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pv magazine webinars

Right on Smart Track: Bankability criteria for single-axis trackers

5 July 2023

3:00 pm – 4:00 pm | CEST, Berlin, Madrid
9:00 am – 10:00 am | EDT, New York City
10:00 am – 11:00 am | BRT, São Paulo

Marian Willuhn
Editor
pv magazine

Rob Foree
Project Manager
Black & Veatch

Sun Kai
Head of Smart Tracker Control System
TrinaTracker

Juan Manuel Gómez
CEO
TrinaTracker EMEA

Welcome!

Do you have any questions? ❓

Send them in via the Q&A tab. 👉 We aim to answer as many as we can today!

You can also let us know of any tech problems there.

We are recording this webinar today. 📹

We‘ll let you know by email where to find it and the slide deck, so you can re-watch it at your convenience. 👀 💡

PV Racking Bankability and Smart Trackers

Presented by

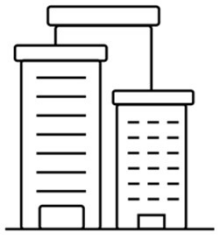
Black & Veatch Management Consulting, LLC

July 5, 2023

Rob Foree, MBA
Project Manager

Black & Veatch Today

120+ Offices



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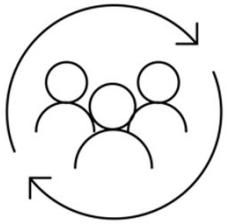
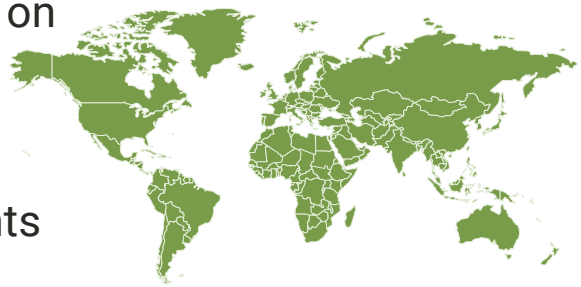


10,600+ Professionals

$4.3B Revenue in 2022

Founded **1915**

Projects on **6** Continents



8th largest employee-owned ESOP in the U.S.

voted

2022 Best Places to Work for LGBTQ Equality

7,000 Active Projects Worldwide

ENR Rankings:

Ranked #13 in Top 500 Design Firms

Power #2	Telecom #6
Solar Power #2	Petrochemical #8
Hydro Plants #4	Water Supply #8

Global Advisory

Providing industry-leading management consulting services to support technology, operational, financial, and regulatory challenges that require integrated, end-to-end global capabilities.

Global Advisory serves the market in an integrated manner with our talent and capability aligned within two primary domains:

Strategic Advisory

- Strategy & Planning
- Rates & Regulatory
- Transaction Services

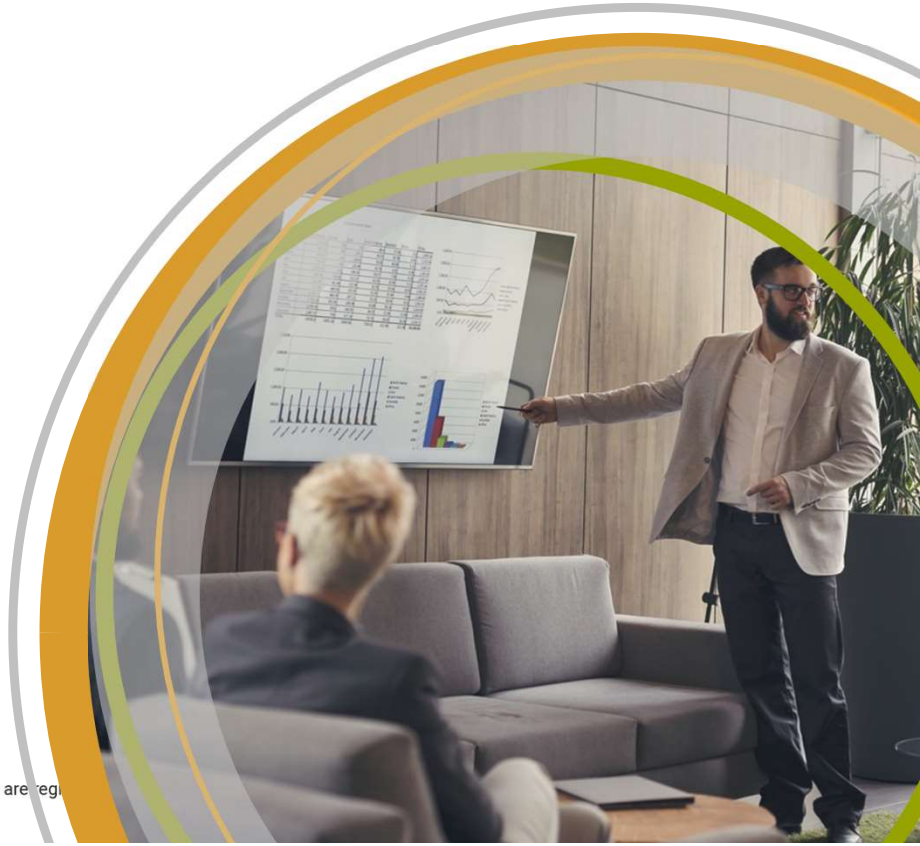
Digital Advisory

- Digital Grid
- Digital Asset
- Digital Customer

What Is a Bankability Study?

A bankability study is an assessment of technology risk.

Will the technology perform as expected?



BLACK & VEATCH

Why is a Bankability Study Important?

Helps a startup company raise capital and helps finance projects using new technologies.

Provides an honest evaluation and representation of the manufacturer and technology to the outside world.

Is a component in a financial institution's risk assessment process.

Helps stakeholders get comfortable with the technology.

How Do We Assess Technology Risk?

Technology Design
Smart Trackers

Manufacturing

Company

Performance and Reliability

Installation, Operation and Maintenance

Smart Trackers and Bankability

Smart Trackers

Capabilities and Benefits

- Reduce row-on-row module shading on projects with undulating terrains (0-4% gain)
    - Dependent on how undulating the terrain is
- Diffuse light gains during cloudy conditions (0-2% gain)

Methodologies

- Algorithms
- Weather forecasting vs. on-site pyranometers
    - Risk of flat modules during sunny or partly cloudy conditions
    - What are the thresholds for going flat and chasing cloudy conditions
    - SAT battery usage
- Diffuse horizontal irradiance (DHI) vs. Global horizontal irradiance (GHI)
- Ganged vs. Independent row for reducing shading losses

BLACK & VEATCH

Solar Project Performance

Smart Tracking (with and without)

Production Estimating

- Model hypothetical projects holding all project assumptions and variables constant except tracker type
- PVsyst production estimating using proprietary modeling methodologies

Project Cost Estimating

- Internal cost estimating tool from Black & Veatch Solar EPC
- Based on actual project bids and builds

O&M Cost Estimating

- IE provides input on O&M costs based on project financing projections

Estimated LCOE calculation comparison

Trina Tracker

Boosting Power Beyond the Horizon

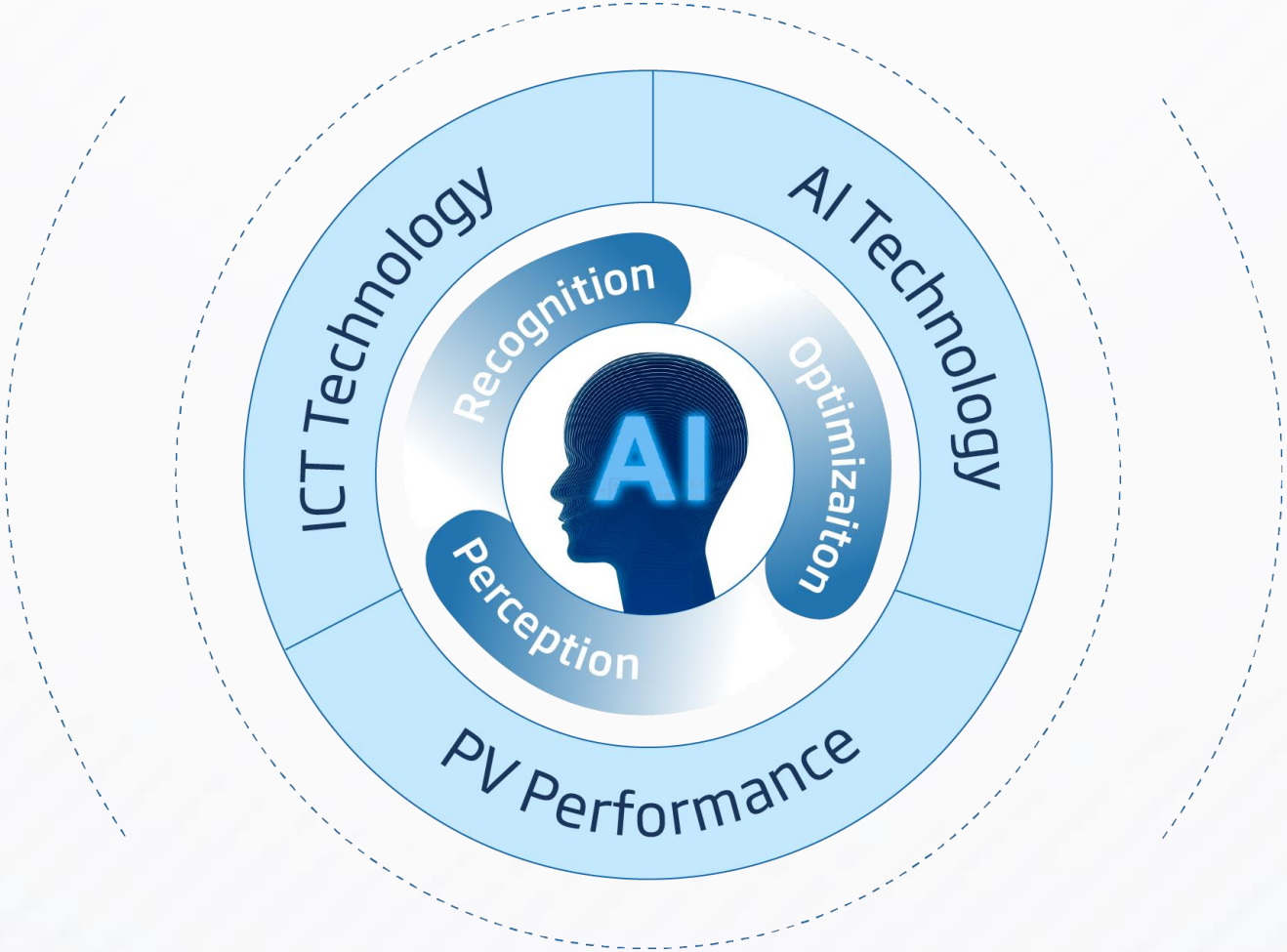
SuperTrack Makes Smart Tracker

Dr. SUN Kai
Head of Smart Tracker Control System

How to Define Smart

Finer
Data Granularity

Higher Accuracy Model



Broader Optimization
Dimensions

Robuster Platform

How to Define Smart Tracker

TrinaTracker
Boosting Power Beyond the Horizon

Reliable
Ensure tracker safety

Adaptive
Adapt to various weather and terrain conditions

High Yield
High power generation and high revenue

Intelligent
Self-perception, self-learning, and self-optimization

B&V Independent Assessment of SuperTrack

To conduct this independent assessment, Black & Veatch provided the following services

- Review of the Trina SuperTrack technology
- High-level review of Trina's production estimate modeling capabilities
- Hypothetical project design
- Production estimates using PVsyst
- Project construction cost estimations
- Project cost estimations including O&M, lease, asset management and financing costs

"Black & Veatch is of the opinion that Trina Solar's SuperTrack methodology is logical and consistent with other advanced tracking algorithms used within the industry. Use of on-site measurements to detect favorable conditions for diffuse light recapture is advantageous."

Note: The content comes from B&V's report

Impact of SuperTrack on LCOE

TrinaTracker
Boosting Power Beyond the Horizon

Project Location
Campina, Spain

Latitude
37.398º

Longitude
-4.709º

Estimated Percent Gain for TrinaTracker SuperTrack Diffuse Sky and Row-on-Row Shading Recovery Technology

TrinaTracker SuperTrack Diffuse Sky and Row-on-Row Shading Recovery Component	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%

Cost increased by about 0.34% Energy output increased by 3.06% LCOE reduced by 2.72%

LCOE Calculations

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

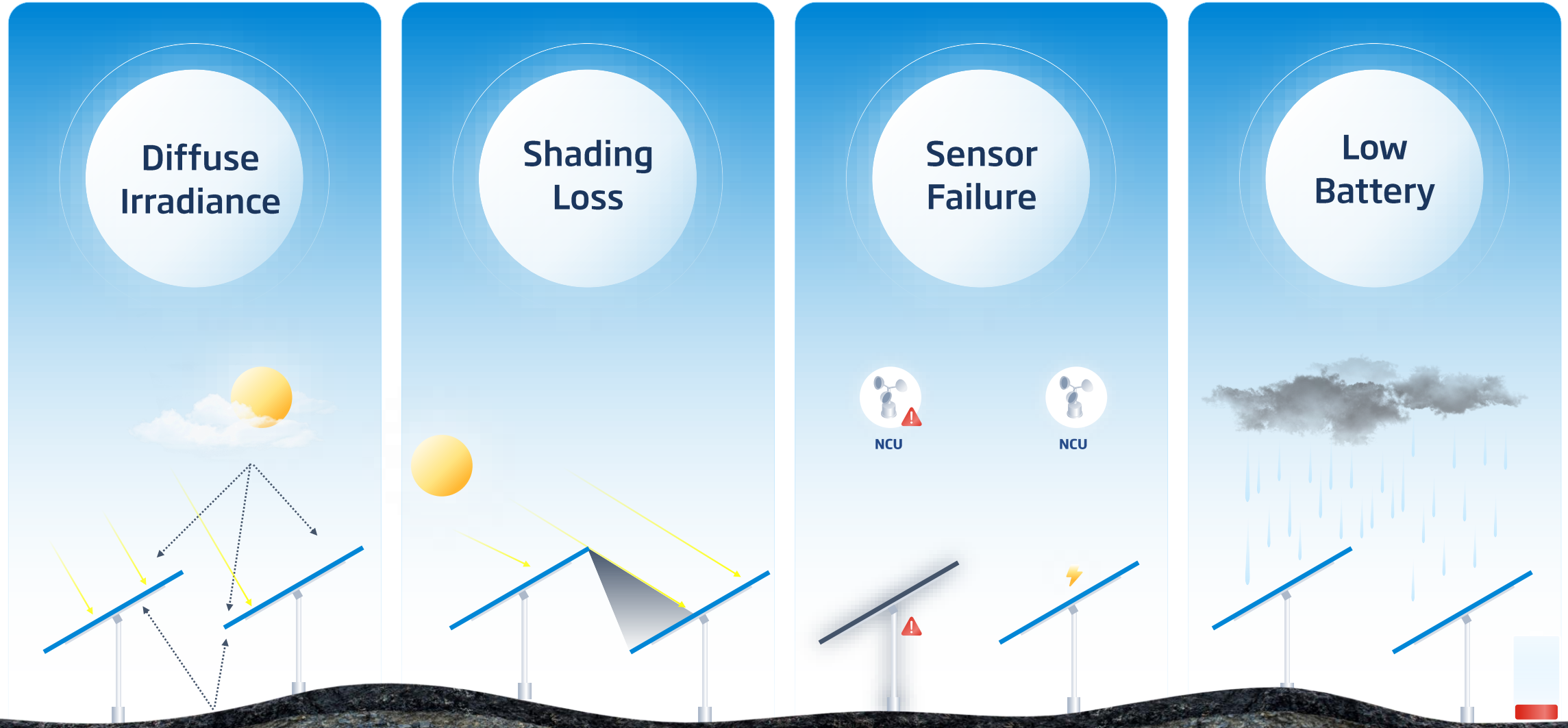
Note: The data comes from B&V's report

SEB | Simulation Software for SuperTrack

Pain Point Issues of Conventional Tracking System

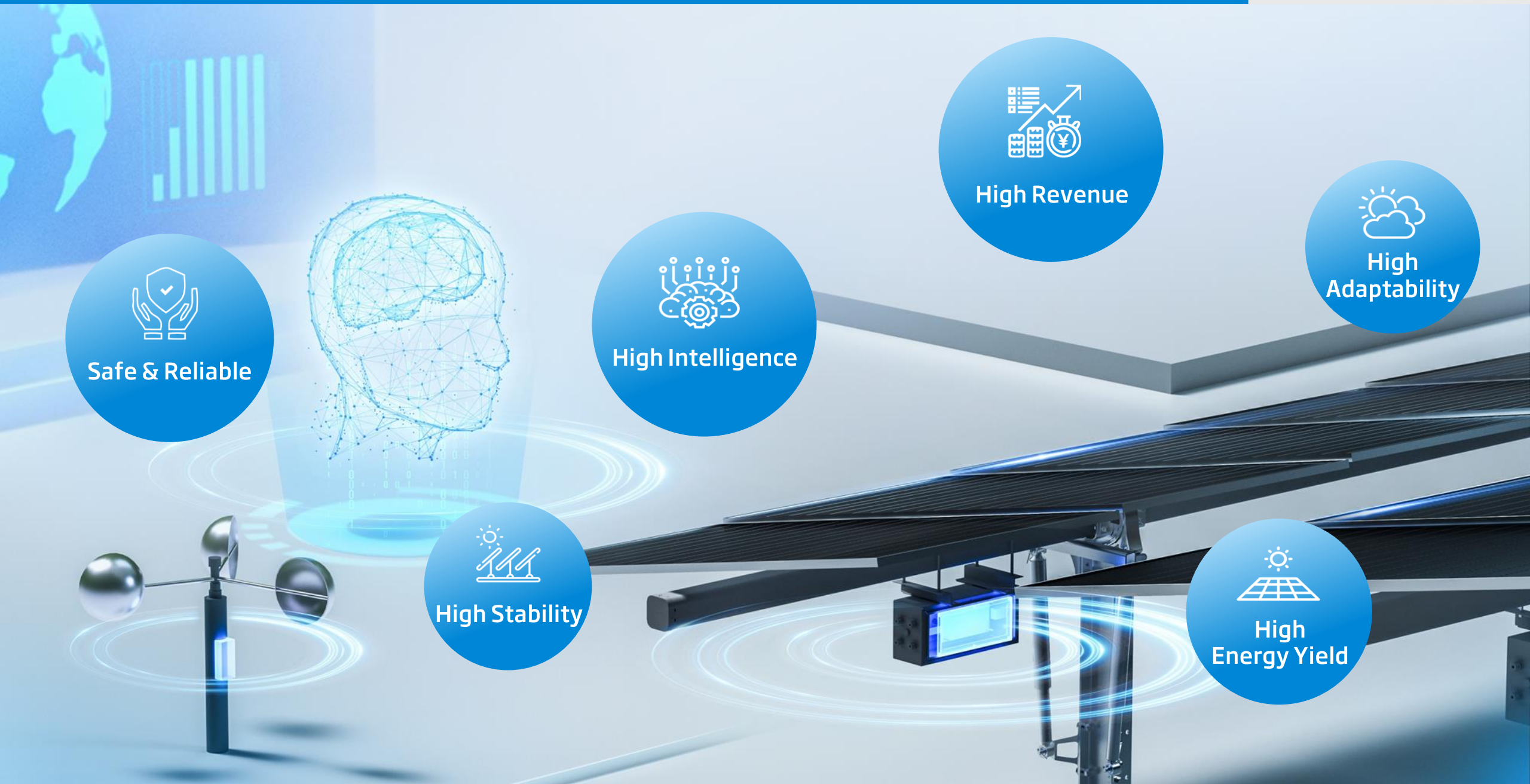
TrinaTracker
Boosting Power Beyond the Horizon

The traditional tracking system can not give full play to the power generation potential of trackers



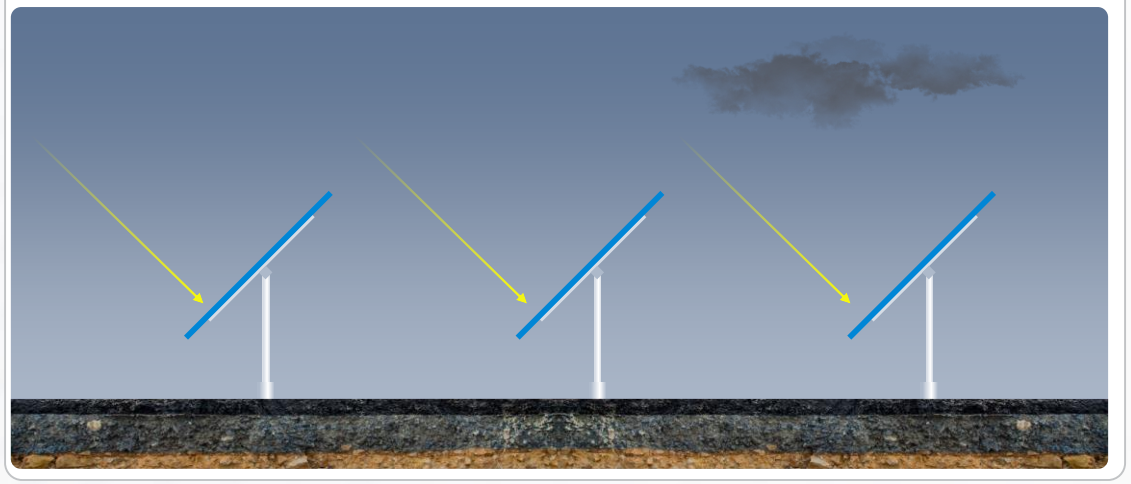
Smart Tracker Control System – SuperTrack & Trina Smart Cloud

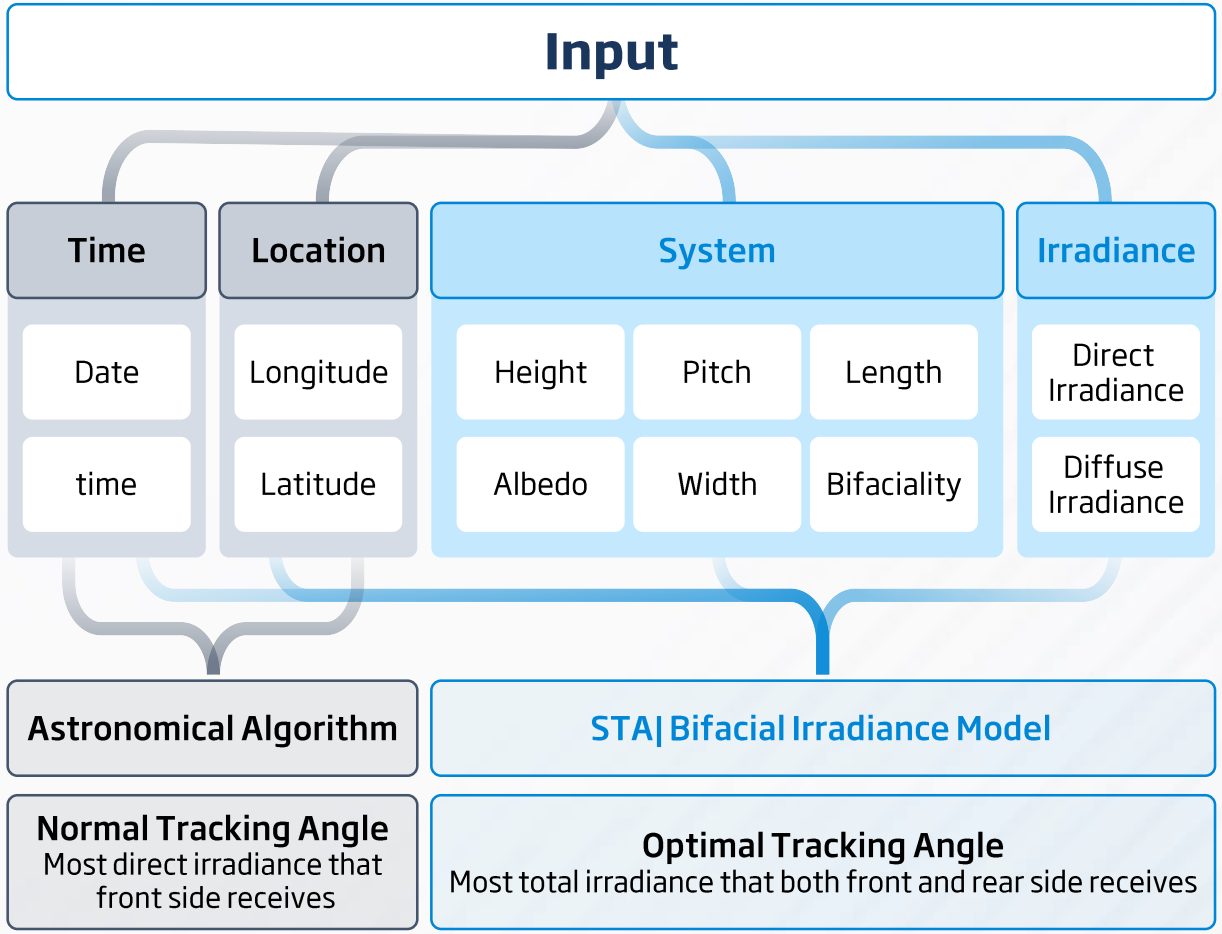
TrinaTracker
Boosting Power Beyond the Horizon



Astronomical algorithm

- Solar azimuth based tracking on overcast days
- Underutilization of diffuse irradiance
- Failed in extreme weather protection
- Energy loss due to low battery mode





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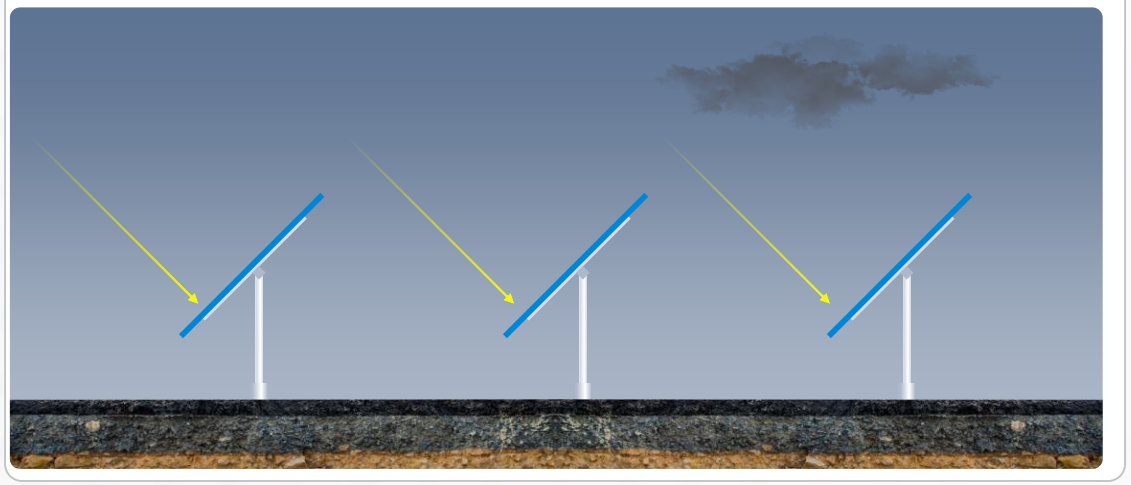
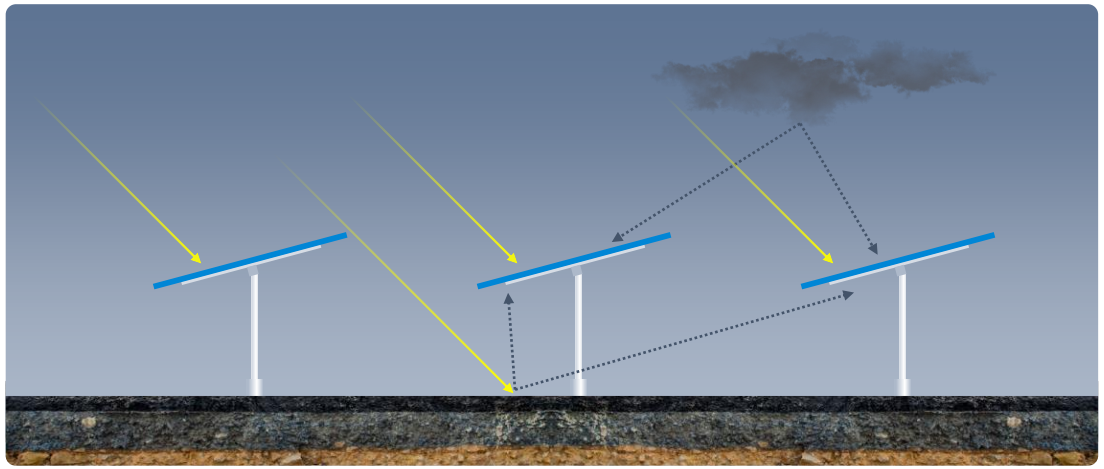
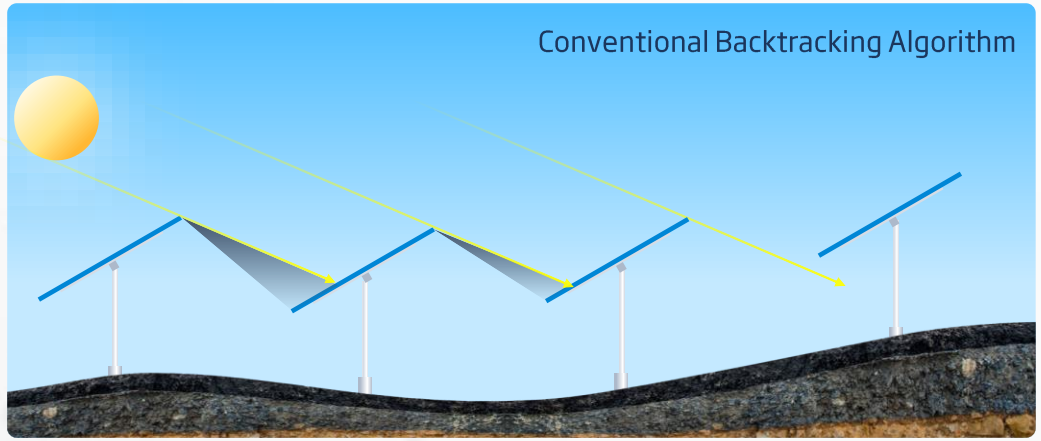


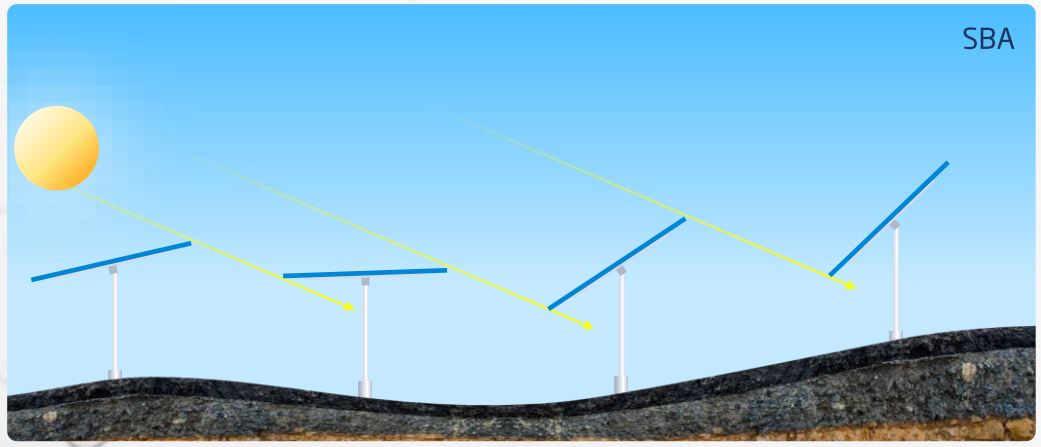
STA | Smart Tracking Algorithm

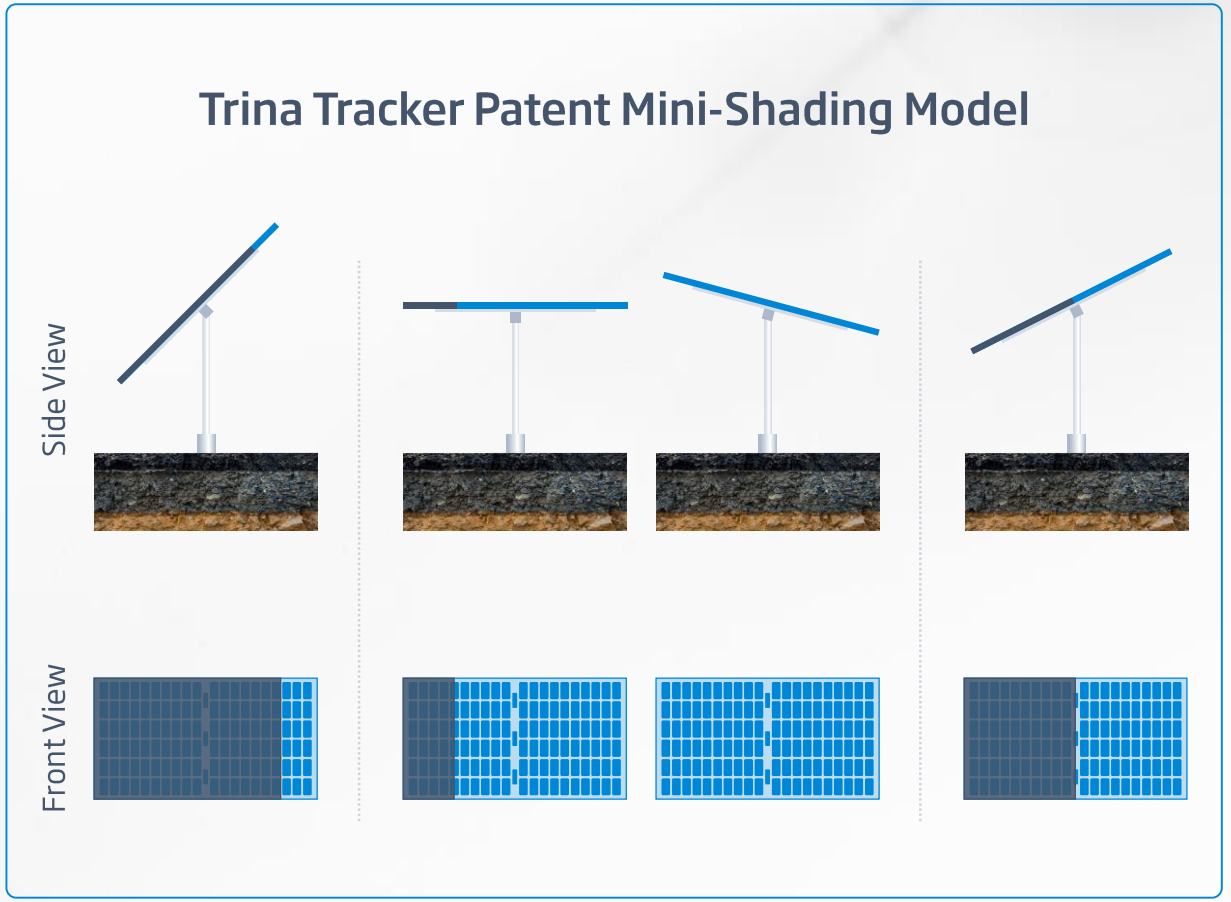
- Minimize tracker rotation on overcast days
- Fully utilization of diffuse irradiance
- Extend duration time of battery to flexibly respond to extreme weather
- Recover to normal tracking mode in time



SuperTrack- SBA| Smart Backtracking Algorithm







Fully utilize terrain topography data, system operational data, Mini-Shading Model to

Calculate and output the optimal tracking angle group to boost the energy production during backtracking period

Case study

TrinaTracker
Boosting Power Beyond the Horizon

Project site	Test time	Proportion of diffuse irradiance	Average slope	Annual energy gain
Tongchuan	**One Year**	**53%**	**3%**	**3.06%**

TrinaTracker
Boosting Power Beyond the Horizon

Energy gain on a typical overcast day
8.03%

Average energy gain
3.84%

Project site
Nangong

Test time
Three Months

Proportion of diffuse irradiance
60%

Highly diffuse days / effective days
25/77

Energy gain on a typical overcast day
9.41%

Energy gain on a typical sunny day
4.64%

Project site
Changzhou

Test time
One Year

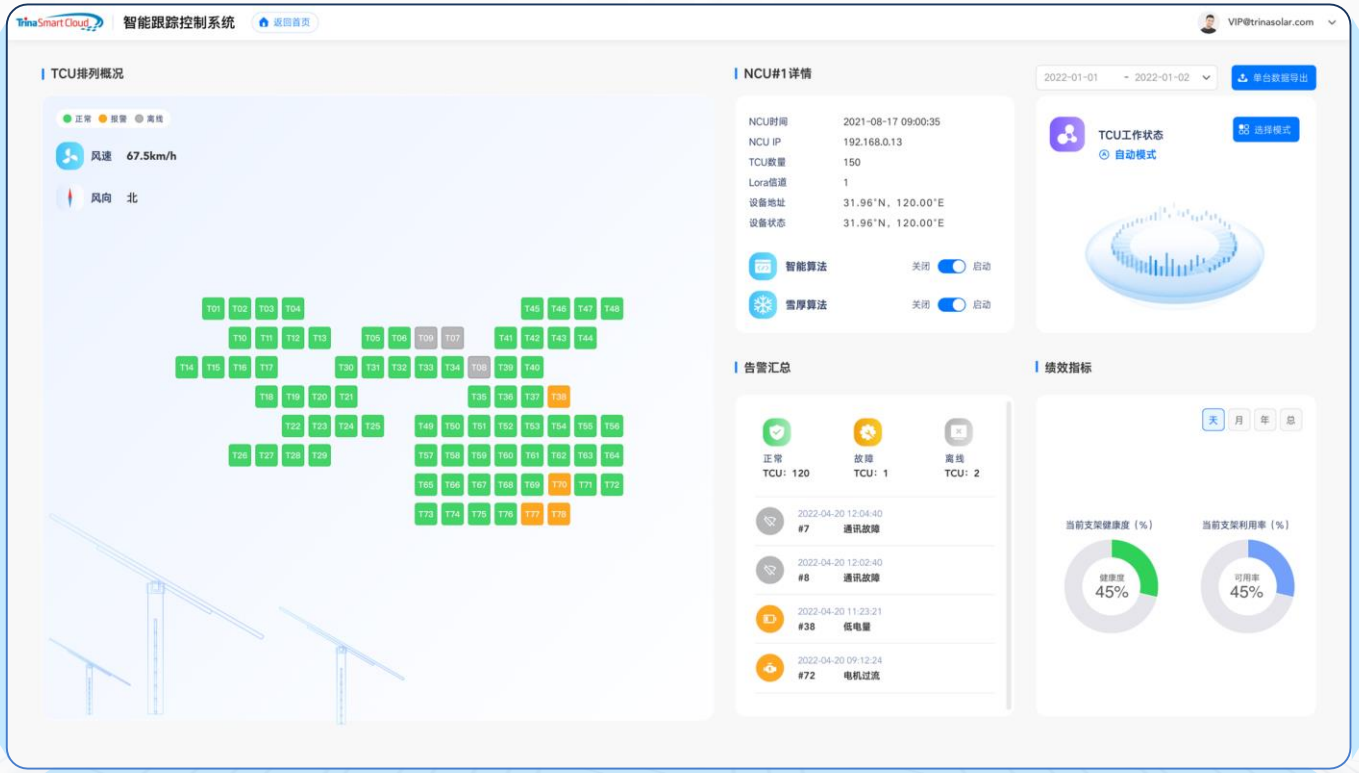
Proportion of diffuse irradiance
64%

Average slope
3.3%

Smart Control System – Trina Smart Cloud

TrinaTracker
Boosting Power Beyond the Horizon

Secure



Reliable

Data Acquisition

Data Storage

Data Transmission

Digital Map

Tracker Availability

Data Sharing

Easy O&M

Core Values

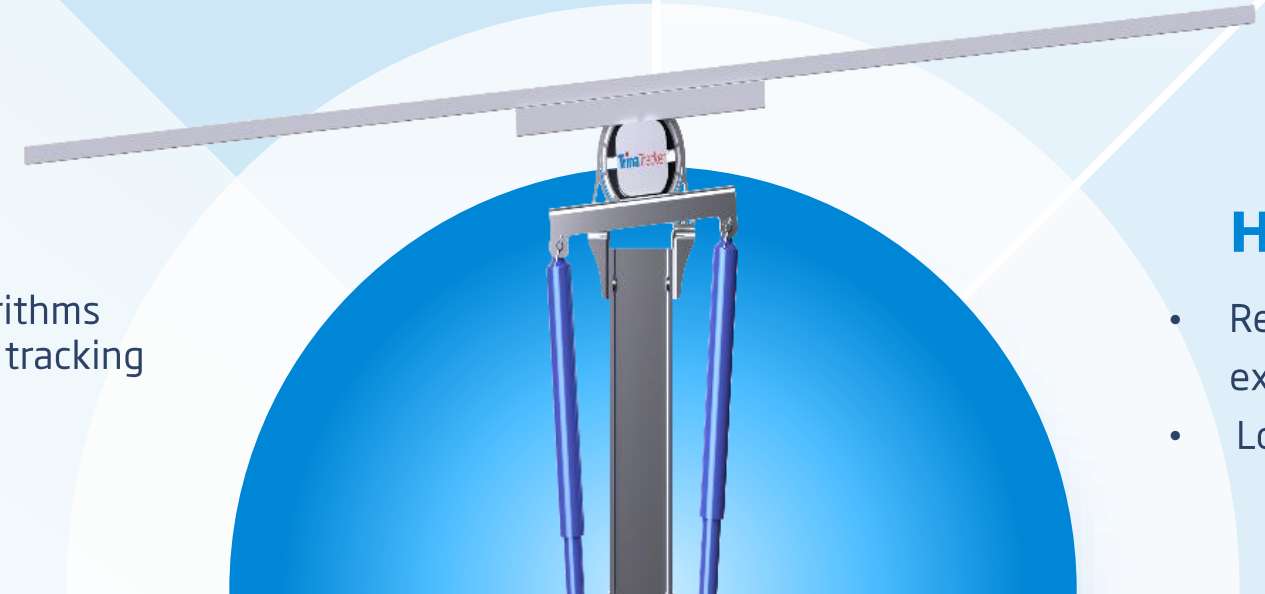
TrinaTracker
Boosting Power Beyond the Horizon

High adaptability

- Adaptive to complex terrain and weather conditions

High intelligence

- Self-perception, self-learning, self – optimization



High Energy yield

- Proprietary models and algorithms
- Compared with conventional tracking algorithm, boosting energy generation by up to 8%

High stability

- Reduce rotation of trackers and extend the duration time of battery
- Long-term test & verification

Trina Tracker
Boosting Power Beyond the Horizon

THANK YOU!

TrinaTracker

Boosting Power Beyond the Horizon

Going **Smart**

Is The Intelligent Way To The Future!

Juanma Gómez García

CEO of TrinaTracker EMEA

2023-07-05

TrinaTracker
Boosting Power Beyond the Horizon

TrinaTracker is a global leading smart tracking solutions provider

The company develops high-tech, intelligent and tailor-made tracker solutions. When these smart solutions are implemented, they create strong synergies that maximize energy production and reduce cost.

The ultimate company's priority is to achieve the lowest energy price for its clients

Company History

TrinaTracker
Boosting Power Beyond the Horizon

1961 — GRUPO CLAVIJO

1997 — Trinasolar

2004 — MFV SOLAR STRUCTURES FOR SOLAR ENERGY

2006 — Trinasolar NYSE

State Key Laboratory of PV Science and Technology recognized by the Ministry of Science and Technology. It set the foundation for the research on photovoltaic intelligent tracking systems.

2008

Trina PV Industrial Park, one of the largest in the world.

2012 — NCLAVE

49% acquisition

TrinaPro

2017 — MFV SOLAR STRUCTURES FOR SOLAR ENERGY + Qualitas Equity + GRUPO CLAVIJO european leading technologies

2018 — NCLAVE

2020 — TrinaTracker

NCLAVE 100% acquisition

1st Corporate Research Institute specialized in Photovoltaic Intelligent Tracking Systems

Vanguard™ 2P

2021 — TrinaSmart Cloud

Agile™ 1P

2022 — SuperTrack

Vanguard™ 1P

Positioning as Global Leading Smart Tracker Solution Provider

2023

Vanguard™ 2P

Multi-motor – multi-control

Smart Tracker Solution

TrinaTracker
Boosting Power Beyond the Horizon

Vanguard™ 1P

- Flat land

Vanguard™ 2P

- Hard soil and agriculture

Agile™ 1P

- Irregular and uneven terrains

Solution for all terrains
Compatible with latest module types

TrinaSmart Cloud

(Proprietary SCADA)

- Remote monitoring and control
- Real time data
- Advanced alarm system

SuperTrack Smart Tracking Algorithm

- Up to 8% energy increase with highly diffused irradiation and uneven terrains

Comprehensive Range of Services during the lifecycle

- Pre-Sales
- Engineering
- Fullfillment
- Project Management
- Commissioning
- Installation
- Technical consultancy, supervision and training
- After-Sales

Comprehensive Range of Intelligent Lifecycle Product Services

TrinaTracker
Boosting Power Beyond the Horizon

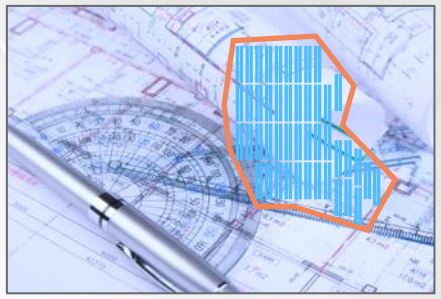
Initial proposal → End of operating phase

Pre-sales

- ✓ Topography study
- ✓ Pull-out test
- ✓ Layout optimization
- ✓ Preliminary structure analysis
- ✓ Optimum structural solution recommendation
- ✓ Local framework analysis
- ✓ Preliminary logistics
- ✓ Supply chain optimization

Engineering

- ✓ Final layout
- ✓ Tracker discretization
- ✓ Final tracker site configuration
- ✓ Calculation notes
- ✓ Technical set of drawings
- ✓ Deliverables list



Project Management

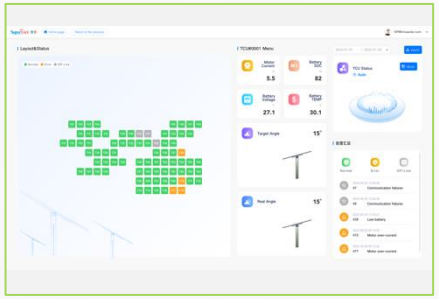
- ✓ Technical assistance
- ✓ Assembly supervision
- ✓ Technical training
- ✓ Project contract management
- ✓ Quality control
- ✓ Schedule optimization and mitigation measurements
- ✓ Subcontractor certification

Commissioning

- ✓ System architecture design TCU, NCU and sensors package configuration and parameterization
- ✓ Installation and documentation checklist
- ✓ Advance training to plant operation staff

After-sales

- ✓ Warranty Certificate
- ✓ RCA report elaboration
- ✓ Action plan implementation
- ✓ Technical assistance support (remote / physical)
- ✓ Ticketing service
- ✓ MTBF & failure rate ratios
- ✓ Tracker retrofitting
- ✓ Trouble-shooting
- ✓ O&M manuals.

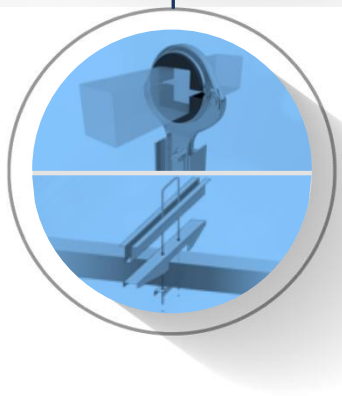


Research, Development and Innovation Capabilities

R + D
Technological centers in Spain and China

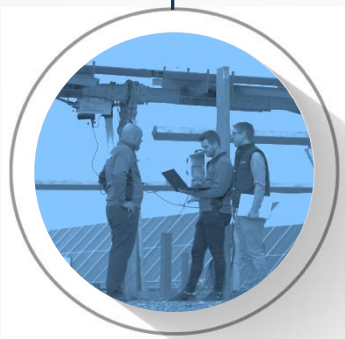
+215
Engineers

124 Patented technologies
60 Patents for inventions
53 Utility model



Indoors precise testing capabilities

Outdoors fields for holistic tracker assesment



10 GW Manufacturing Capacity

Product lifecycle management

Whole-process quality management

Digital management

- ✓ MES traceability system
- ✓ CSP after-sales service system

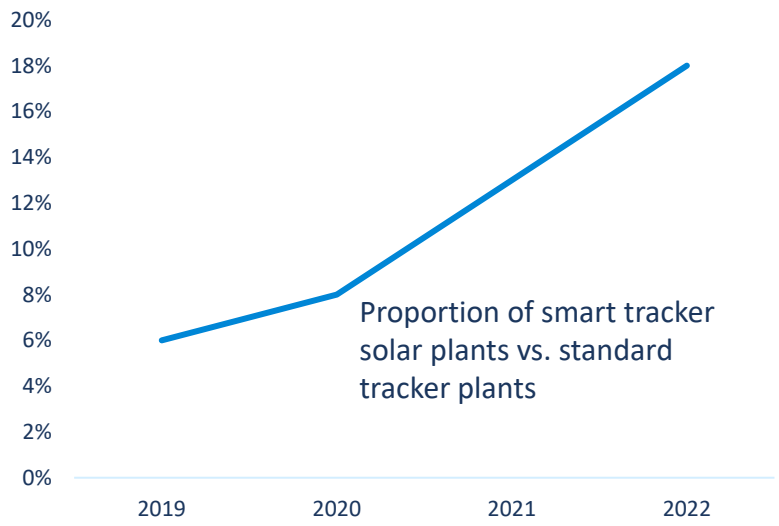
Quality management

- ✓ Incoming material quality control
- ✓ Design quality control
- ✓ Production quality control
- ✓ Delivery quality control

Intelligent manufacturing scenarios

- ✓ Intelligent production
- ✓ Coordinated decision making
- ✓ Intelligent IoT
- ✓ Planning collaboration
- ✓ Quality control

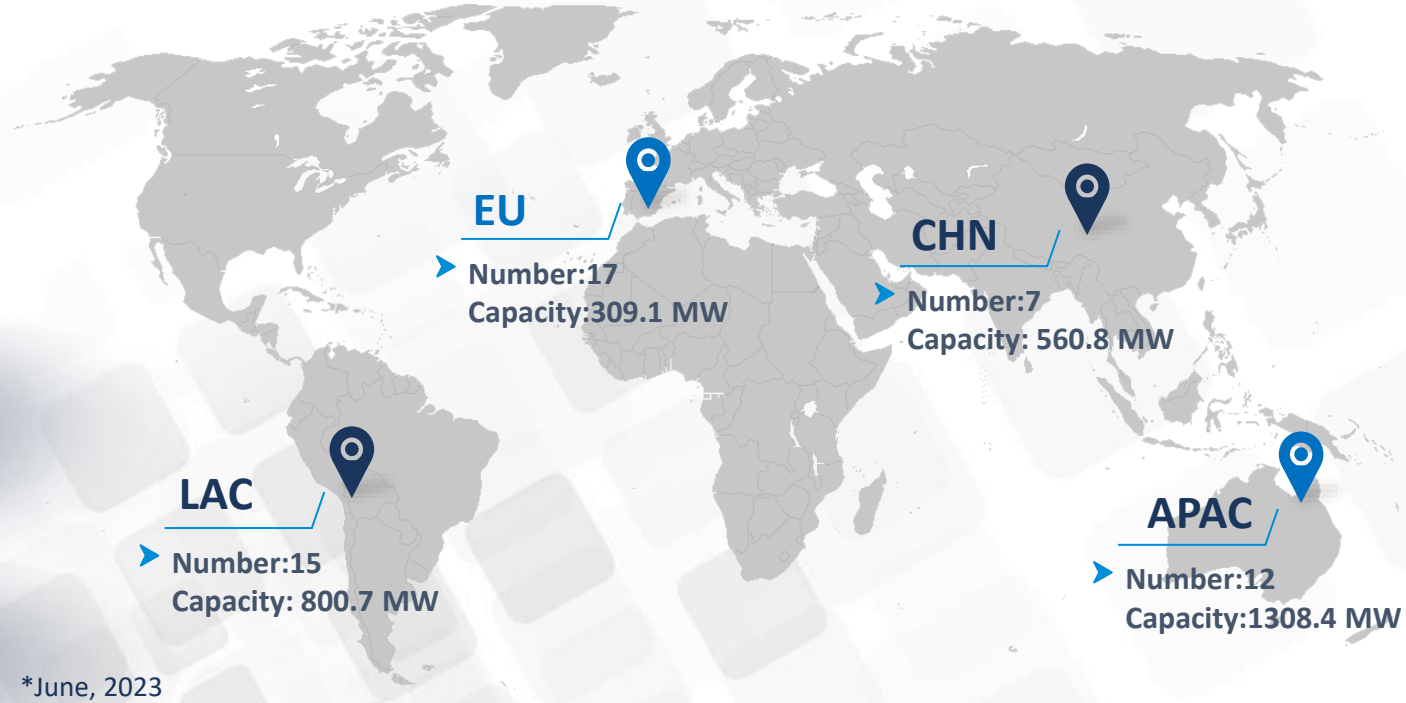
Smart Tracker Technology Boosts TrinaTracker Business



Smart tracking technology is being commonly recognized as effective method to increase power gain

TrinaTracker contributes almost 40% of total shipment in 2022

TrinaTracker has signed 2.979 GW* of Smart Tacking Systems.



*June, 2023

Trina Tracker
Boosting Power Beyond the Horizon

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Q&A

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by Bella Peacock

[Australian startup launches 6 kW / 7.2 kWh mobile solar generator]

by Bella Peacock

pv magazine webinars

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Monday, 10 July 2023
4:00 pm – 5:00 pm, CEST, Berlin, Paris, Madrid
10:00 am – 11:00 am, EDT New York City

At the cutting edge of PV technology

Thursday, 13 July 2023
4:00 pm – 5:00 pm CEST, Berlin, Paris Madrid
10:00 am – 11:00 am EDT, New York City

Reliability analysis of n-type modules

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pv magazine webinars

Marian Willuhn
Editor
pv magazine

Thank you for joining today!