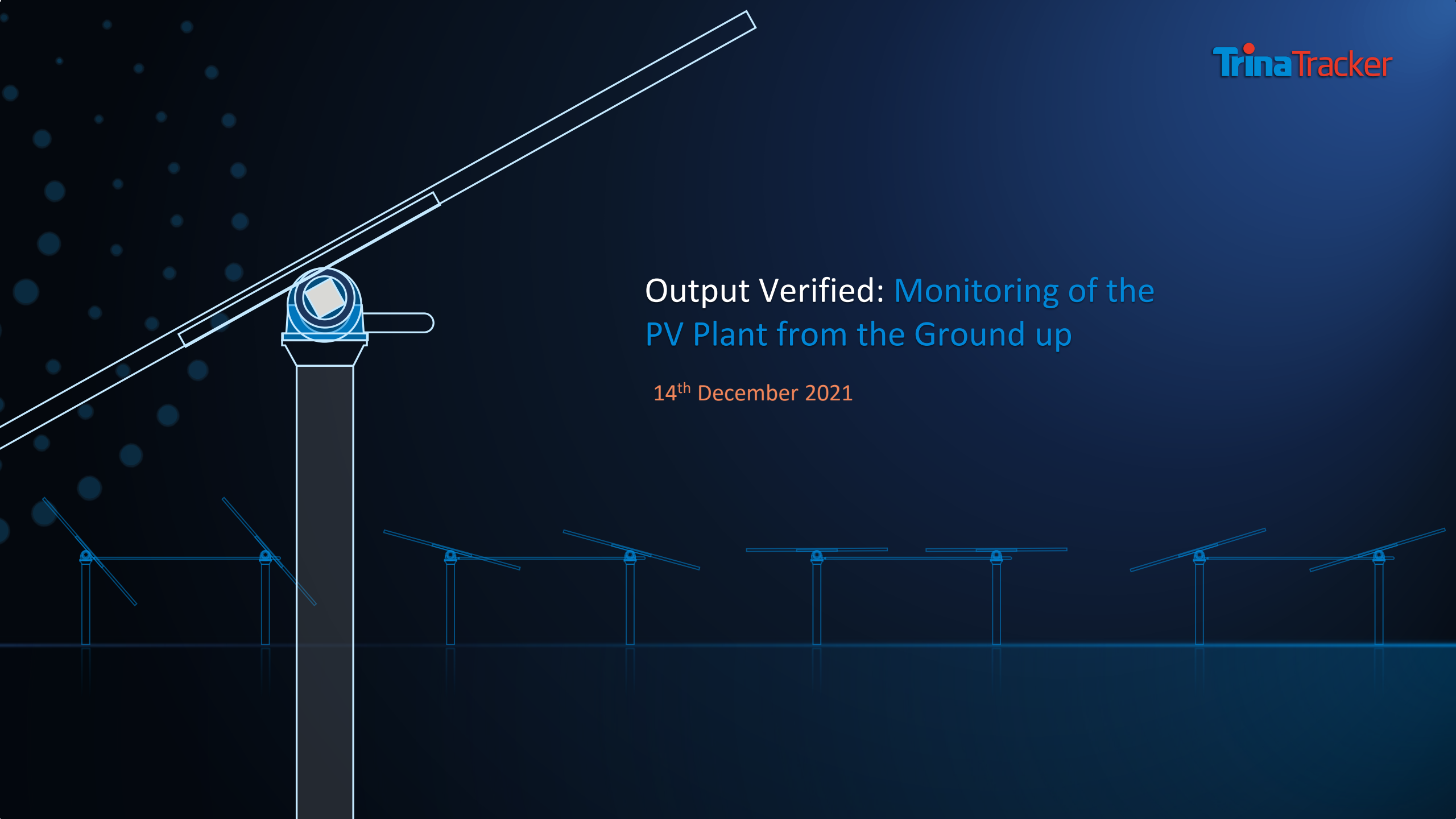


# Output Verified: Monitoring of the PV Plant from the Ground up

14th December 2021

TrinaTracker

# ACHIEVEMENTS

Over **17** Years

Experience

**40** COUNTRIES

Across 5 continents

**7 GW+**

GLOBAL INSTALLATIONS

## Offices & Branches

Spain / France / UAE / United States / Mexico / Brazil / Chile / Australia / China

## Production centers

Spain / Brazil / Argentina / China

TrinaTracker

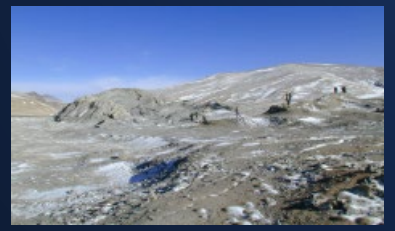
# STATE-OF-THE-ART TRACKER DESIGN ADAPTED TO ANY CONDITIONS

Irregular Site Layout

Uneven Terrain

Strong Wind Region

Difficult Soil



High Corrosive Area


**Reliable aerodynamic stability**

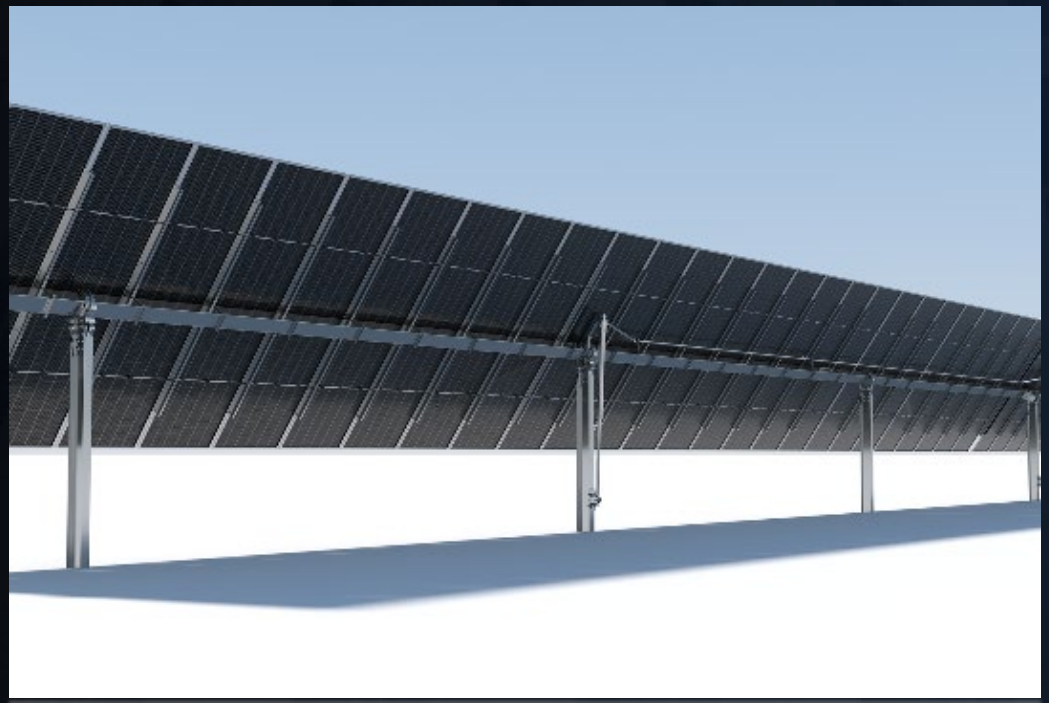
**Compatible** with all module formats

TrinaTracker

# PORTFOLIO

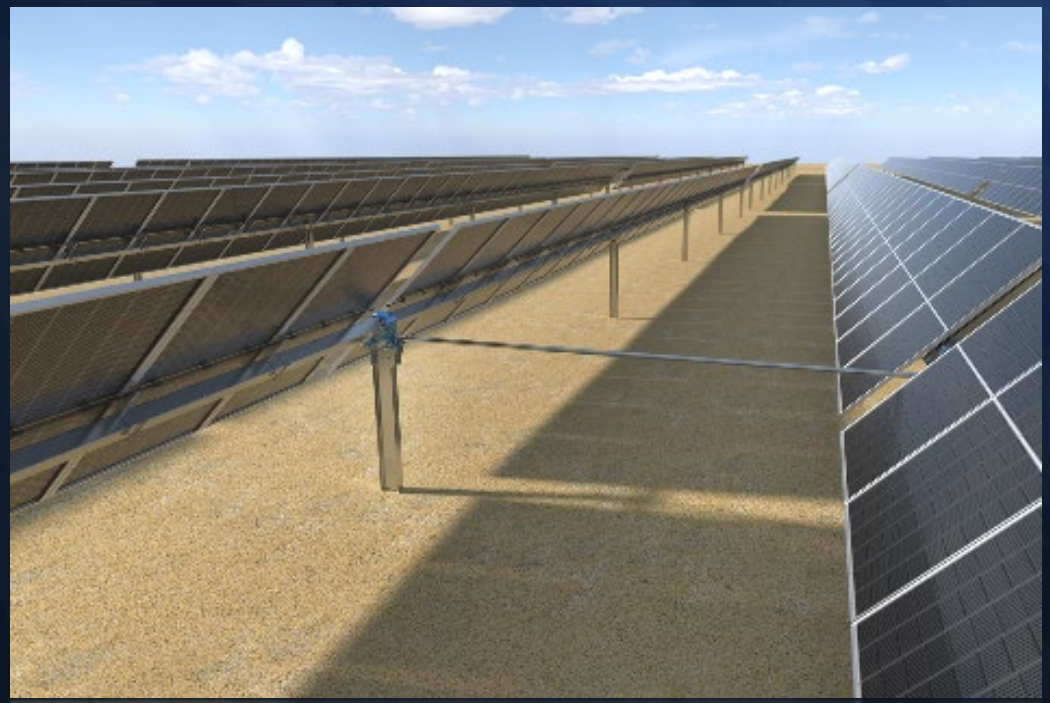
## Vanguard™

Single row 2P



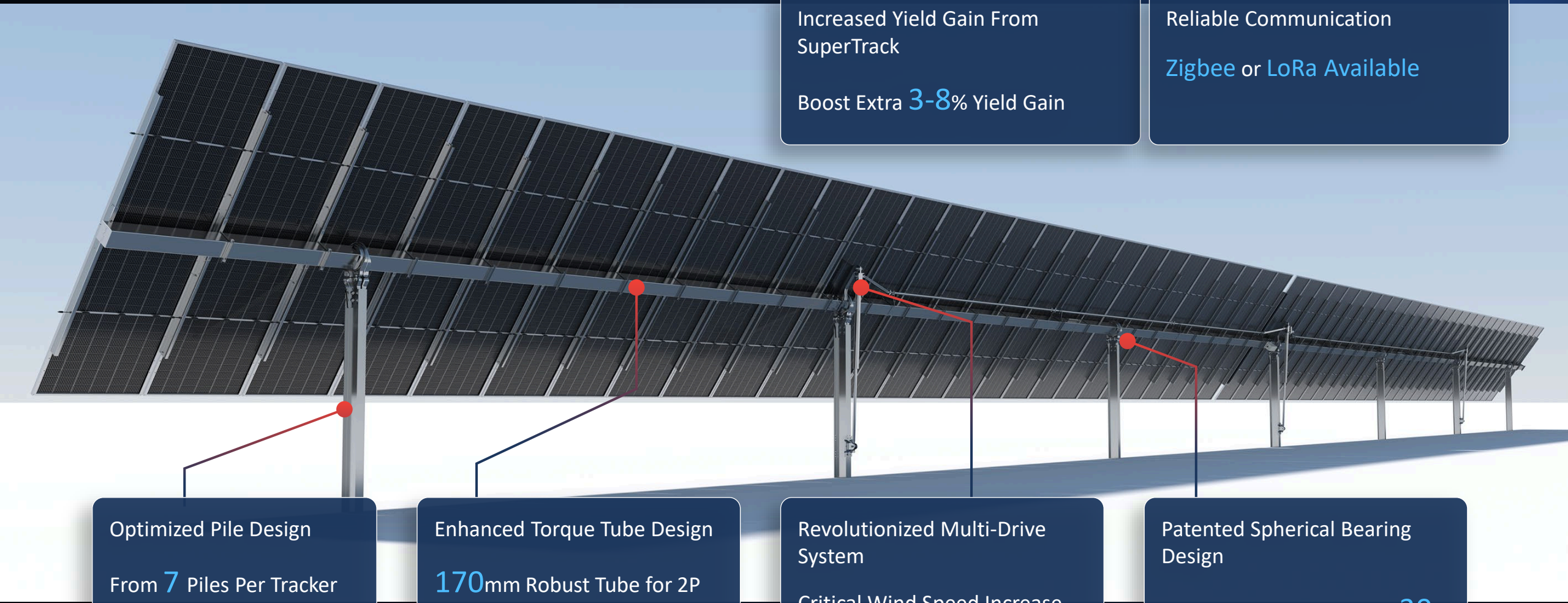
## Agile™

Dual row 1P



TrinaTracker

# Vanguard™ 2P Single Row



Increased Yield Gain From SuperTrack

Boost Extra 3-8% Yield Gain

Reliable Communication

Zigbee or LoRa Available

Optimized Pile Design

From 7 Piles Per Tracker in inner rows

Enhanced Torque Tube Design

170mm Robust Tube for 2P Operation

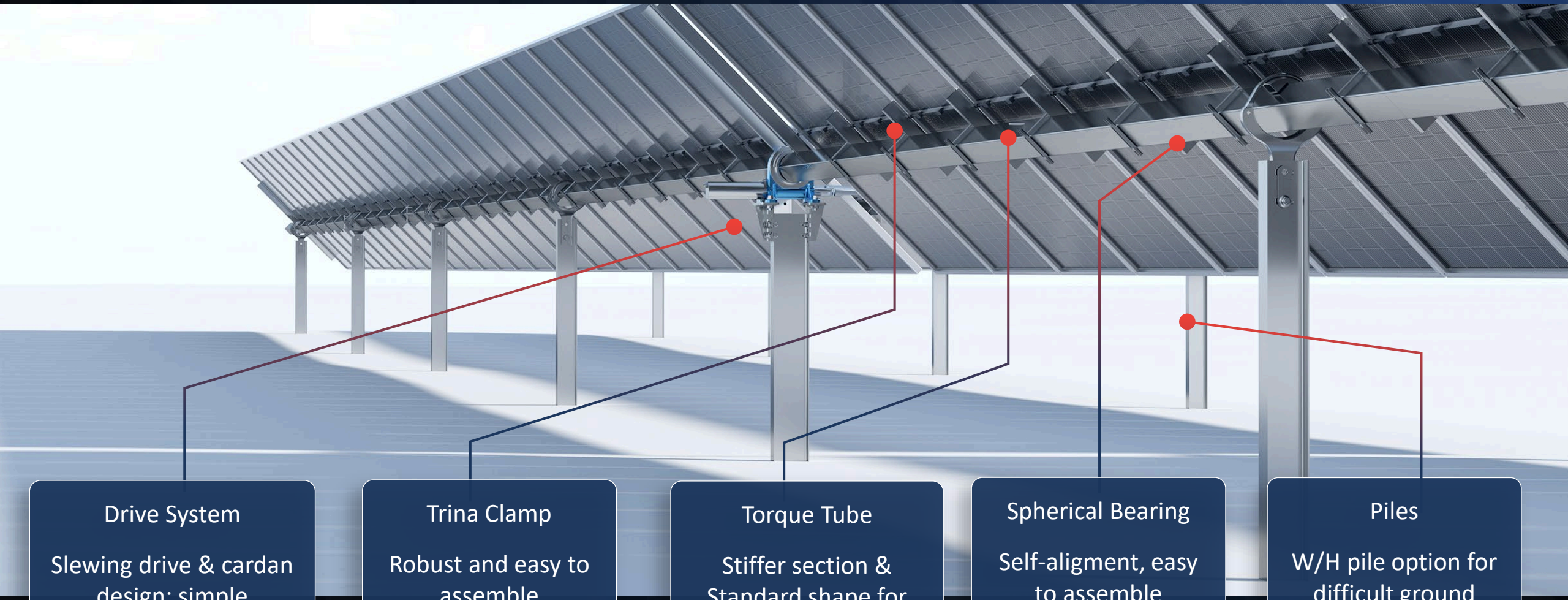
Revolutionized Multi-Drive System

Critical Wind Speed Increase Signifcantly

Patented Spherical Bearing Design

Angle Adjustability Up To 30%

# Agile™ 1P Double Row



**Drive System**

Slewing drive & cardan design: simple assembly process

**Trina Clamp**

Robust and easy to assemble

**Torque Tube**

Stiffer section & Standard shape for supply chain efficiency

**Spherical Bearing**

Self-aligment, easy to assemble

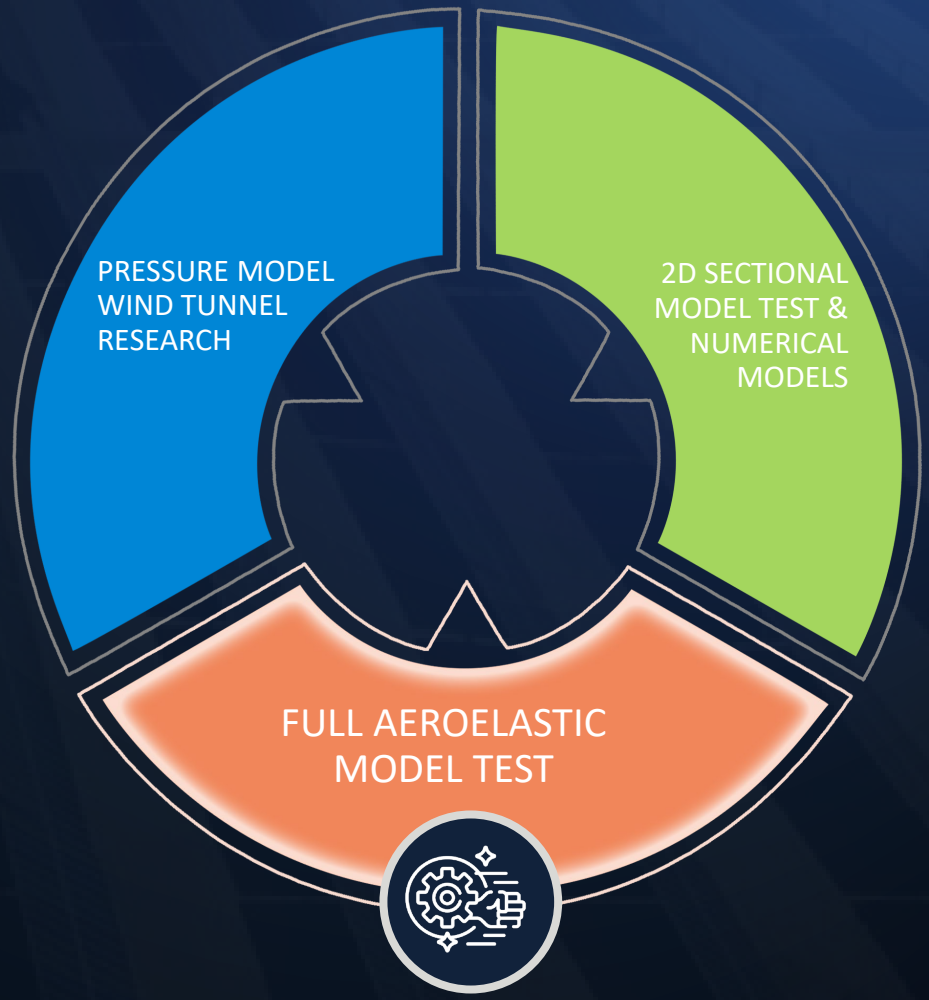
**Piles**

W/H pile option for difficult ground conditions

# WIND TUNNEL TEST PERFORM BY THE TWO WIND ENGINEERING CONSULTANCY LEADERS


RWDI

cpp WIND ENGINEERING & AIR QUALITY CONSULTANTS



# LOWERING LCOE, CAPEX AND OPEX

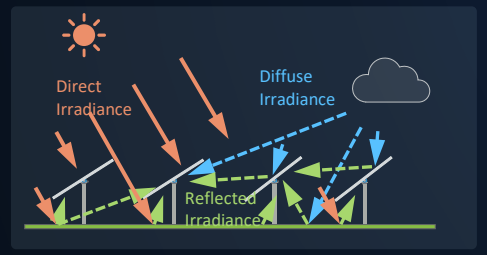
## TrinaTracker Components

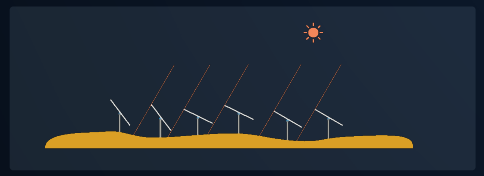
- Optimised Post Design
- Optimised Purlin Design
- Stiffer Torque Tube
- Wind, Snow & Hail Stow Alarms
- Multi-drive Sistems
- Tailored Tracker Layout

+

## High-tech Software Solutions

- SuperTrack algorithm



- Trina Smart Cloud


+

## Preventive Operation & Maintenance

- Components optimization
  1. Nº Motors per MWp
  2. Nº Actuators per MWp
  3. Nº Bearing per MWp
  4. Nº TCUs per MWp
  5. Nº Bolted unions per MWp
- Quality control


=

- Low BOS cost
- Low O&M cost
- High energy yield

# TRINA IOT LAYOUT

First-class intelligent total solution provider

## Business

### 1.0 PV Product

- High efficiency modules

### 2.0 PV System

- Development and construction of large power stations
- Intelligent distributed energy solutions
- Intelligent optimization solution

### 3.0 Internet Of Things (IOT)

- Integrated energy services
- Energy storage intelligent solutions

# TRINA IOT SOLUTION

## Intelligent IOT platform. Sharing new momentum of IOT

### PV power

- ✓ Intelligent cloud
- ✓ Monitor & control
- ✓ Data sharing
- ✓ Smart O&M
- ✓ SCADA system

### Campus micro-grid

- ✓ Energy monitoring
- ✓ Energy efficiency
- ✓ Equipment maintenance
- ✓ Energy saving analysis

### Factory digitalization

- ✓ Intelligent power distribution
- ✓ Energy center
- ✓ Production scheduling
- ✓ Operations management
- ✓ Environmental monitoring

### Intelligent building

- ✓ Energy management
- ✓ Environmental monitoring
- ✓ Intelligent Device
- ✓ Intelligent Control

### Commercial complex

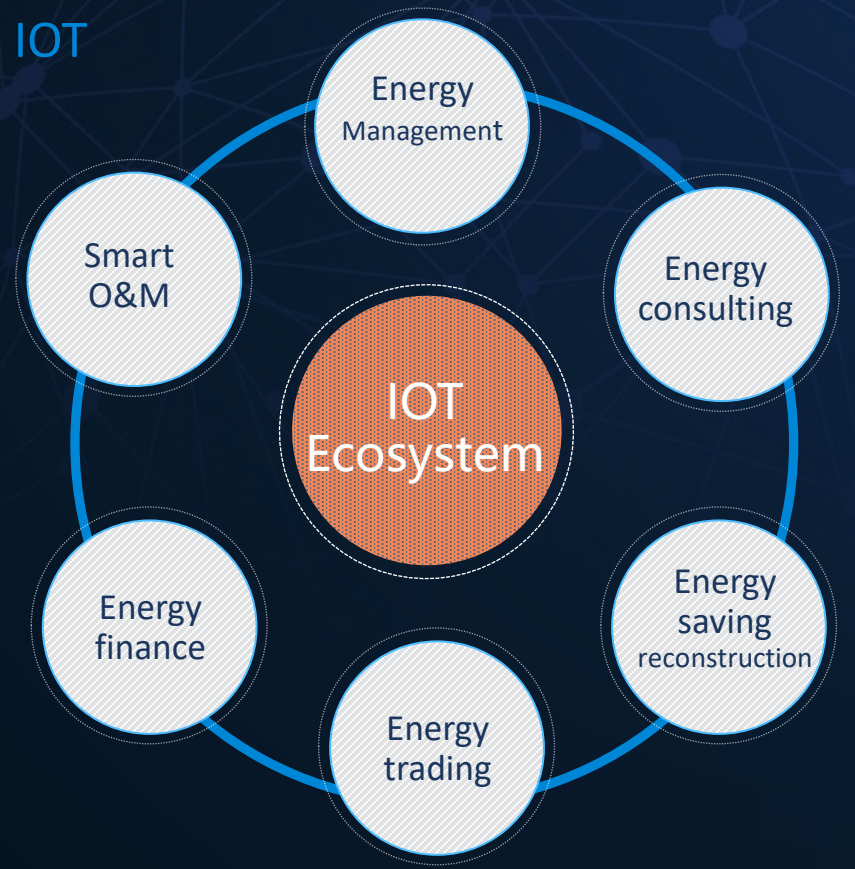
- ✓ Energy consumption management
- ✓ Operations management
- ✓ Marketing assistant
- ✓ Group management
- ✓ Security system

# CREATE IOT ECOSYSTEM, TOWARDS NEW ERA

Intelligent IOT platform. Sharing new momentum of IOT

## Partners


## IOT




## End users

- ✓ Power generation company
- ✓ New energy enterprise
- ✓ Power grid company
- ✓ Sell electricity enterprises
- ✓ Small and medium-sized electricity users
- ✓ Industrial enterprise
- ✓ Public facilities
- ✓ Wisdom city

# WHAT IS Trina Smart Cloud?

An Intelligent tracking solution

## Centralized intelligent operation

### System Diagnosis + Smart O&M

- ✓ Safer & more reliable with “Active Stow Protection”
- ✓ Smart analysis of operating states, pre-warning O&M instructions
- ✓ Fault diagnosis and O&M suggestions in advance
- ✓ Improve O&M efficiency
- ✓ Reduce O&M cost

## Numerical solar tracker solution

### Monitoring & Alarm + Online analysis + Remote Control

- ✓ Data acquisition: Visualization of real-time status and performance
- ✓ Monitor the system availability
- ✓ Visualization of alarms & events
- ✓ Real-time rapid data analysis and processing
- ✓ Intelligent and precise control remotely and accurately

# HOW Trina Smart Cloud CAN BENEFIT O&M?

1. Digital intelligent Real-time monitoring

**For operation and maintenance staff:**

- ✓ Monitors PV plant in real-time and remotely
- ✓ Reduces management costs

2. Real-time and rapid Data online analysis

**For operation and maintenance staff:**

- ✓ Provides O&M suggestions
- ✓ Improves the reliability of PV power plant

3. Real-time alarm detailed information

**For operation and maintenance staff:**

- ✓ Discovers faulty equipment in time
- ✓ Takes effective measures
- ✓ Improves O&M efficiency

4. Remote precise control & command

**For operation and maintenance staff:**

- ✓ Improves O&M efficiency
- ✓ Reduces the total costs

# HOW DOES Trina Smart Cloud REDUCE LCOE?

Functionalities

- ✓ Integrated alarm protection
- ✓ Integrated cleaning robot
- ✓ Integrated smart tracking algorithm
- ✓ PR diagnosis & analysis

→ Reduces power loss, improves system efficiency → Power Saving

- ✓ Quick trouble shooting
- ✓ Quick remote commissioning
- ✓ Package offer, fast site deployment

→ Improves O&M efficiency reduces O&M cost & time → O&M Saving

- ✓ Provides data package API
- ✓ Highly visualized Human Machine Interface
- ✓ Mature customized configuration

→ User-friendly software, easy to integrate into other platforms → Easy Hardware & Software

Reducing LCOE

LCOE

Trina Smart Cloud

# WHY DOES Trina Smart Cloud DRIVE SMART O&M?

Online analysis

Analysis

Tracking solution

Data

Control

Monitoring and Data acquisition

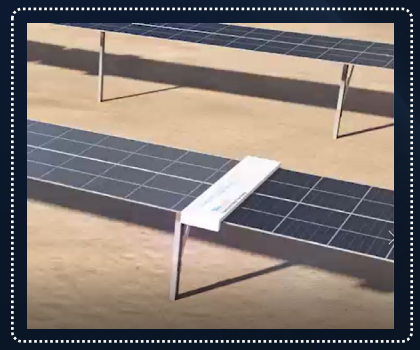
Remote Control

Smart O&M

Full diagnosis and O&M suggestions in advance

PR Analysis and Recommendations

Control of intelligent cleaning robot



# 15 Output Verified: Monitoring of the PV Plant from the Ground up

# Trina Smart Cloud: INTELLIGENT, EFFICIENT, RELIABLE & SAFE

For the whole solar power plants: Remote and advanced monitoring and control system

Its centralized intelligent algorithm that drives intelligent O&M tracking


It increases performance and productivity with the power of the comprehensive and reliable data

- Weather Data
- NCU
- TCU
- Inverter
- Transformer
- PV string

It enables reliable and precise operation across a wide range of weather conditions

It provides full diagnosis and O&M suggestions in advance to ensure stable operation of whole PV station

BayWa r.e.

r.e.think energy

# SCADA data @ BayWa r.e.:
# needs from an EPC, O&M and IPP perspective

# BayWa r.e.‘s portfolio covers a broad range of renewable energies


**4 GW** **installed capacity** in wind and solar globally.

**16 GW** global **project pipeline** solar and onshore and offshore wind.


**9 GW** under **operational management; digital asset operations** expertise and **technical management** for solar, wind farms and biogas plants; services in energy trading.

**7 GW** **direct marketing portfolio** and broad energy trading services incl. PPA**.**

New **IPP portfolio** plans to ramp up to 2.5 GW in the medium term.


**25 years** of **solar distribution experience**, a wide range of quality products and services for about **11,000** **installation** and **sales partners** globally.

**Tailor-made** **Energy Solutions** for **commercial and industrial clients** from self-consumption to green energy supply.

# Monitoring focus EPC, O&M and asset owner

Project life time (25 – 30 years)

## EPC

(2 years)

- Commissioning
- Successful PR test
- Plant design
- Monitoring of of warranties

## O&M

(~ 2 - 5 years)

- Reaction times
- Automated alarms
- Process driven (CC + onsite staff)
- Automated reporting

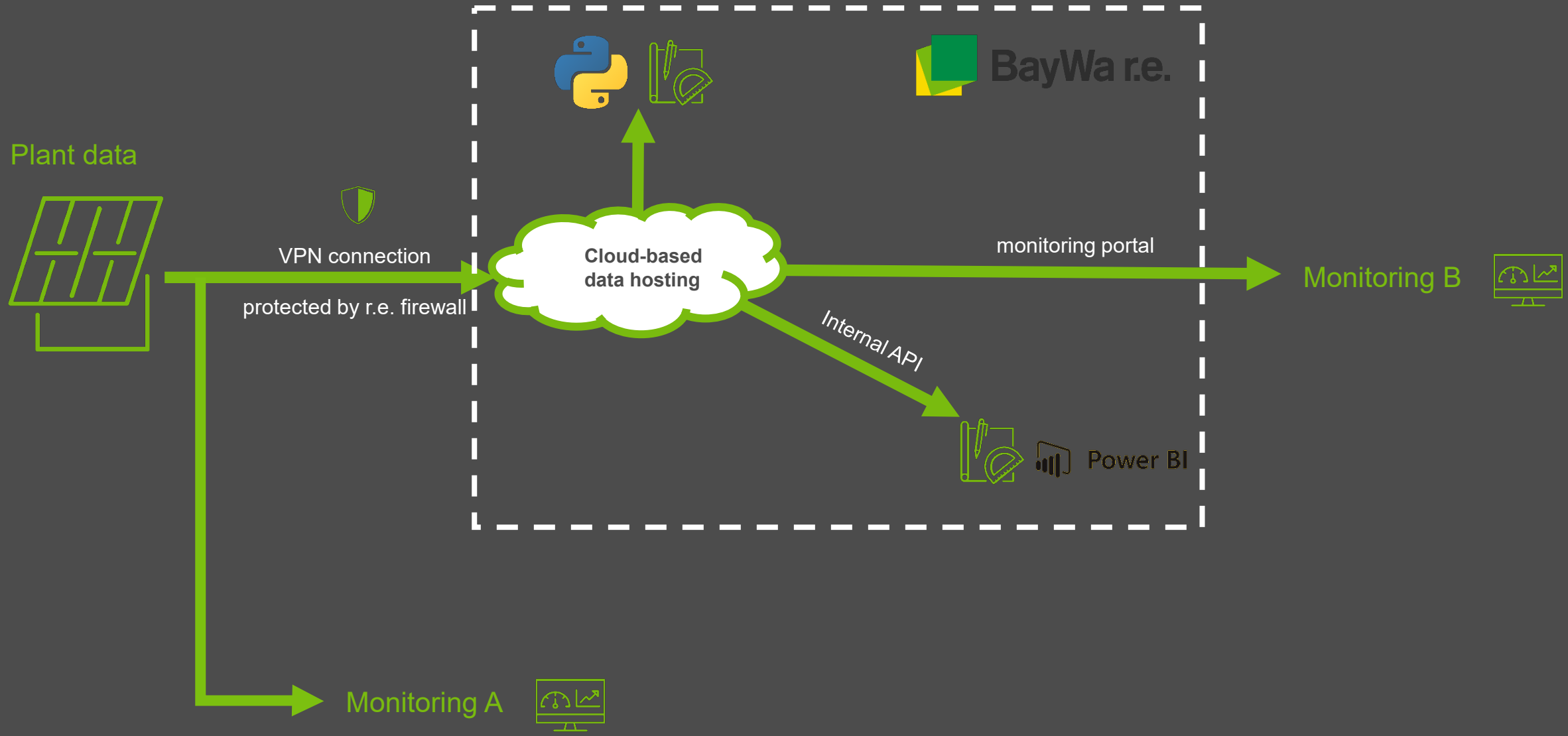
## Technical asset manager

(enfire project lifetime)

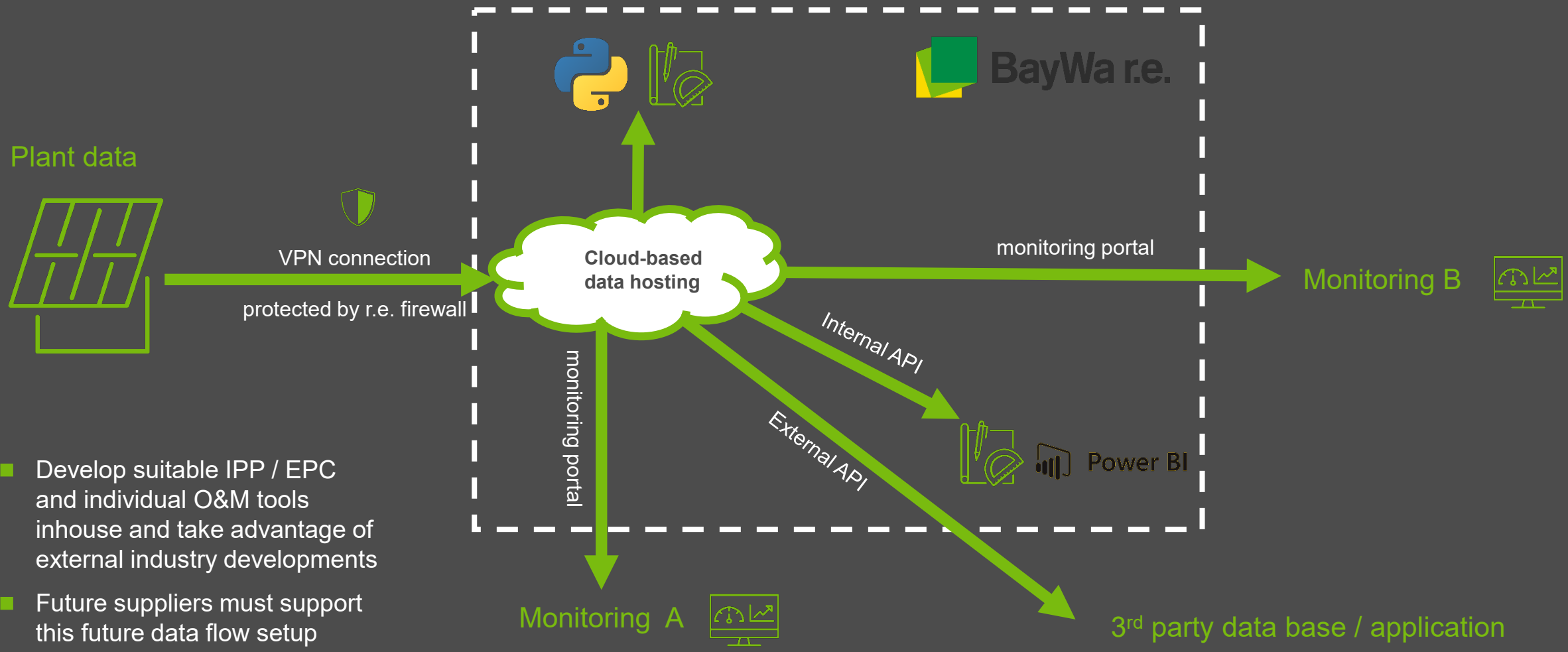
- Trend analysis
- OPEX optimization
- Design optimization
- Warranty claims

- Existing solutions mainly focusing on O&M demands
- Increasing complexity and system individuality (trackers, East-West orientation, storage, feed-in schemes…)

# Current data flow model @ BayWa r.e.

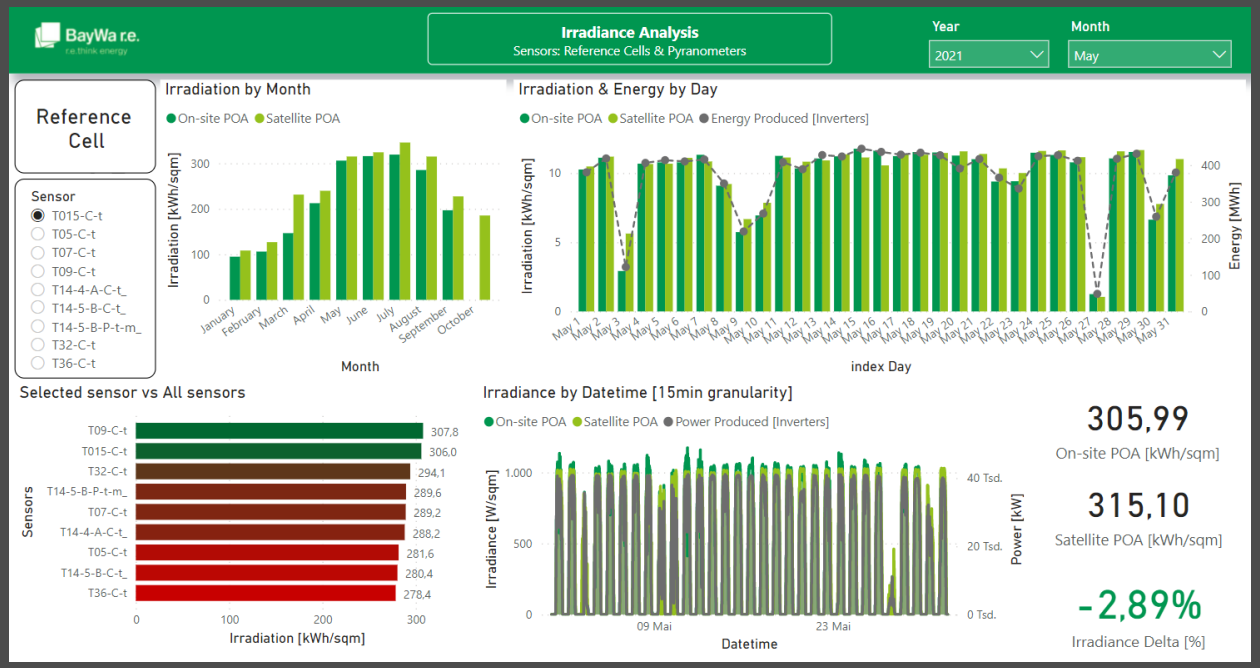


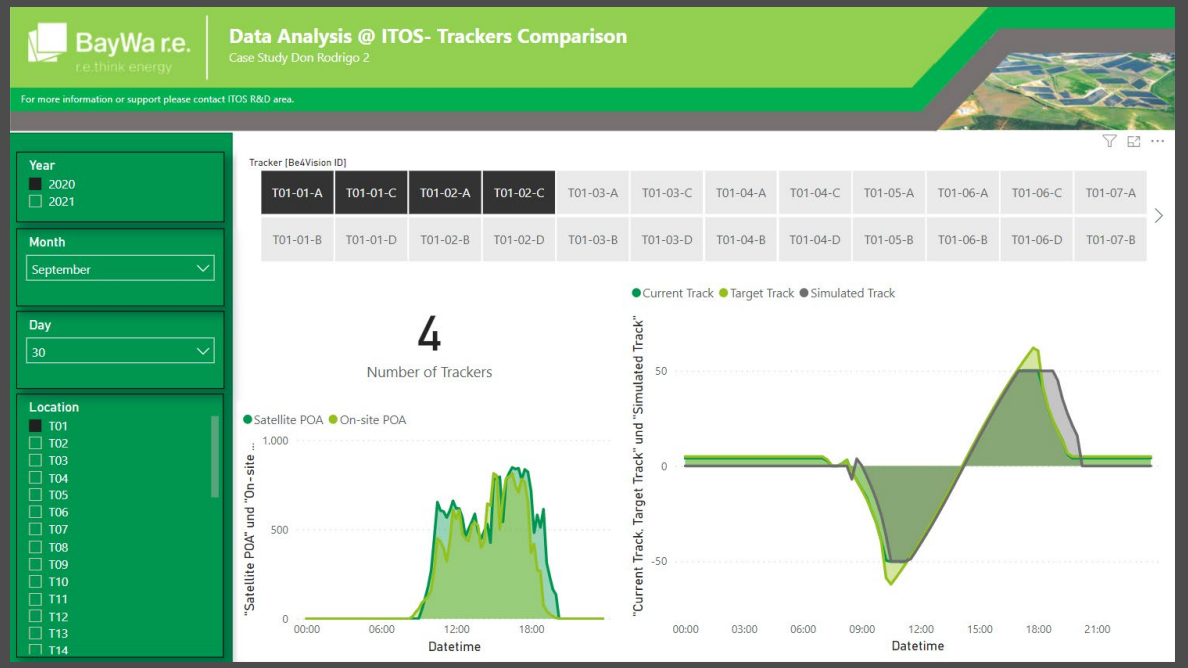
# Future data flow model @ BayWa r.e.




- Develop suitable IPP / EPC and individual O&M tools inhouse and take advantage of external industry developments
- Future suppliers must support this future data flow setup

# Example for individual BayWa r.e. solutions with Power BI & pvlib



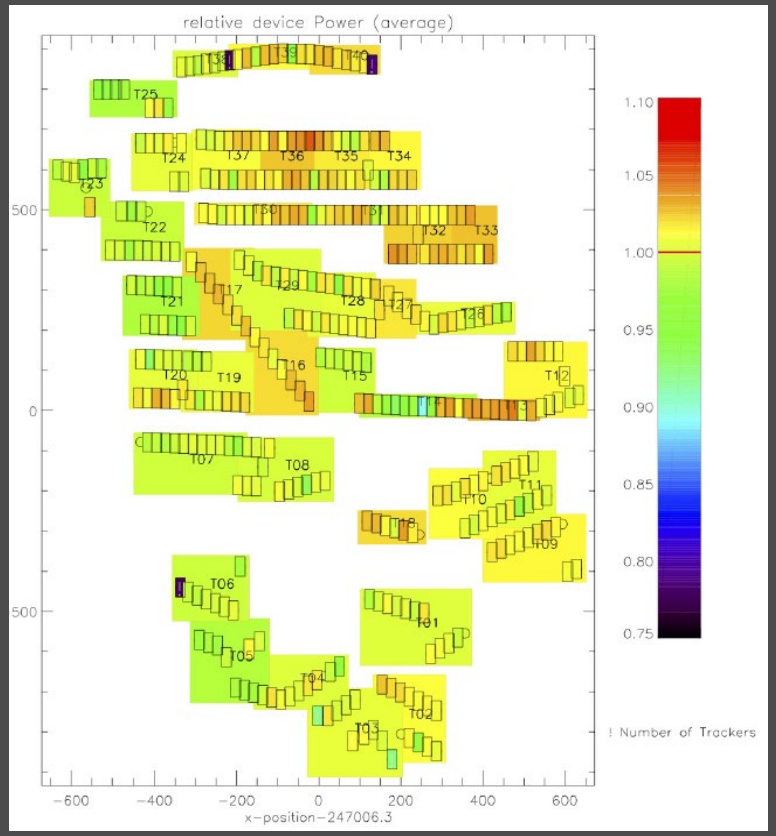

**Problem:**
Irradiance data quality in regular operation (**O&M**)

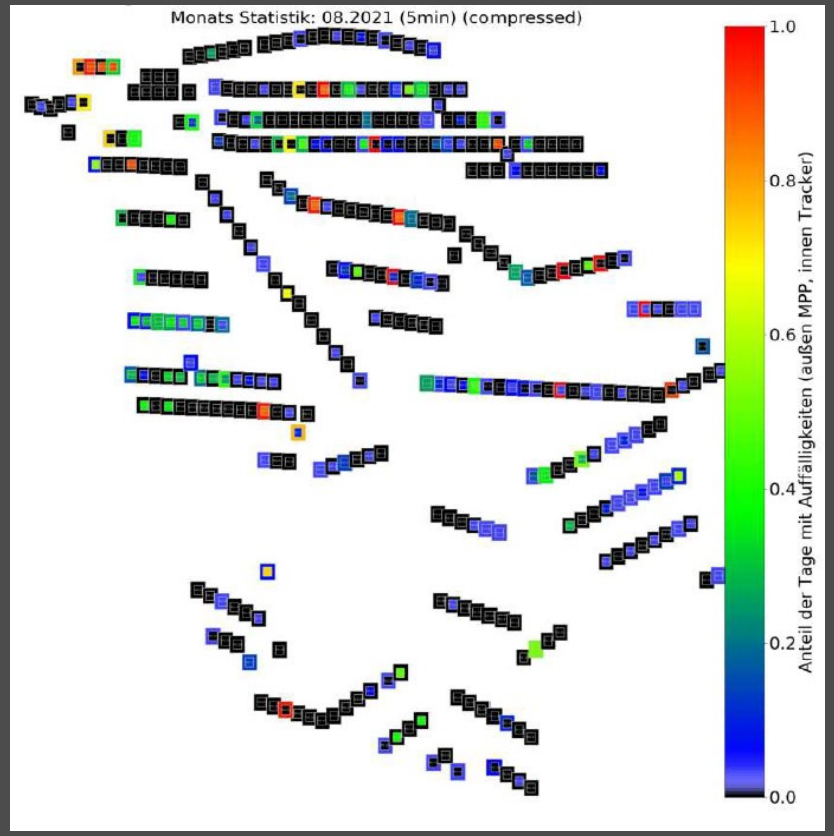
**Solution:**
Building up an dash board for individual irradiance data quality monitoring in Power BI

**Problem:**
Scrutinize tracking / backtracking parameters of a supplier (**EPC**)

**Solution:**
Internal simulation of tracker angles with pvlib and comparison with actual figures in Power BI

# Example for individual BayWa r.e. solutions with Python




**Problem:**
Influence of plant topography on backtracking (**EPC**)

**Solution:**
Visualization of inverter production in the morning / evening hours as a function of the gradient with Python

**Problem:**
Effect of misaligned tracker units on production (**EPC/O&M**)

**Solution:**
Coupling of mechanical and electrical components with Python

# Conclusion

- BayWa r.e. as the data gate keeper
- BayWa r.e.'s set up
  - Constant market screening of suitable 3rd party data analysis solutions via external API ("not re-inventing the wheel")
  - Constand development of individual tools via internal API (currently Power BI or Python scripts)
- O&M Monitoring must haves
  - Display of all relevant components in one overview where it is relevant (e.g. trackers and inverters)
  - Logical dependencies of components reflected in failure management (transformer / inverter / trackers)
  - Integration flexibility of all suppliers and technologies (e.g. storage)
  - Propper criticality alarm assessment

| *Component* | *Monitoring / review cycle* | *Criticality* |
|---|---|---|
| Transformers | daily O&M routine | Highest |
| Inverters | daily O&M routine | High |
| Tracking | daily O&M routine | Medium |
| Modules | monthly/quarterly – trend | Highest |
| Backtracking | monthly/quarterly – trend | Medium |

- Compliance of any solution applied with mandatory legal IT security standards
  - BayWa r.e. implemented an Information Security Management System (ISMS) over the last two years, successful ISO 27001 certification audit by TÜV Süd (49 CW 2021)
  - Europe NIS directive (e.g. KRITIS in Germany) / USA NERC

**Christoph Reiners**

Head of product management ground mounted PV systems

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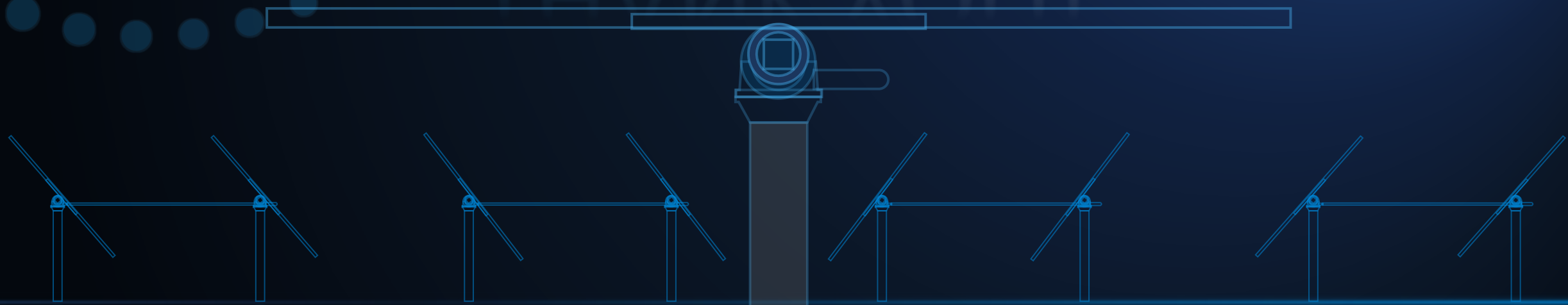
# Copyright

# THANK YOU!



Please feel free to contact us at info.trinatracker@trinasolar.com