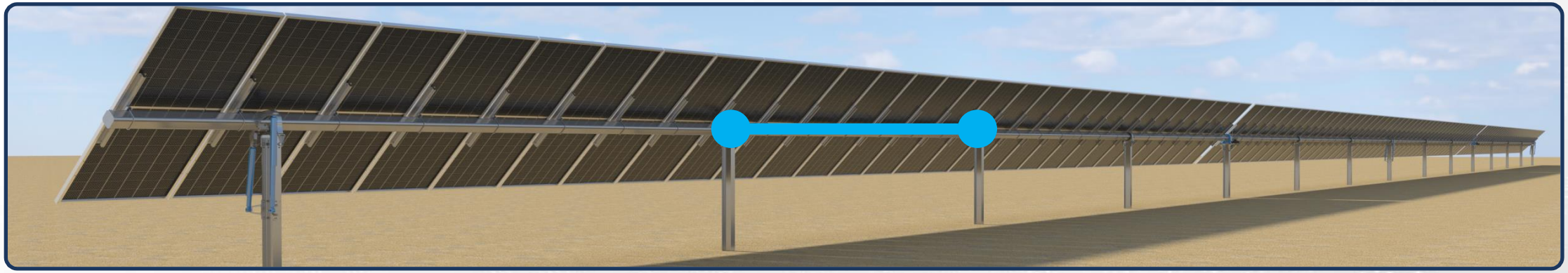


Pain Point 1	Pain Point 2	Pain Point 3
Flat terrain and bigger modules: How to overcome current tracker's length limitations and achieve lower system cost, compatible with bigger modules?	**Reliability for longer trackers:** How to ensure the longer trackers with bigger modules are reliable?	**Complex construction:** How to solve issues like complex and long construction periods and high labour costs?

Tracker Scenario Pain Points

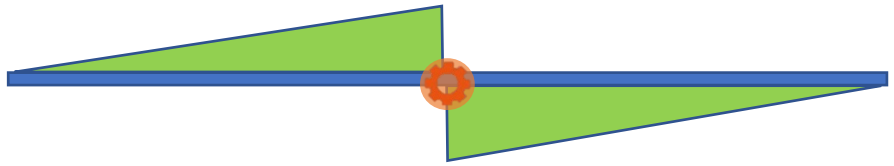
Pain point 2

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



Single Drive

- Longer tracker, bigger torque peak
- Less critical wind speed



Multi-Drive

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

Tracker Scenario Pain Points

Pain point 2

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

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

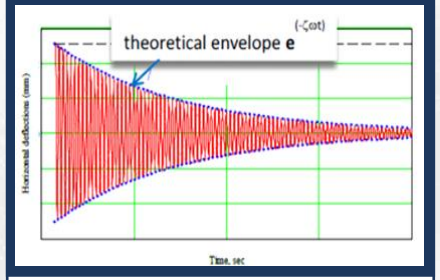
L1 Pressure Study

Model: Rigid tracker model

Output: Static, pressure coefficient, torque coefficient, DAF

Application: Main beam, column, purlin

L2 Free Vibration Test



Model: Full-size tracker

Output: Natural frequency and damping ratio in torsion and vertical bending directions

Application: Matching of dampers

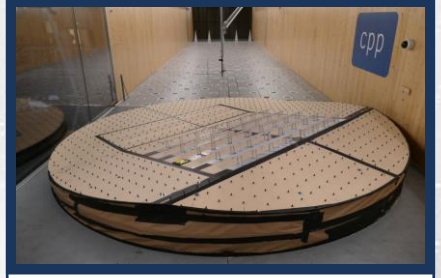
L3 Aeroelastic Study

Model: Flexible tracker model

Output: Minimum critical wind speed

Application: Extreme weather protection strategies

L4 Slope Study



Model: Tracker model

Output: Different EW slopes

Application: Inner and outer perimeter ratio of the tracker

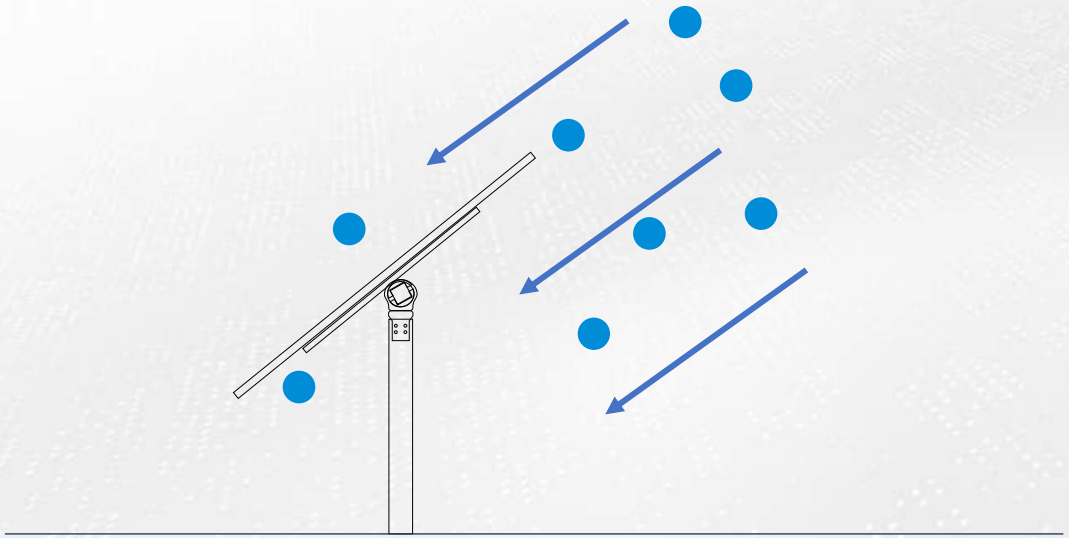
Tracker Scenario Pain Points

Pain point 2

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

Large Hail Protection Angle

After the hail protection feature 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.

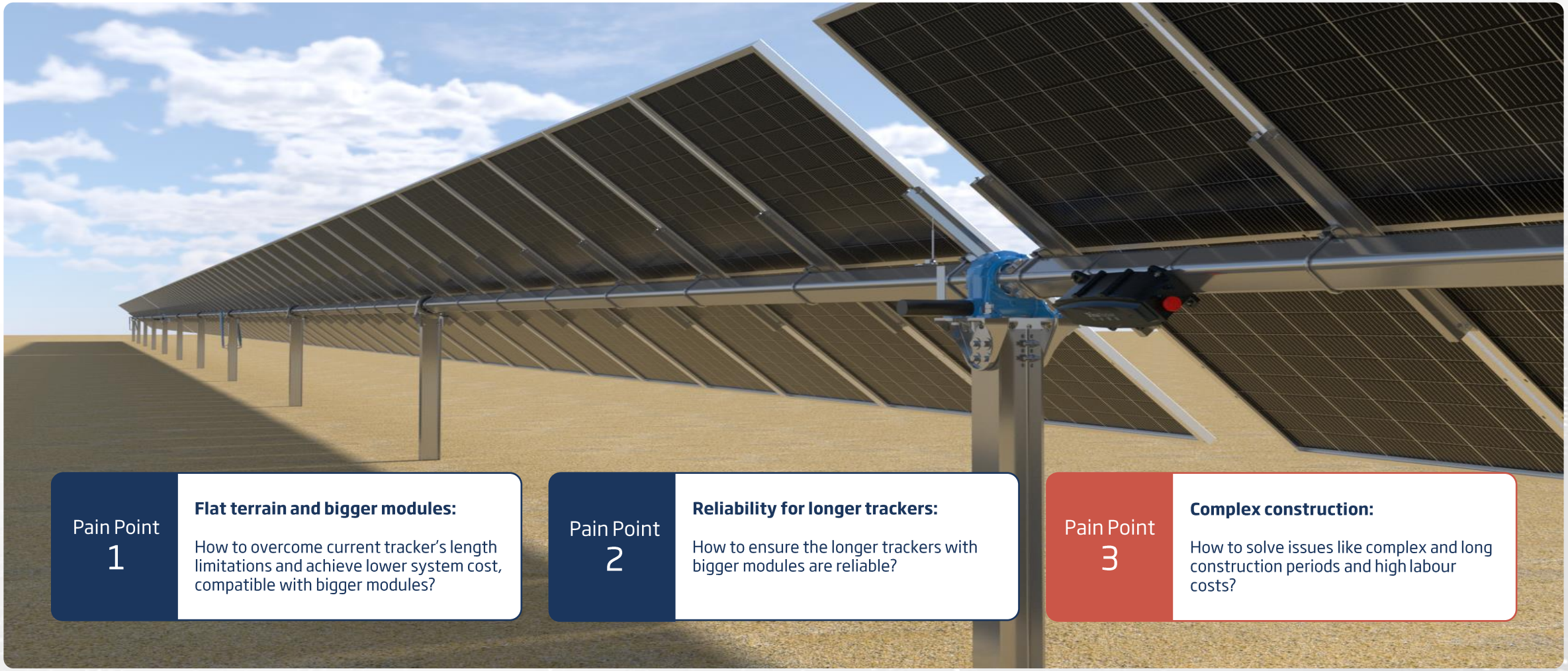


Upgraded Vanguard 1P wind protect feature

Level	Wind speed (3s)	Stow position
1 (low)	12m/s - 15m/s	+15 to +60° or -15 to -60°
2 (medium)	15m/s - 20m/s	+30 to +60° or -30 to -60°
3 (high)	>20m/s	±30°

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

Upgraded Vanguard 1P- Fully Solves Scenario Pain Points



Pain Point 1	Pain Point 2	Pain Point 3
Flat terrain and bigger modules: How to overcome current tracker's length limitations and achieve lower system cost, compatible with bigger modules?	**Reliability for longer trackers:** How to ensure the longer trackers with bigger modules are reliable?	**Complex construction:** How to solve issues like complex and long construction periods and high labour costs?

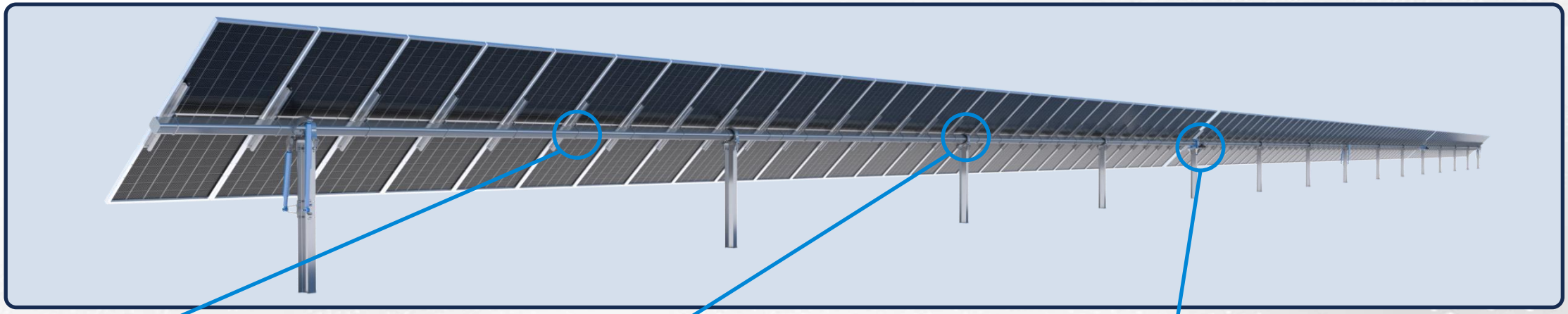
Tracker Scenario Pain Points

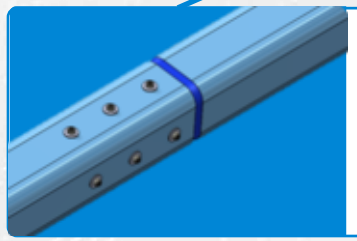
Pain point 3

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

Grid connection time is tight and the construction environment is harsh. How to improve the installation efficiency?

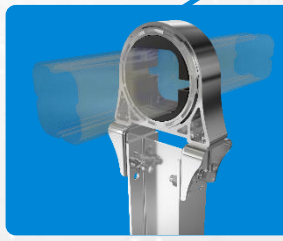
- Quick installation requirements





Shrink tube

Save 50% tube connection time



Patented spherical bearing

Spherical bearing design - no installation calibration required

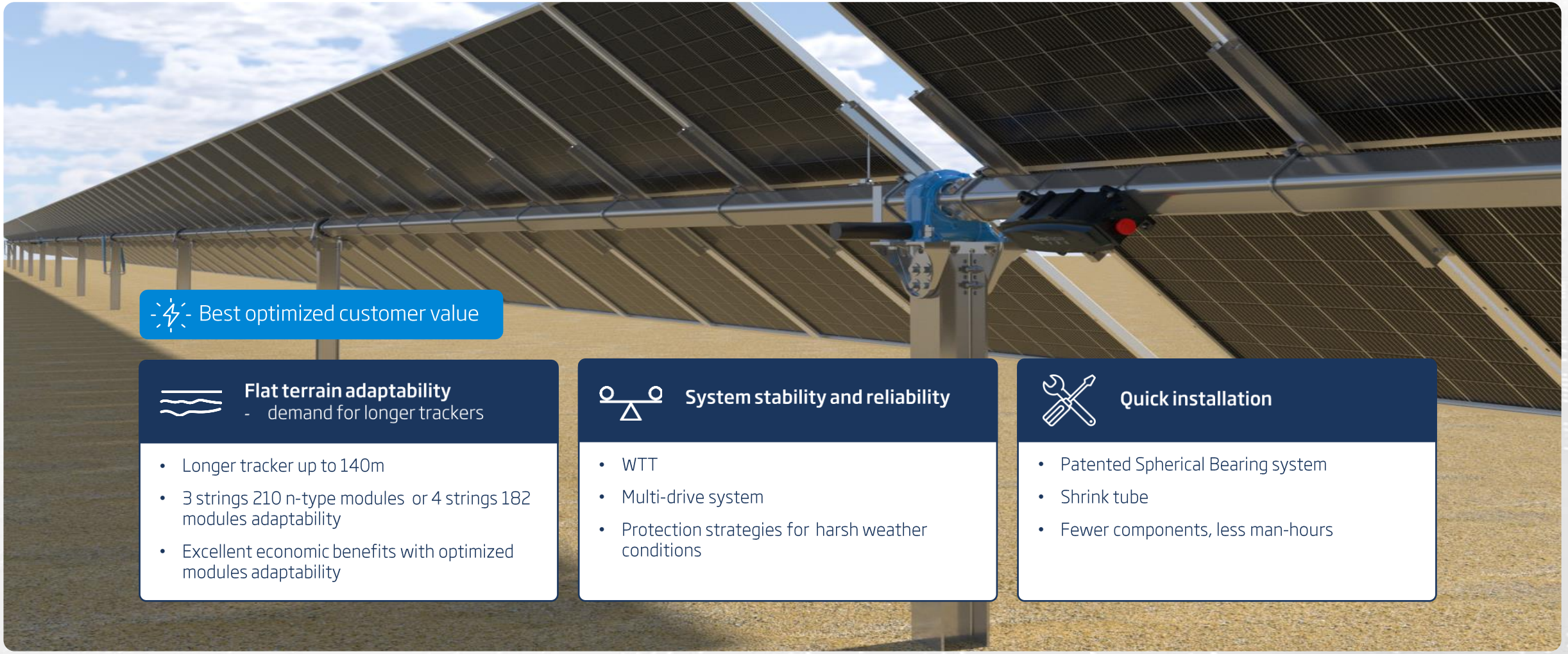
Multi-motor system

Compared with the standard mechanical multi-drive tracker needs 34% fewer components

3 Value for Customers

Summary of Values

Upgraded Vanguard 1P



Best optimized customer value

Flat terrain adaptability
- demand for longer trackers

- Longer tracker up to 140m
- 3 strings 210 n-type modules or 4 strings 182 modules adaptability
- Excellent economic benefits with optimized modules adaptability

System stability and reliability

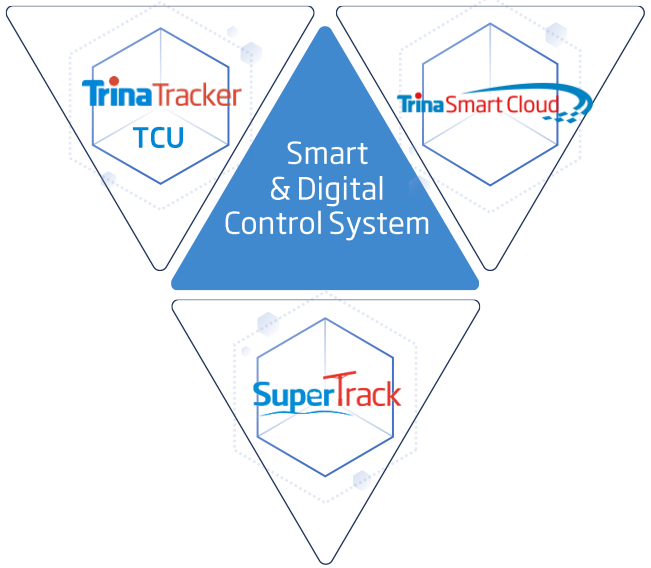
- WTT
- Multi-drive system
- Protection strategies for harsh weather conditions

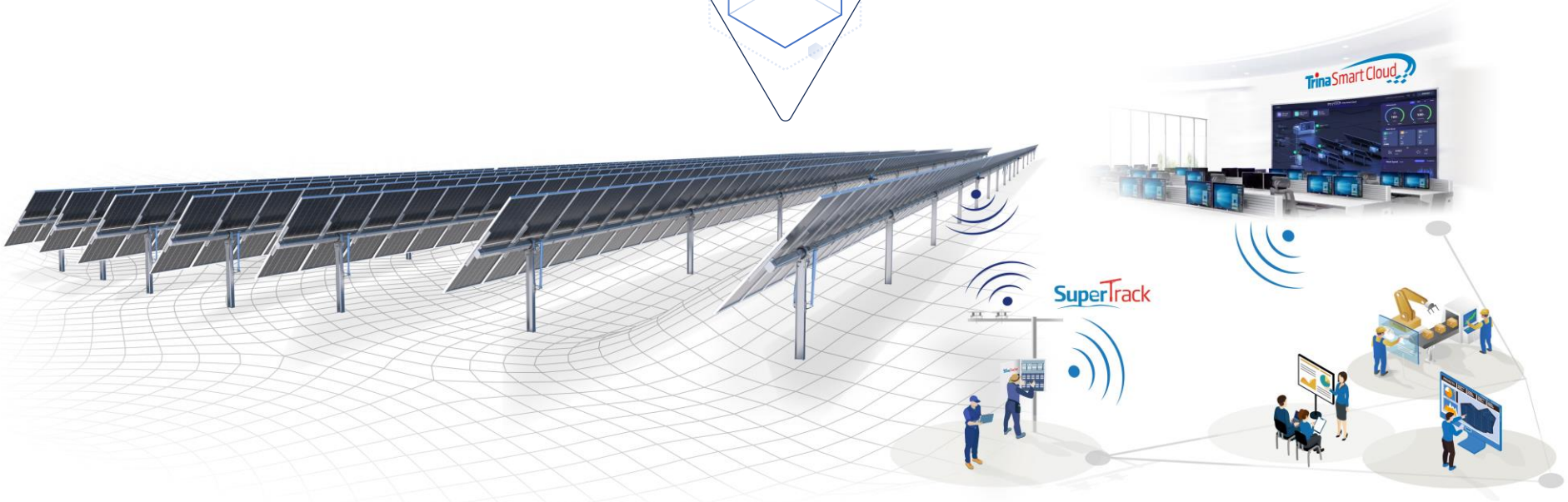
Quick installation

- Patented Spherical Bearing system
- Shrink tube
- Fewer components, less man-hours

Device Adaptability-Smart Control System

Designed to be compared with Vanguard 1P





Thank You!

Get in touch with:

Daniel Tobalina
Senior R&D
Mechanical Engineer

CPP WIND ENGINEERING CONSULTANTS

TrinaTracker
A Business Unit of Trina Solar

Wind Tunnel Testing of Solar Structures

TrinaTracker Webinar, 1st February 2024

Parsa Enshaei
penshaei@cppwind.com

TrinaTracker
A Business Unit of Trina Solar

Who We Are

- *Offices around the world – United States, Australia, Canada, Malaysia, India, UAE*
- *Experimental and computational capabilities*
- *Four wind tunnels - Two in the US, one in Australia, one in Malaysia*
- *Range of services with a focus on wind loads on tall buildings, outdoor and indoor wind environment, and solar structures*

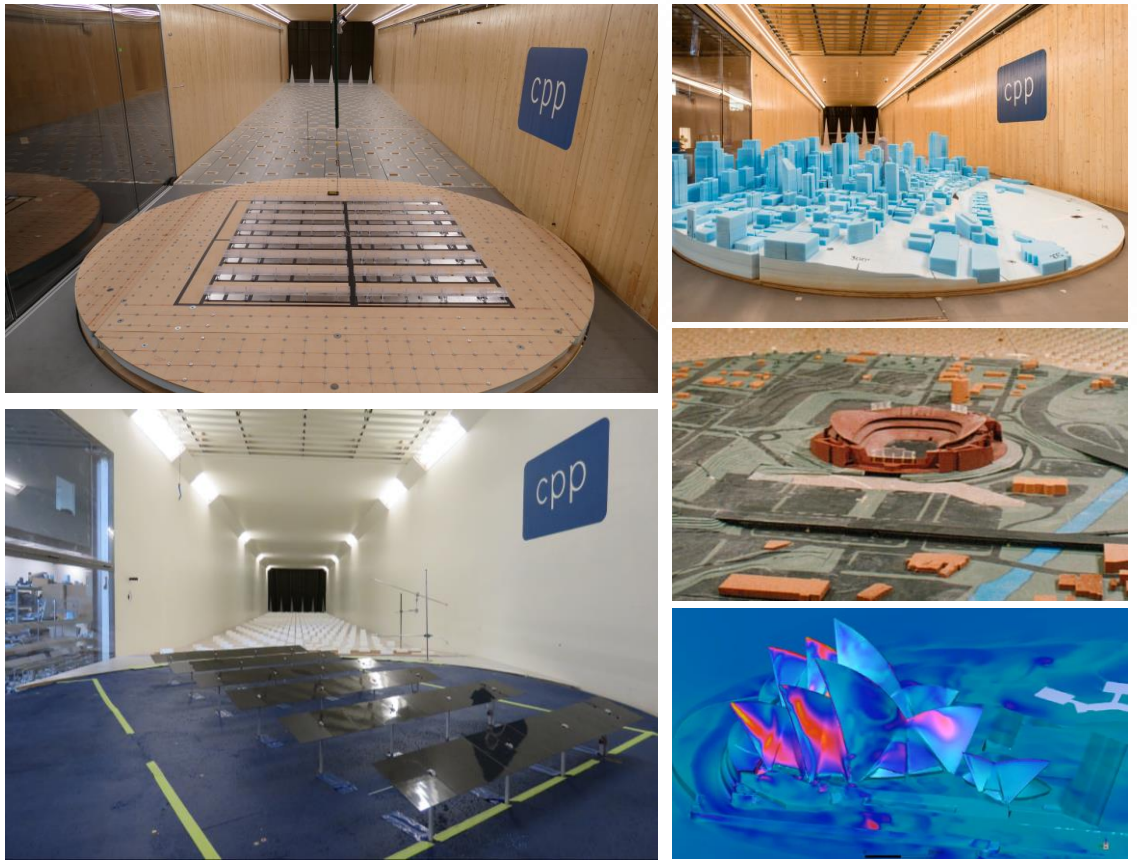
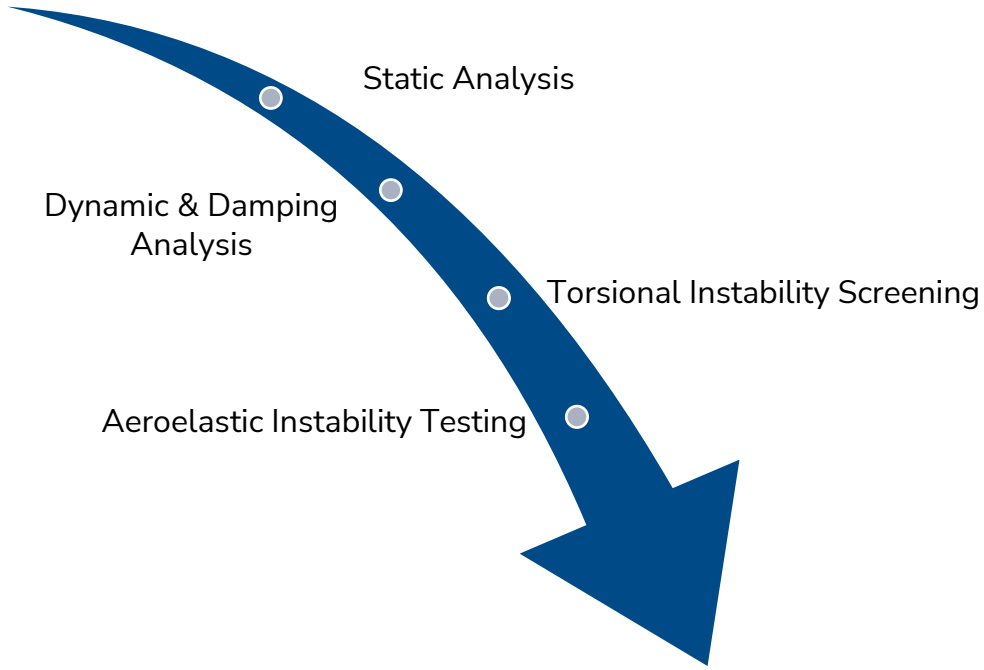


***Figure**: CPP services across different sectors*

TrinaTracker
A Business Unit of Trina Solar

Solar Services

- *Product Test Types:*
  - Rigid pressure tests
  - Aeroelastic instability



Safe & Economical Design

TrinaTracker
A Business Unit of Trina Solar

Pressure Tests

- *Assumed-static analysis for normal forces and moments*
  - Not accurately covered in wind codes
  - Extensive database for trackers
  - Gap adjustment factors
- *Dynamic (resonant) effects can amplify loads*
  - Not covered in wind codes
  - Understanding damping levels are important

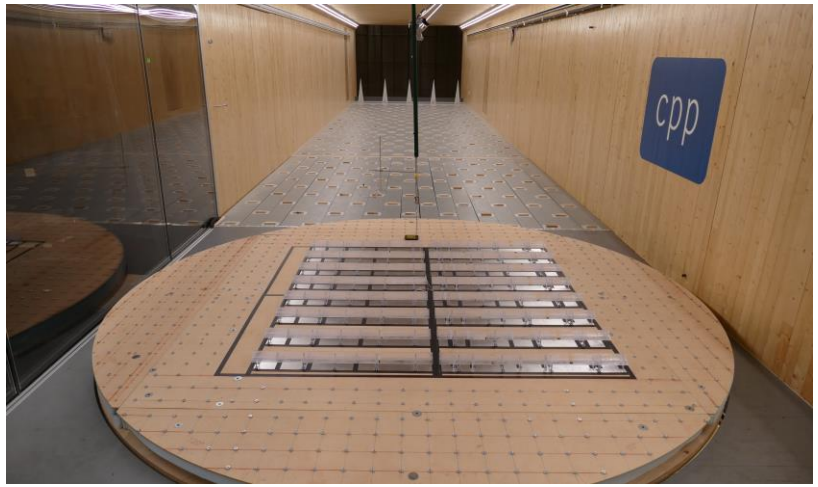
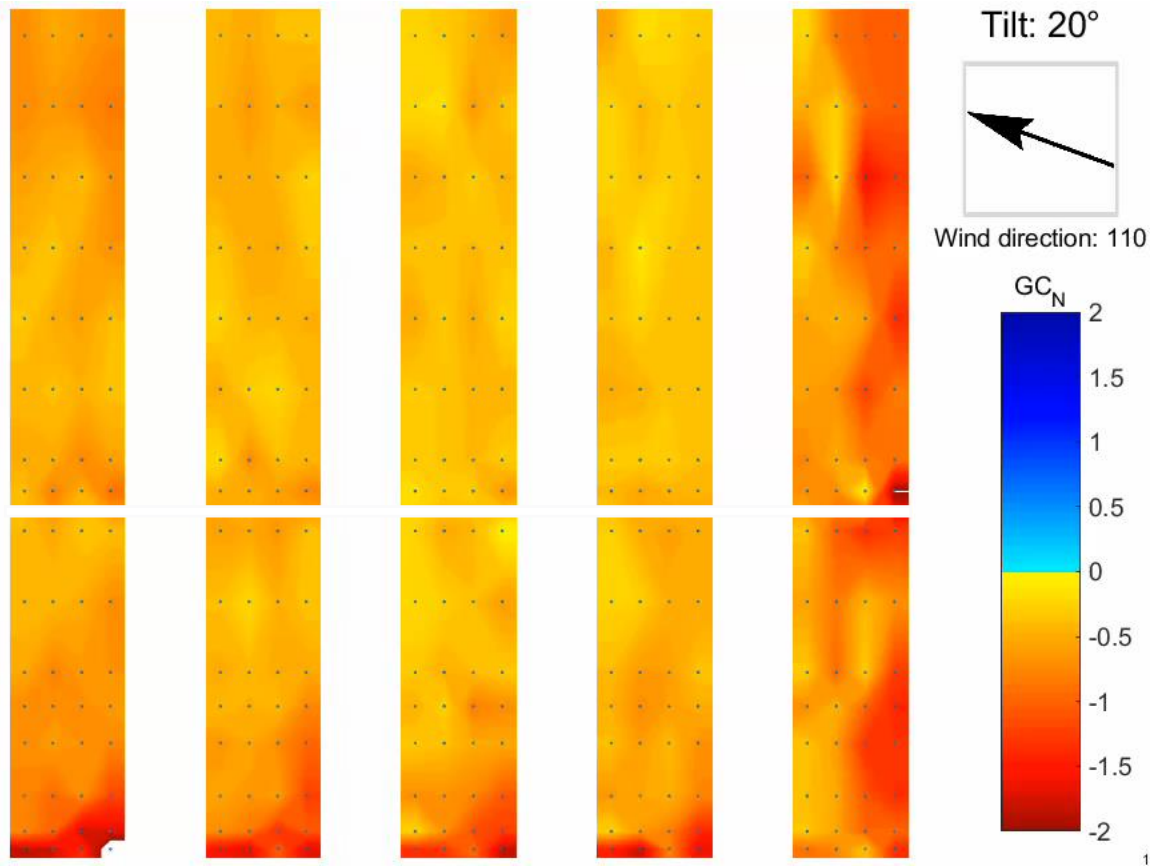


***Figure**: Pressure testing of solar trackers*

***Figure**: Vortex shedding across rows of solar trackers*

TrinaTracker
A Business Unit of Trina Solar

Pressure Tests

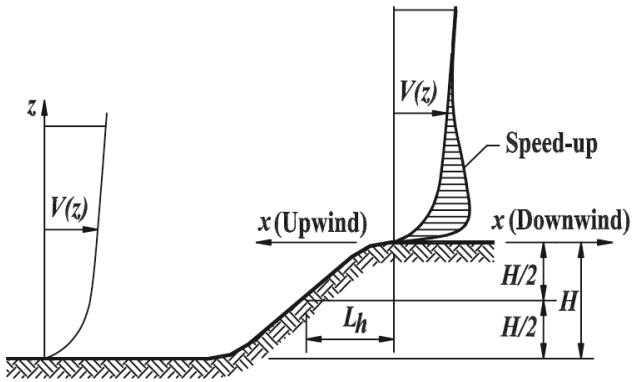


Video: *Timeseries for fluctuating pressures*

TrinaTracker
A Business Unit of Trina Solar

Topography

- *Code targets wind speed up*
- *Loss of shelter and flow angle not accounted for*



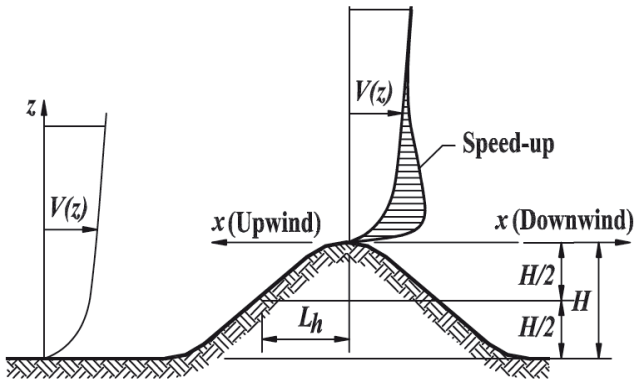


***Figure**: Slope dimension conventions*

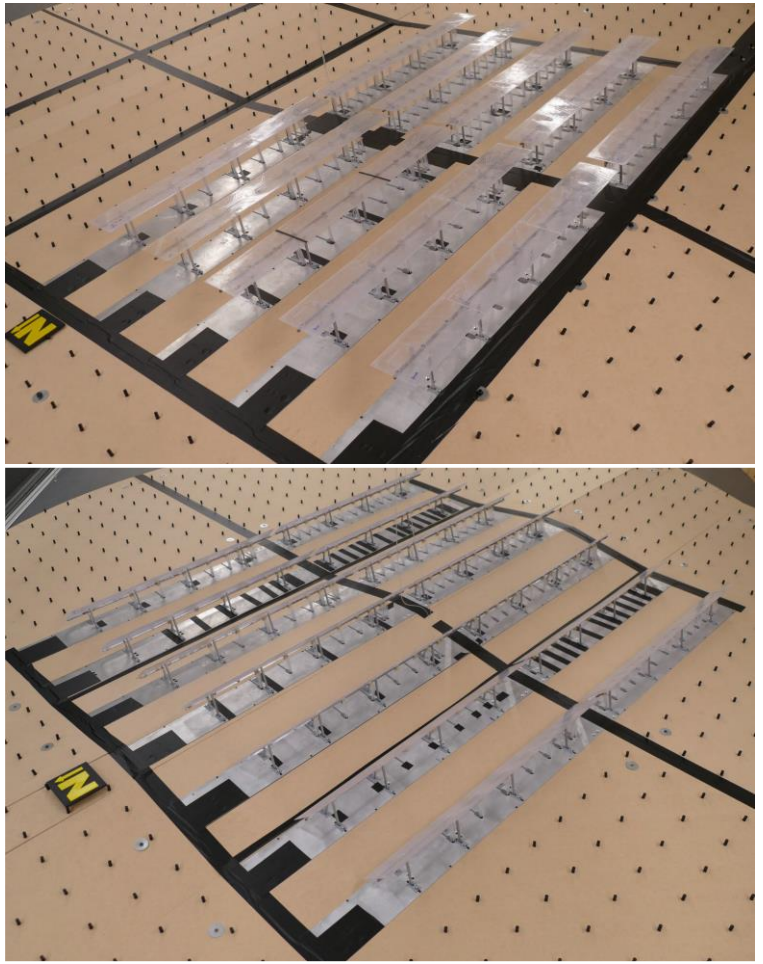


***Figure**: Pressure tests on slope (top) and ridge (bottom)*

TrinaTracker
A Business Unit of Trina Solar

Torsional Instability

***Video**: Full-scale instability on site*

***Figure**: Aftermath of damage incurred:*

***Top**: At the Oakey 2 site in October 2018 (pv magazine, 2020)*

***Bottom**: South of Spain (Valentin et, al, 2022)*

CPP WIND ENGINEERING CONSULTANTS

TrinaTracker
A Business Unit of Trina Solar

Aeroelastic Instability Testing

- *Scaled model that moves like the full-scale system in torsion*
- *Guidance in designing the wind protection (stow) strategy*

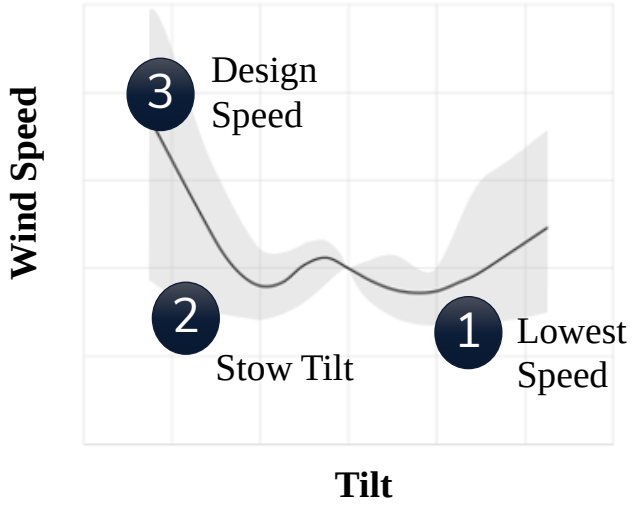


***Figure**: Sample trend for critical wind speed with tilt*

***Figure and video**: Examples of solar aeroelastic tests in CPP's wind tunnels*

TrinaTracker
A Business Unit of Trina Solar

Avoiding Instability

- *Increase stiffness*
  - Thicker or larger torque tube
  - Shorter flexible spans – multiple drives
- *Increase damping*
  - Assists in reducing dynamic amplification
  - Effective at moderate-high tilts
- *Testing recommended for all solutions*

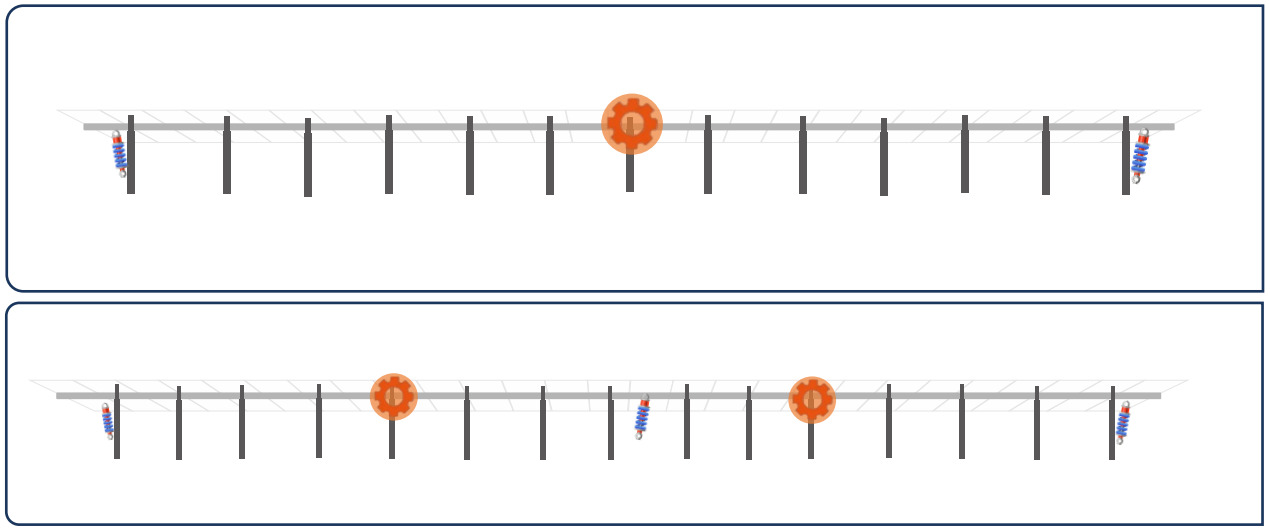


***Figure**: Single and multi-drive TrinaTracker Vanguard 1P*

TrinaTracker
A Business Unit of Trina Solar

Collaboration & Future Work

- *Ongoing development with Trina*
  - In-person visits and training days
  - More complex aeroelastic models
  - Advanced dynamics

CPP WIND ENGINEERING CONSULTANTS

Thank You

Any questions?

Parsa Enshaei, Senior Engineer
penshaei@cppwind.com

CPP WIND ENGINEERING CONSULTANTS

500 Princes Highway
Unit 2
St. Peters, NSW 2044
Australia

T: +61 2 9551 2000
F: +61 2 9557 9447

cppwind.com

Trinasolar

TrinaTracker

TrinaTracker

Smart Control System Solution

February 1, 2024

Index

1 TrinaTracker Smart Tracking Solution

- High Reliability
- High Performance
- High Efficiency

Vanguard 1P

Agile 1P

FixOrigin

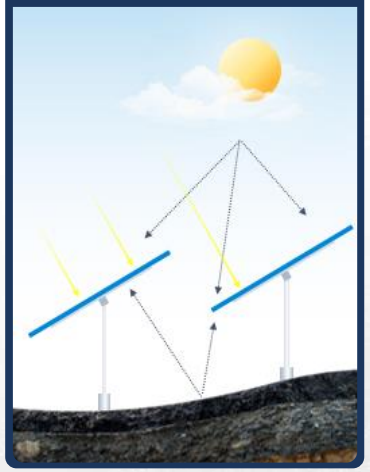
Driven by customer demand and technological innovation,
TrinaTracker Smart Tracking Solution + Smart Control System

2 Pain Points of Photovoltaic Power Plant

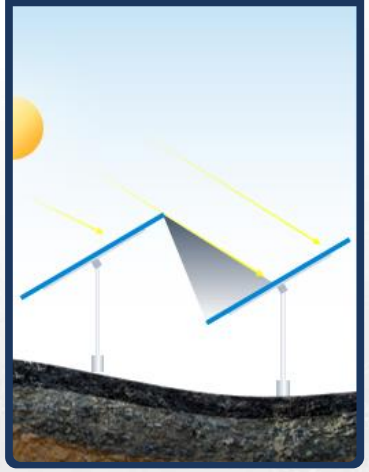
Power supply instability
+ Battery instability

Communication abnormalities

Underutilization of diffuse irradiation



Shading loss



Low O&M efficiency
High O&M cost

- Ensure the reliability of tracker operation
- Improve generating power
- Reduce generation losses
- Improving O&M efficiency
- Availability Guarantee

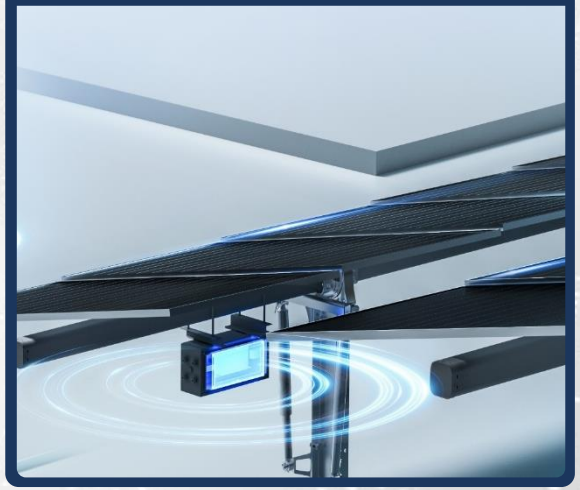
3 TrinaTracker Smart Control System

TrinaTracker

TrinaTracker
Smart Controllers

TrinaSmart Cloud
Tracker Level SCADA

SuperTrack
Smart Tracking Algorithm



Multiple Protection

- Strong wind protection mode
- Manual snow removal mode

Multiple Power Supply Modes

- String-powered
- Self-powered
- AC-powered
  Low temperature solution
  (-40 °C~ 60°C)

Multiple Communication Methods

- Wireless LoRa/ZigBee or Wired RS485
- The compatibility of antenna communication

Dual Power Supply Solution

- The main power supply and backup battery

Monitoring and Control

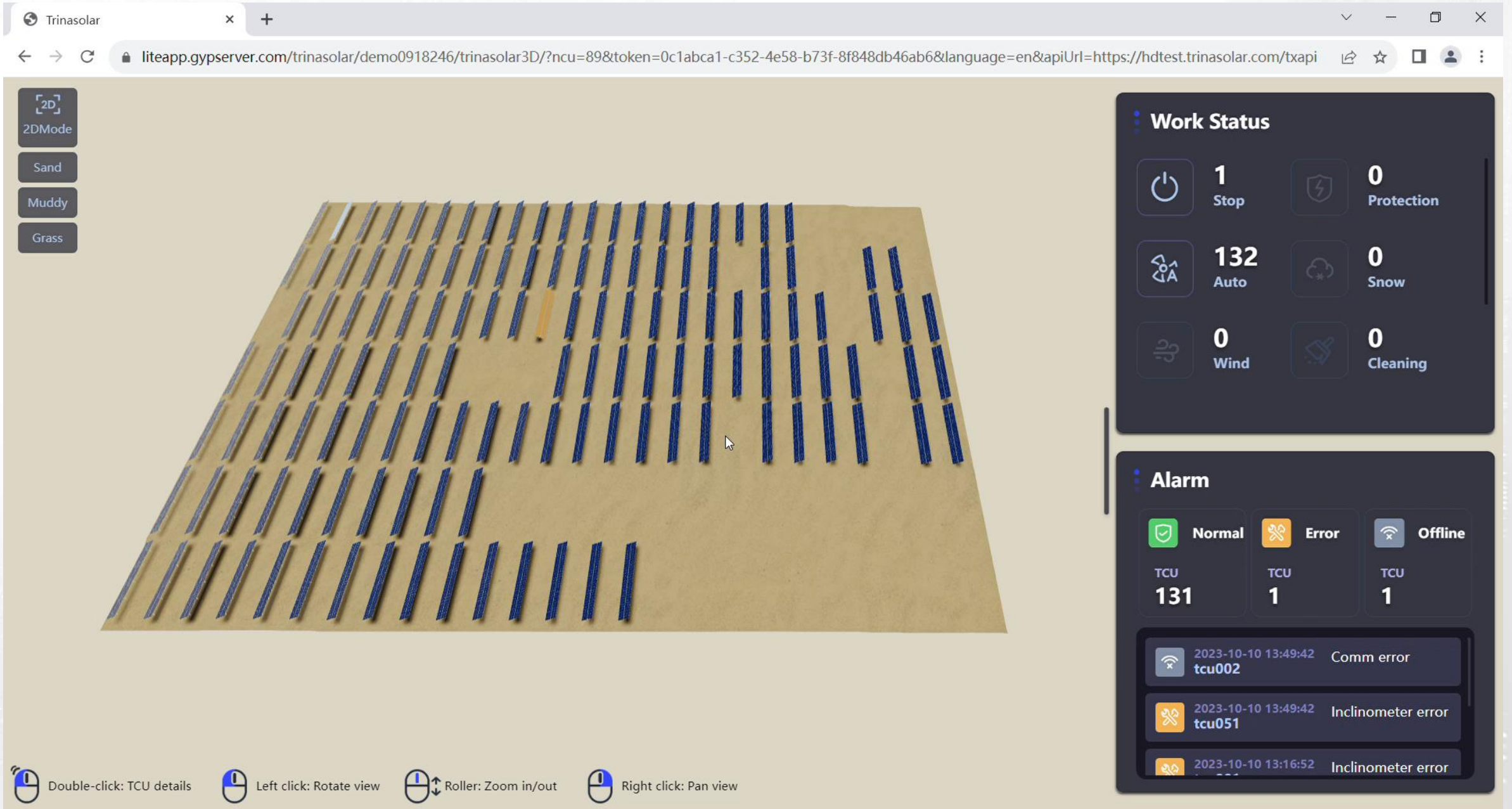
- Data Collection
- Data Storage
- Data Forwarding
- Flexible Switching of Work Modes
- User-Friendly UI

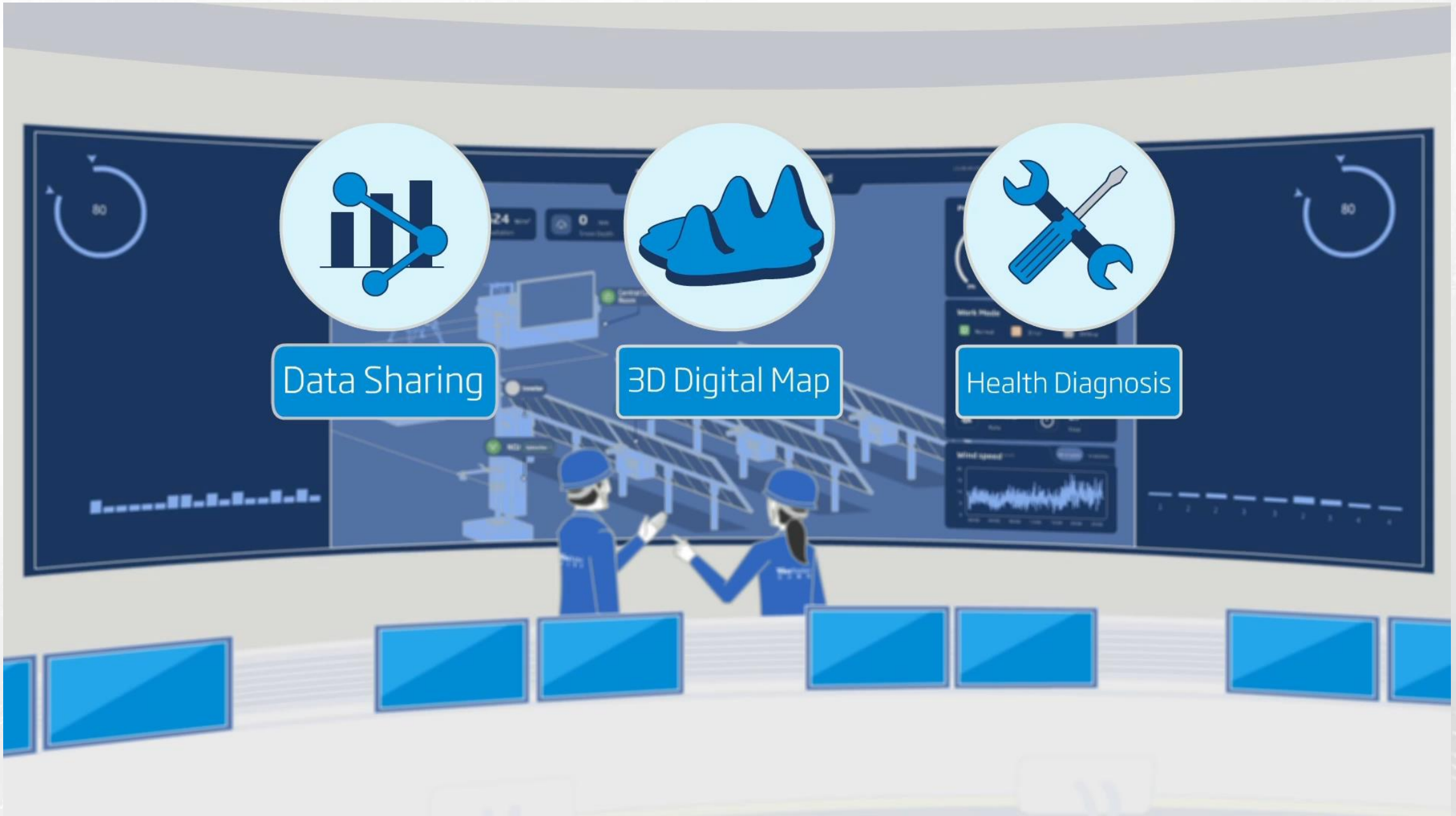
Smart Operations and Maintenance

- **3D Digital Map**
- **Motor Diagnostic Pre-warning**
- Fault Alert
- Data Query
- Key Parameter Analysis

Secure and Stable System

- **Multi-Role Permission Management**
- **Support integration with Active Directory authentication system**
- **Master-Slave Redundancy Design**
- Data Sharing
- Third-Party Platform Friendly Compatibility
- Cybersecurity
- Hardware & Software Stability


Trinasolar
liteapp.gypserver.com/trinasolar/demo0918246/trinasolar3D/?ncu=89&token=0c1abca1-c352-4e58-b73f-8f848db46ab6&language=en&apiUrl=https://hdtest.trinasolar.com/txapi
2D
2DMode
Sand
Muddy
Grass
Work Status
1
Stop
0
Protection
132
Auto
0
Snow
0
Wind
0
Cleaning
Alarm
Normal
Error
Offline
TCU
131
TCU
1
TCU
1
2023-10-10 13:49:42
tcu002
Comm error
2023-10-10 13:49:42
tcu051
Inclinometer error
2023-10-10 13:16:52
Inclinometer error
Double-click: TCU details
Left click: Rotate view
Roller: Zoom in/out
Right click: Pan view


Data Sharing
3D Digital Map
Health Diagnosis

Digital Drives Power Generation New Era

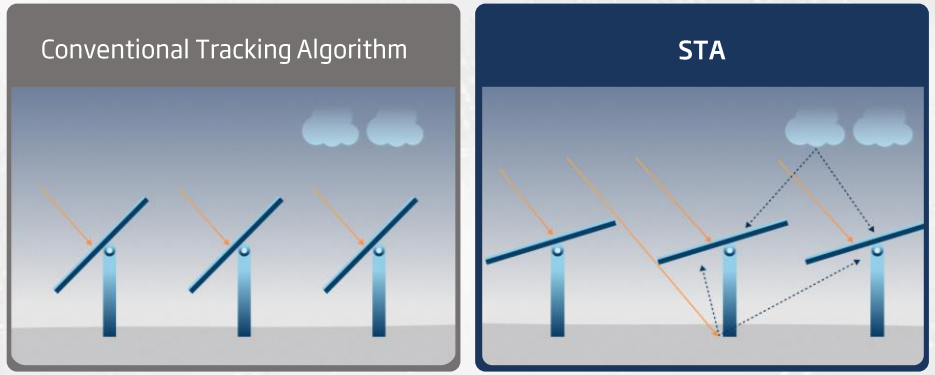
STA
Smart Tracking Algorithm

SBA
Smart Backtracking Algorithm

SuperTrack

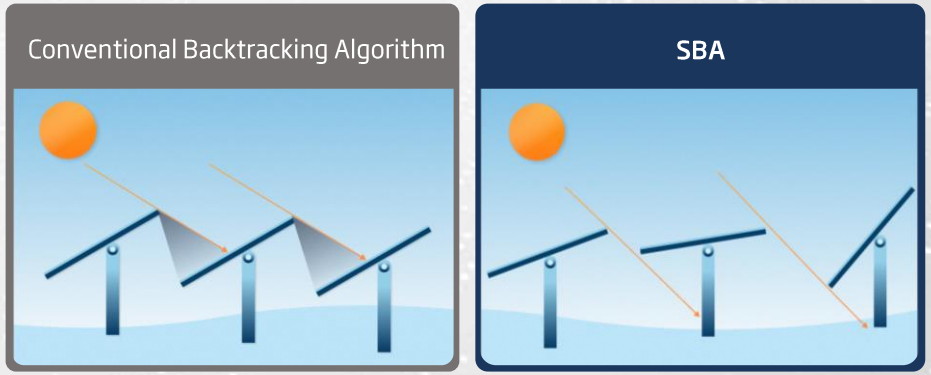
Bifacial Irradiance Model

Improve generating power on a cloudy day or in other conditions with highly diffused irradiance



Mini-Shading Model

Reduce generation losses due to row-to-row shading, which are more significant on complex terrains.



SuperTrack Logic Diagram

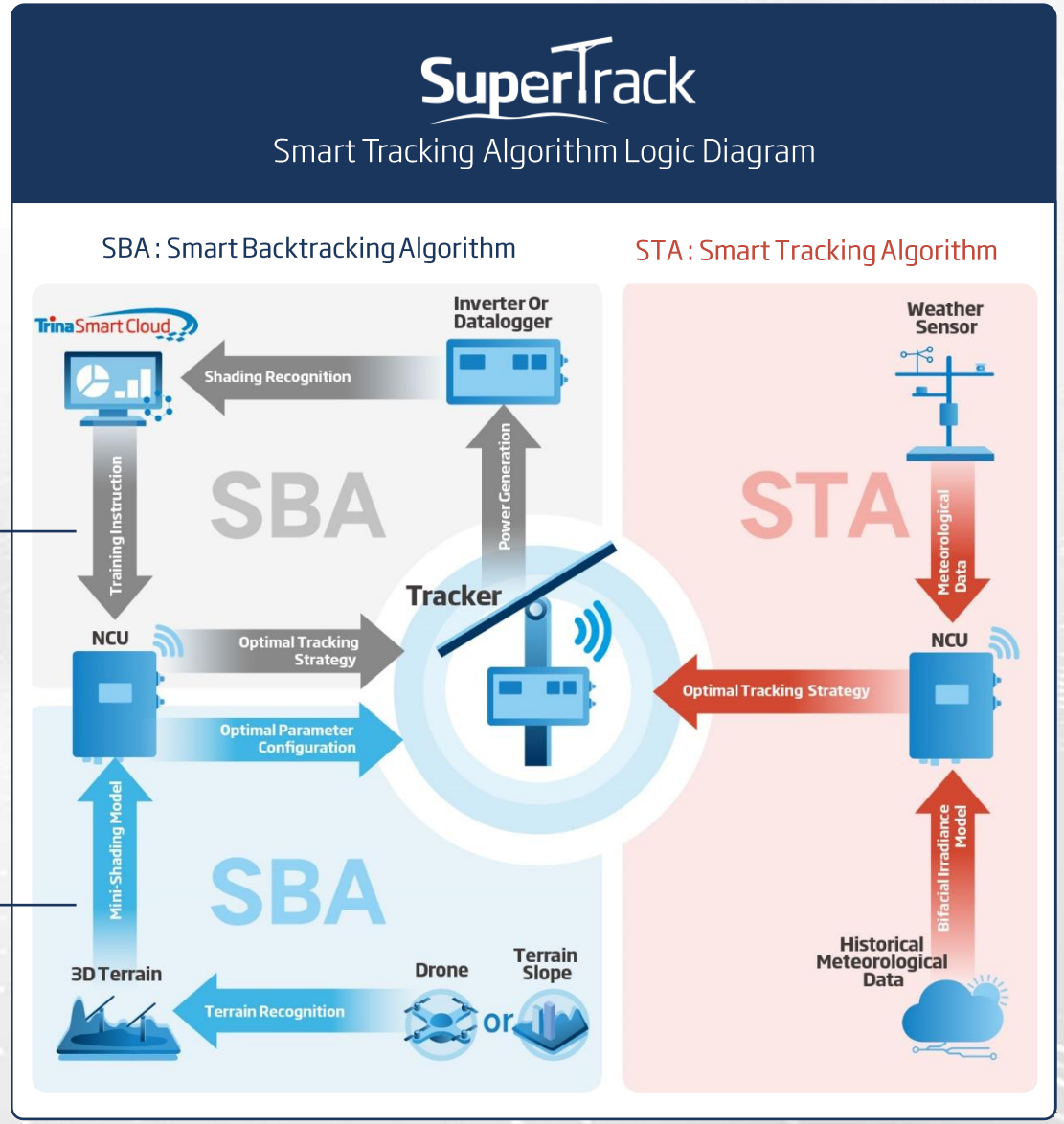
Integrate diverse data such as meteorology, power generation, topography, etc.

Fully explore optimization possibilities for different scenarios, and meet the specific needs of various project site conditions.

There are two ways to implement SBA:

Method 2:
Power generation data from String Inverter or Datalogger

Method 1:
Terrain slope information



4 Core Values

High Reliability	Communication, Power Supply, Battery etc.
High Performance	N-S Slope, Self-Learning, Seasonal optimization etc.
High Efficiency	Cybersecurity, Health Diagnosis, 3D Digital Map etc.

SuperTrack

TrinaSmart Cloud

5 Global Project Application

TrinaTracker

Spain (Córdoba) Campiña
11.3MW

EU
763MW

CHN+
The Belt and Road
1.7GW

Qinghai Lennghu
113MW

LAC
1GW

APAC
1.3GW

Brazil Santa Luzia
519MW

Israel	Qatar	Argentina	Columbia	Brazil	Uzbekistan	South Africa
156MW	876MW	150MW	108MW	211MW	512MW	148MW

Continuous Selling
2 years

Total Capacity
4.9GW

Country
16

6 Case Study

Energy gain on SuperTrack

Campina Spain

Typical Cloudy Day : 5.55%
Overall: 1.16%

Huake China Ningxia

Typical Cloudy Day : 11.83%
Typical Sunny Day: 1.64%

Renquan China ShanDong
Technical Reform

Typical Cloudy Day : 10. 39%
Overall: 2.30%

7 Customer Values

Impact of SuperTrack on LCOE

Estimated Energy Gain for TrinaTracker SuperTrack		
TrinaTracker SuperTrack	Black & Veatch Estimated Gain (%)	TrinaTracker Estimated Gain (%)
Row-on-Row Shading Recovery Only (SBA)	2.80%	2.82%
Diffuse Sky Recovery Only (STA)	0.26%	0.46%
Both Row-on-Row and Diffuse Sky Recovery Implemented	3.06%	3.28%

LCOE Calculations		
Project Site	Tracker Type	LCOE ($/MWh)
Puente Genil, Córdoba, Spain	Traditional SAT	$46.03
	SuperTrack	$44.78

Project Location	Campina, Spain
Project Size	100MW
Latitude	37.398º
Longitude	-4.709º
Terrain	5% Ease slope, 5% West slope
Tracker Configuration	1P
Module	Trina Bifacial Vertex NEG19RC.20

Cost increased by about 0.34%
Energy output increased by 3.06%

Reducing LCOE 2.72%

Thank You!

Get in touch with:

Sun Kai

Head Of Smart Tracking Technology