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pv magazine webinars

How to deal with wind stability issues in tracker-based solar projects

11 November 2025

1:30 pm – 2:30 pm | CET, Berlin, Paris

12:30 pm – 1:30 pm | GMT, London

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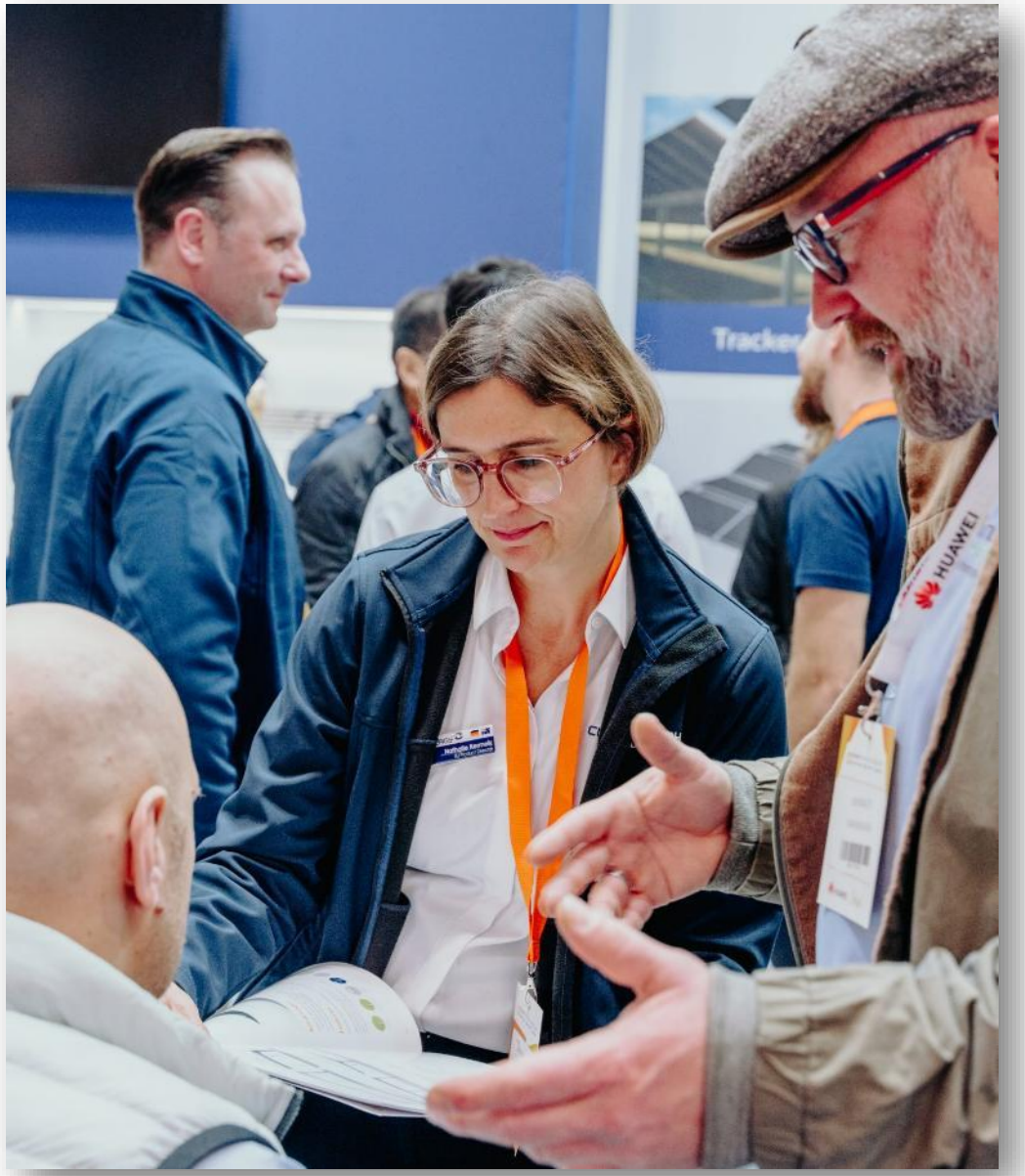


CLENERGY

Product Line

PV-ezRACK®

BUILT TO LAST

Solar Mounting Solutions

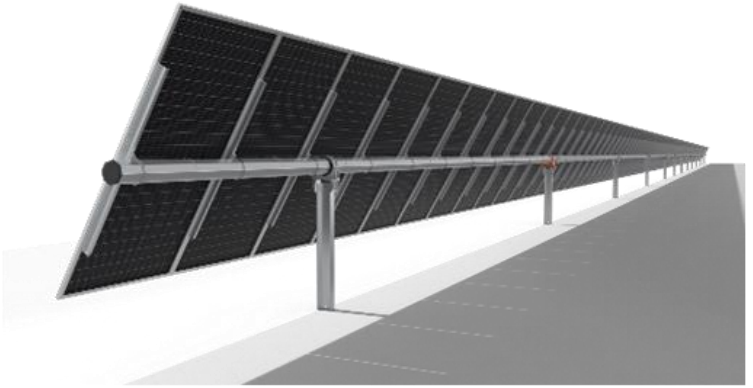
PV-ezRACK®

A Clenergy Product Line

Introducing our Tracker Series

ezTRACKER®

ezTRACKER®



D1P

One Portrait Horizontal

- Single-axis
- Reliable in real world projects
- 1 slew drive and damper

D1P120

One Portrait Smart Solar

D2P120

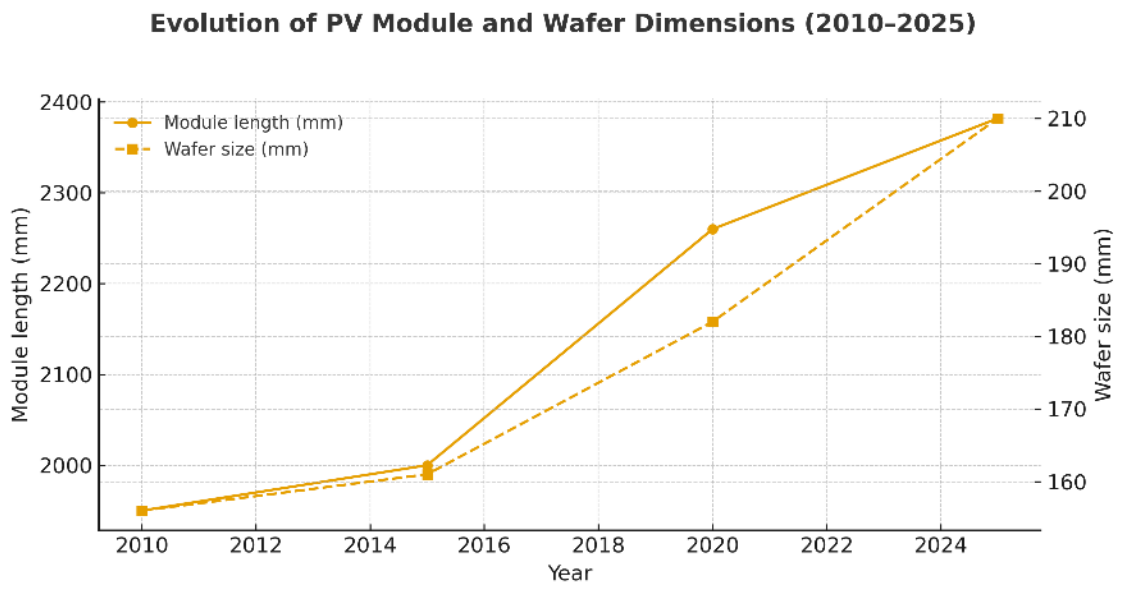
Two Portrait Smart Solar

- Multi-drive system for maximum aeroelastic stability
- Higher power density - supports up to 120 modules with 4×1,500V-strings
- D2P120 is suitable for Agrivoltaics

Why wind forces matter on trackers?

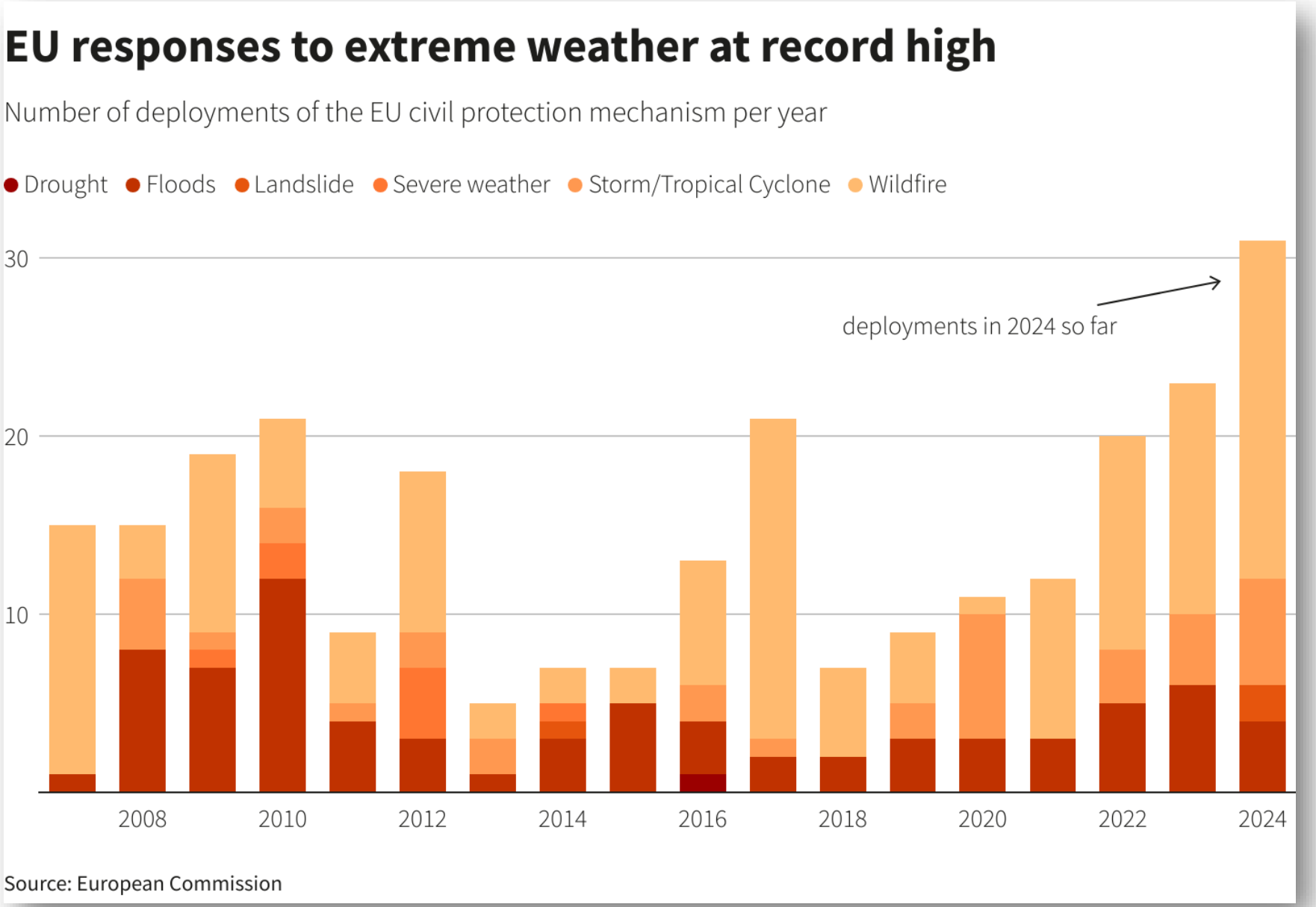
Why wind forces matter on trackers?

- Increasing module sizes in the last 15 years
- Typical 2010 Conditions: 100 tons per MW.
- Current Conditions: 30 - 40 tons
- Special Parameters: Torsional fixation in the centre



Why wind forces matter on trackers?

- Stronger and more frequent wind events
- Expensive failure downtime and damages
- Storm prone wind regions in Europe



How wind interacts with trackers ?

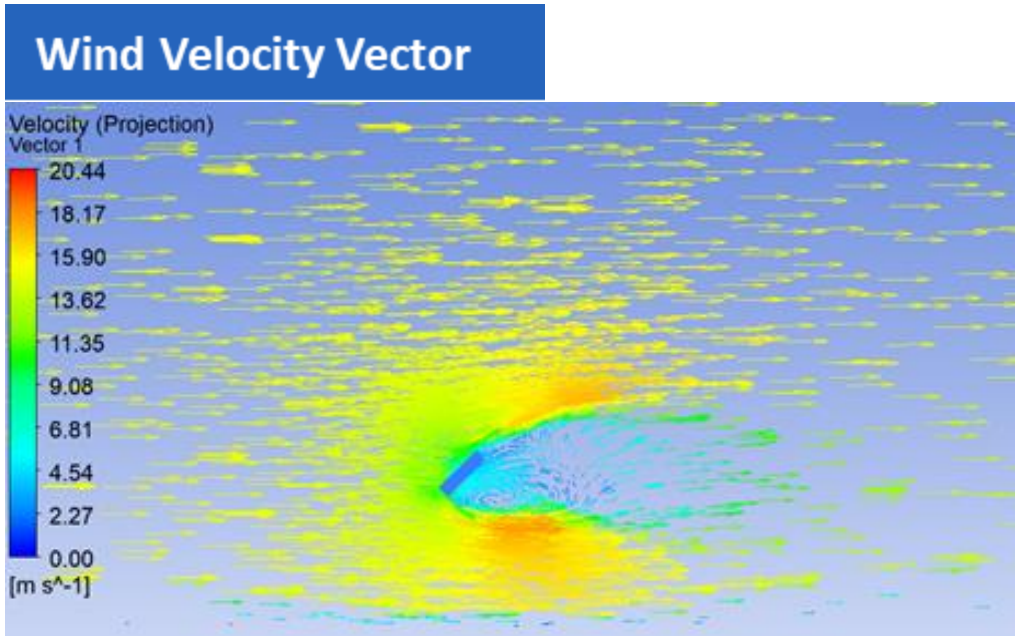
→Static (quasi-static) wind load

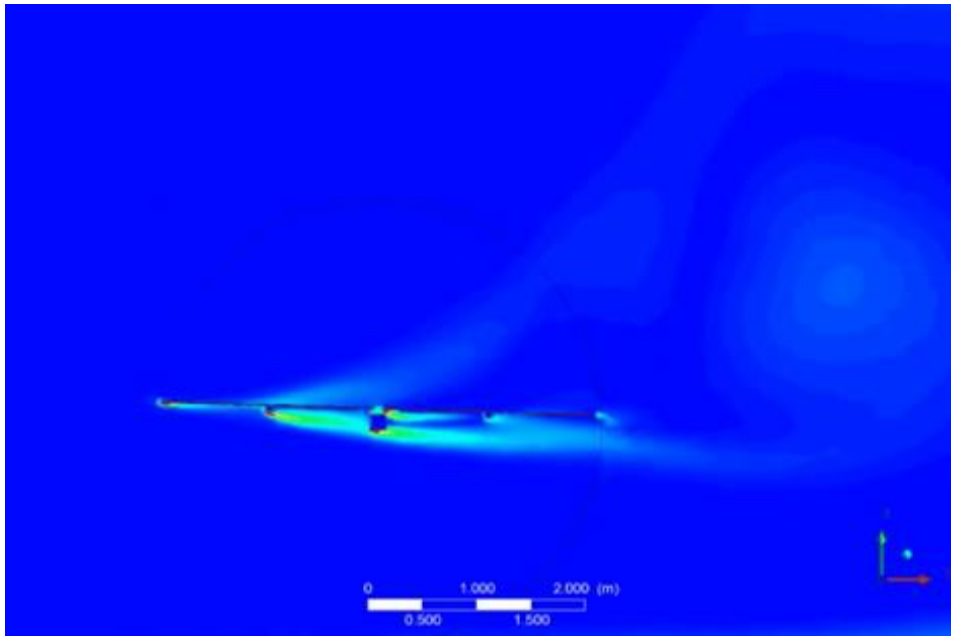
- Steady aerodynamic pressure

- Mainly affects structural strength and deflection limits

→Dynamic wind load

- Caused by turbulent gusts, vortex shedding, and aeroelastic effects





CPP WIND ENGINEERING CONSULTANTS

What We Do | Portfolio | Who We Are | Resources | News | Careers | Contact

Wind Affects Our World. We Know How.

Providing industry-leading wind consulting services to architects, engineers, and developers around the world. When you know how wind affects our world, your buildings can be safer, more comfortable, and more efficient.

Wind On Solar Arrays

How wind interacts with trackers ?

- Reliable and stable performance in CPP wind tunnel model

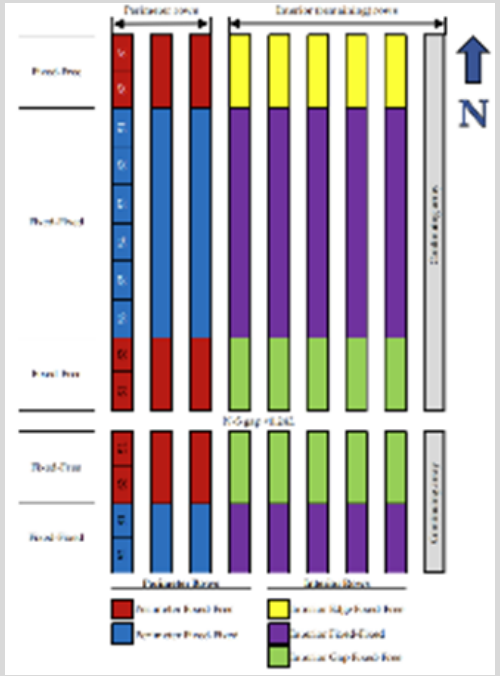
Conducted full-scale wind-tunnel testing with CPP

- Performed CFD transient simulations to study pressure fields and flow paths
- Correlated test and simulation data to refine our tracker aerodynamic model

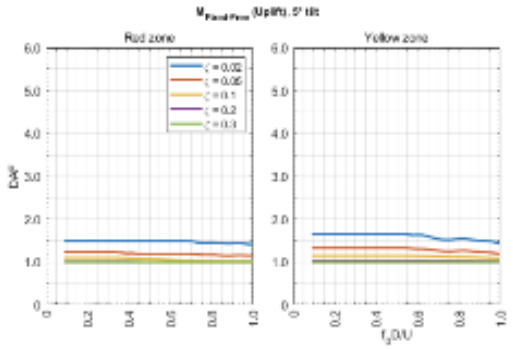
How we react to the challenges

Aerodynamic Optimisation

① Static pressure tests



② DAFs study



③ Damping pluck tests

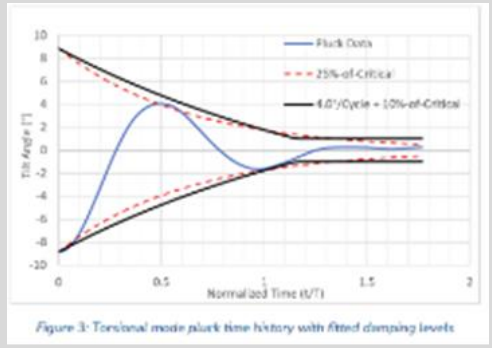


Figure 3: Torsional mode pluck time history with fitted damping levels

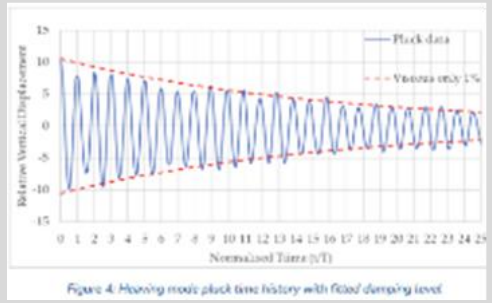


Figure 4: Heaving mode pluck time history with fitted damping level

④ Aeroelastic stability Study

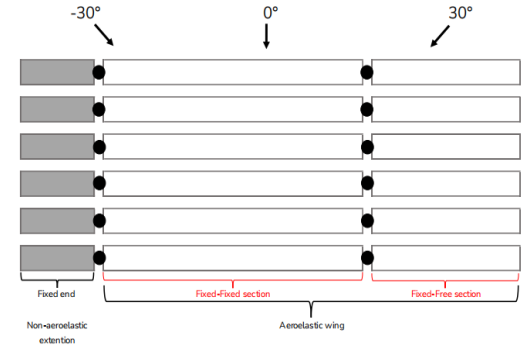


Figure 4: Schematic of the wind tunnel setup for a generic single axis multi-drive tracker

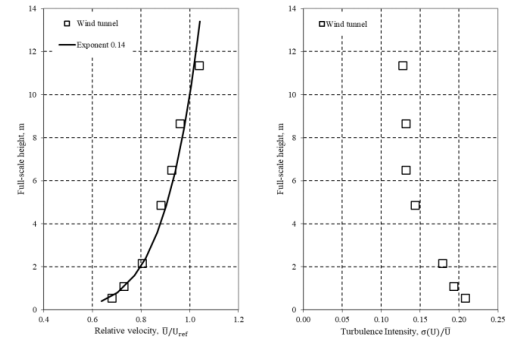
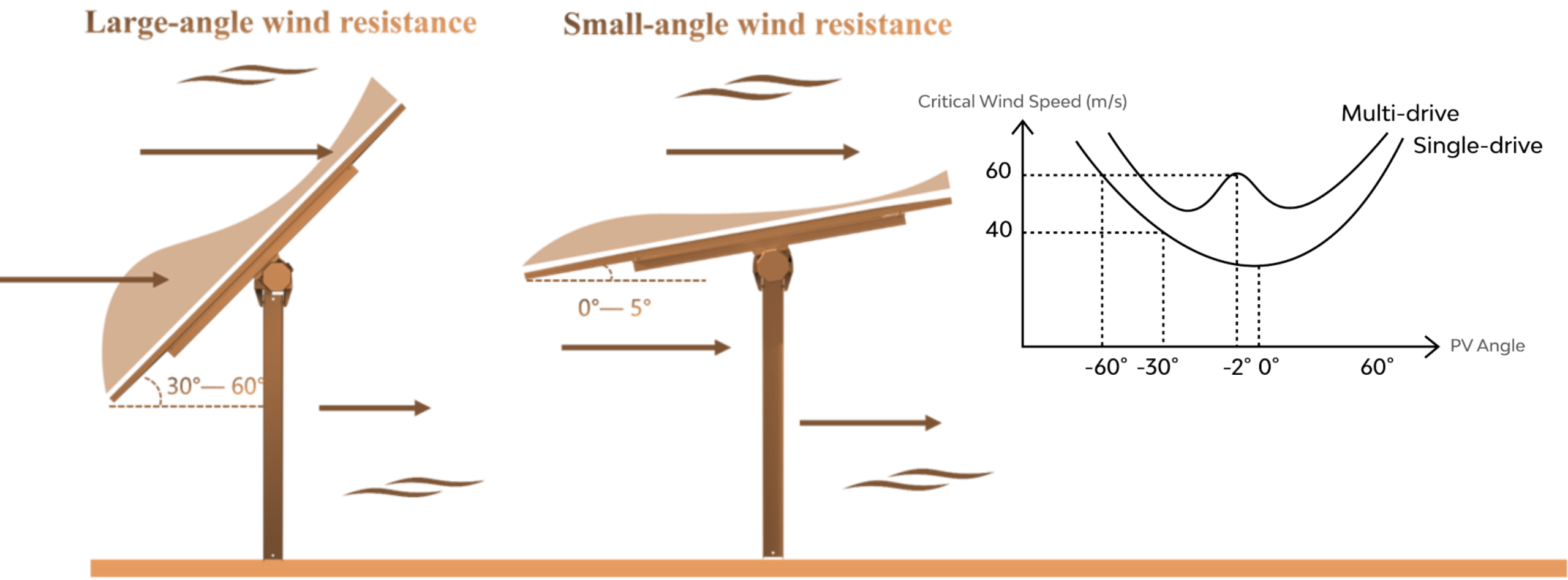


Figure 5: Velocity and Turbulence profiles, measured at the location of the first row in the absence of the model.

Transition from Single-point Drive to Multi-point Drive



ezTRACKER®

ezDrive5.0™ Redefining System Stability

Critical Buffeting Speed Up to

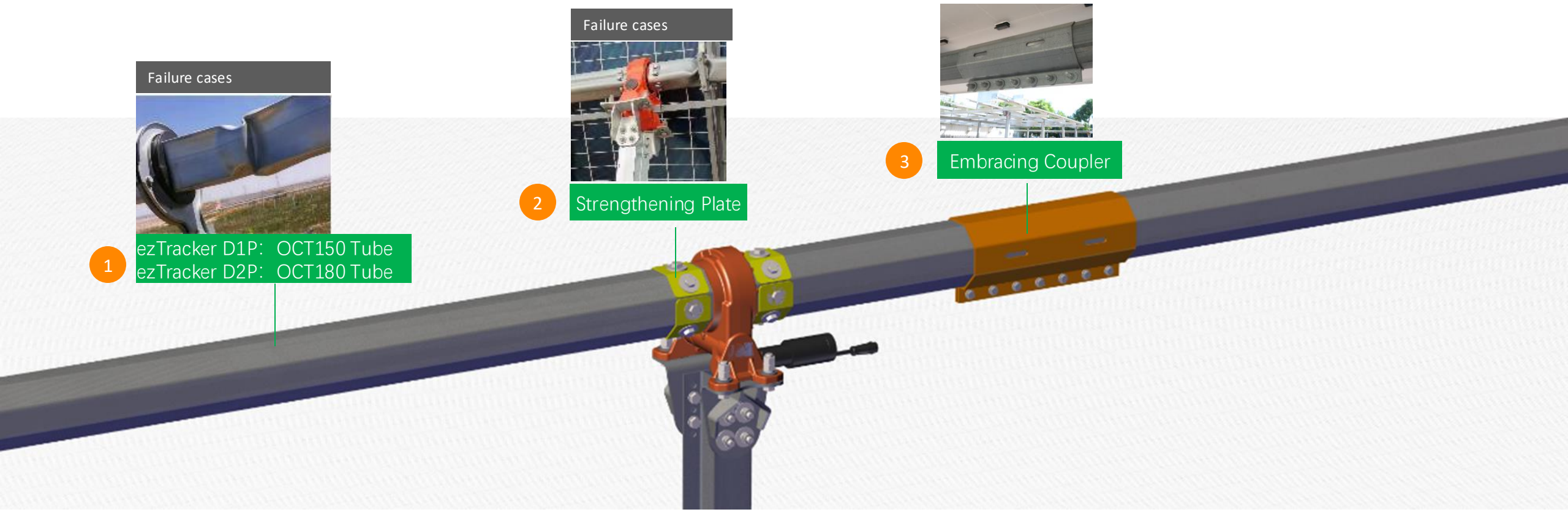
60m/s **(Equivalent to Category 4 Hurricane)**

Aerodynamic Torque Pulsation Attenuation decays by

70% **(Component Stress Life Doubled)**

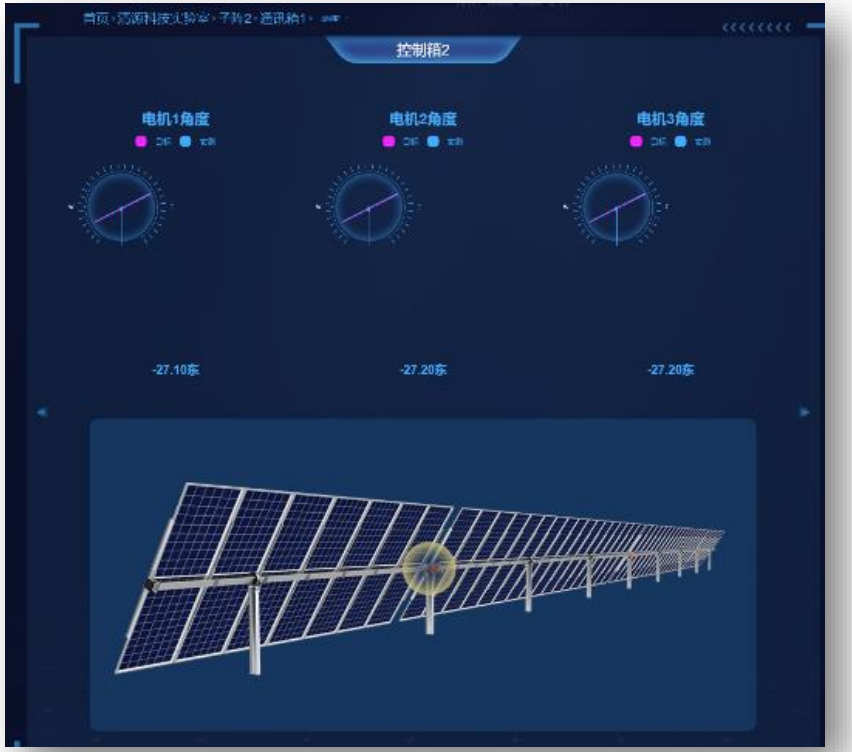
High-strength Torque Tube

1. Improved overall performance by 60% compared to traditional square tubes.
2. 50% improvement in performance
3. Reduce the number of bolts by 30% and shorten installation time by 50%.



Smart control system

- Patented Multi-drive Electrical Synchronisation technology
- Achieve synchronous operation of multiple motors on the same row
- A combination of electronic intelligence and mechanical balance.

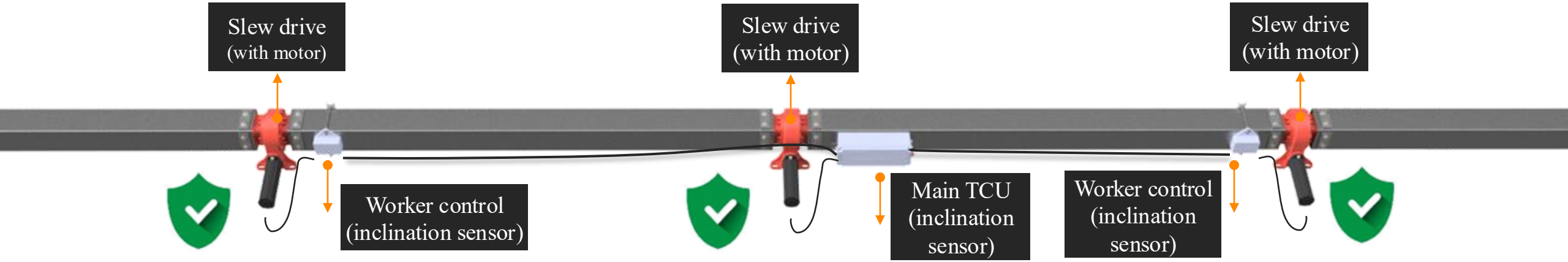


Dynamic power allocation

Fault Protection Mechanisms

Real time monitoring and self - calibration

Better Tracking Accuracy



Communication Topology of ezTracker System

Benefits:

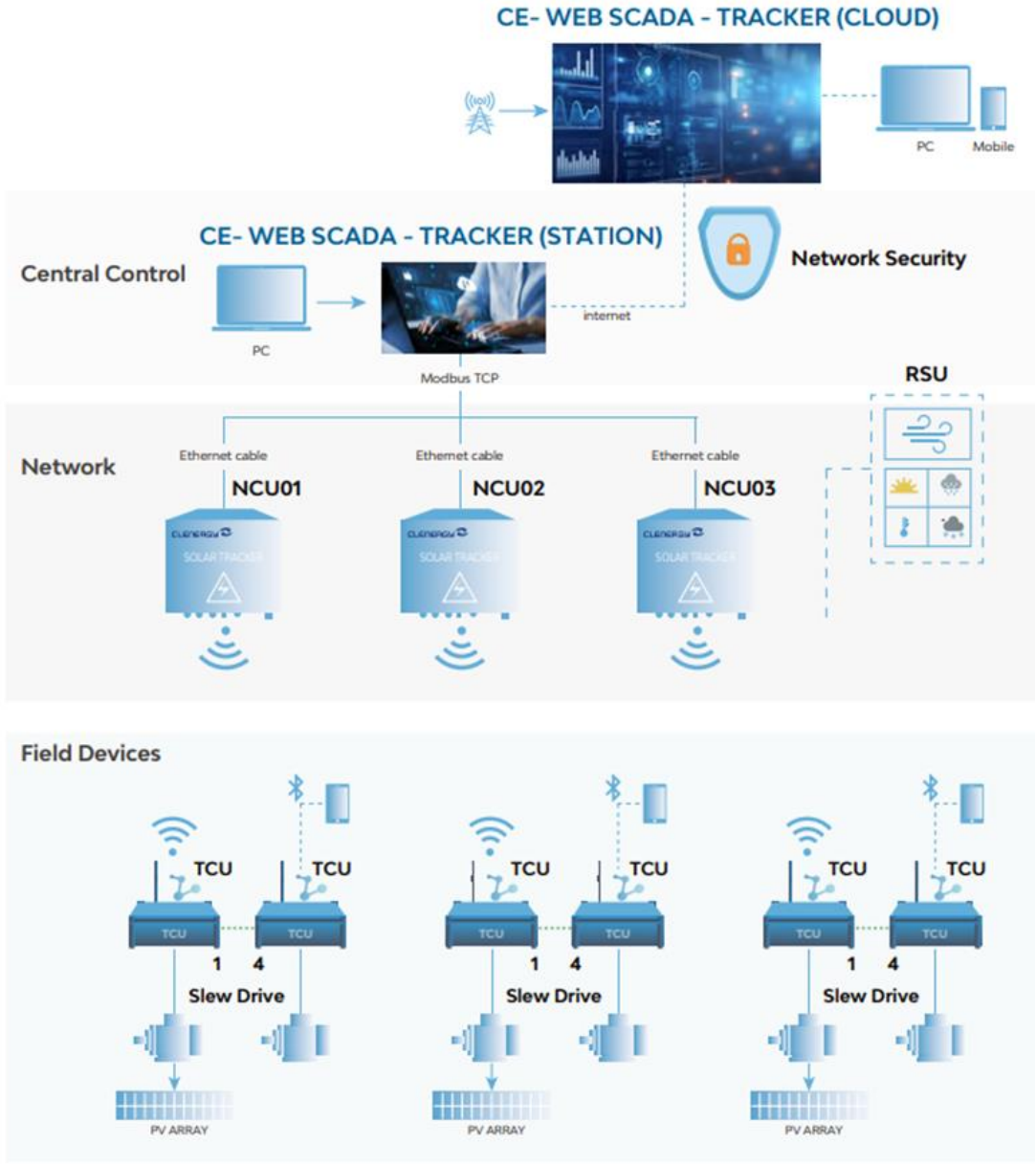
- Faster reaction to issues
- Reduced O&M costs & maximize efficiency
- Lower levelized cost of energy (LCOE)

Key features:

- Real-time monitoring
- Data analysis
- Remote control
- Preventative response

Why Sub1G?

- Support Mesh
- Strong Anti-interference and Penetrability



How Clenergy Meets Global Tracker Reliability Standards

IEC 62817 Test Category	Purpose
Functional Validation	Validate tracking, limits, and recovery functions
Performance Tests	Energy efficiency and stow operation
Mechanical Testing	Structural stiffness and deflection under load
Environmental Testing	Thermal, dust, humidity, freeze, water ingress
Accelerated Mechanical Cycling	Lifetime durability (10 years simulation)
Electronics Qualification	ECS robustness (IP, surge, vibration, thermal, UV)
Additional: Neutral Salt Spray Test (EN ISO 9227)	Anti-corrosion validation for mounting material

Certifications & Standards

Dun & Bradstreet

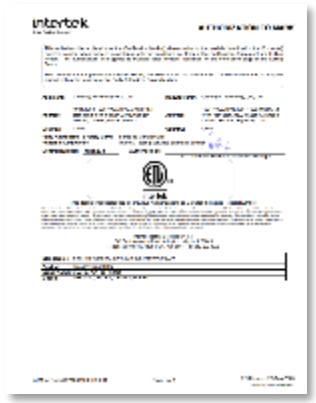
ISO9001

ISO14001

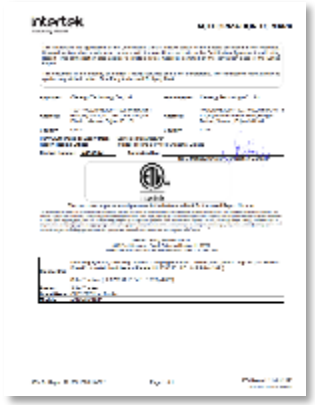
ISO45001

Carbon Footprint

CE



UL3703
ezTracker controller



UL2703
ezTracker D1P series

UL2703
ezTracker D2P series

TUV IEC62817
ezTracker D1P series

TUV IEC62817
ezTracker D2P series

Wind tunnel Reports
ezTracker D1P&D2P

DNV technology review
for clenergy ezTrackers

Clenergy Stats

39 GW
Worldwide installations

41 Billion+ kWh
Green power generation

50+
Country Presence

130+
Engineers Worldwide

12
Subsidiaries & Offices

5
Technology Centres

Melbourne, Australia
Origin

Xiamen, China
Manufacturing

Hamburg, Germany
Branch Office

Manchester, the UK
Branch Office

www.clenergy.com

THANK YOU!

End of Part 1

CPP WIND ENGINEERING CONSULTANTS

Wind Stability Strategy for Solar Trackers

Mitigating Risks, Enhancing Resilience

11th November 2025

Parsa Enshaei

penshaei@cppwind.com

Who We Are

- *Structural engineering + aerodynamics:*
  - Variety of structures:
    - Tall buildings, Stadiums, Bridges, Data centers, Landmarks and Monuments, Airports, etc.
  - **Solar mounting systems**
- *Offices around the world:*
  - US, Australia, Canada, Malaysia, India, UAE
- *Four wind tunnels:*
  - 2 in Colorado, 1 in Sydney, 1 in Kuala Lumpur

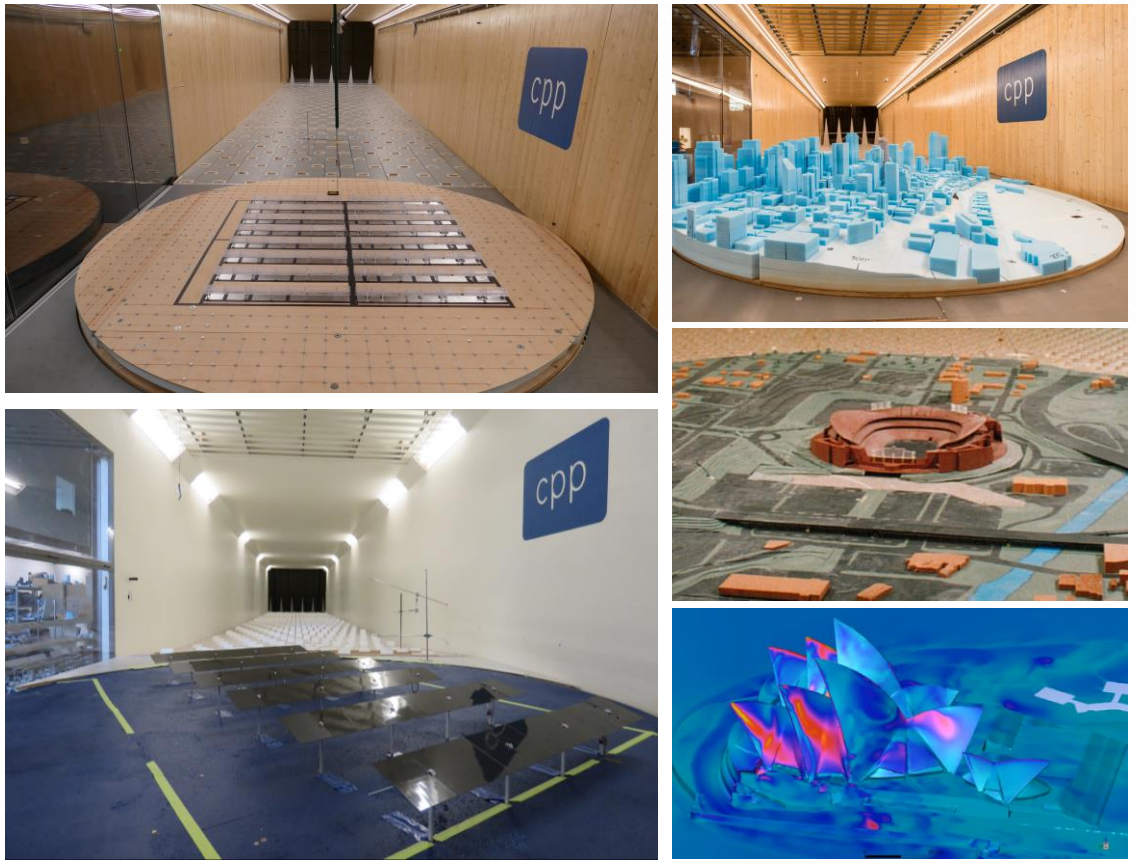
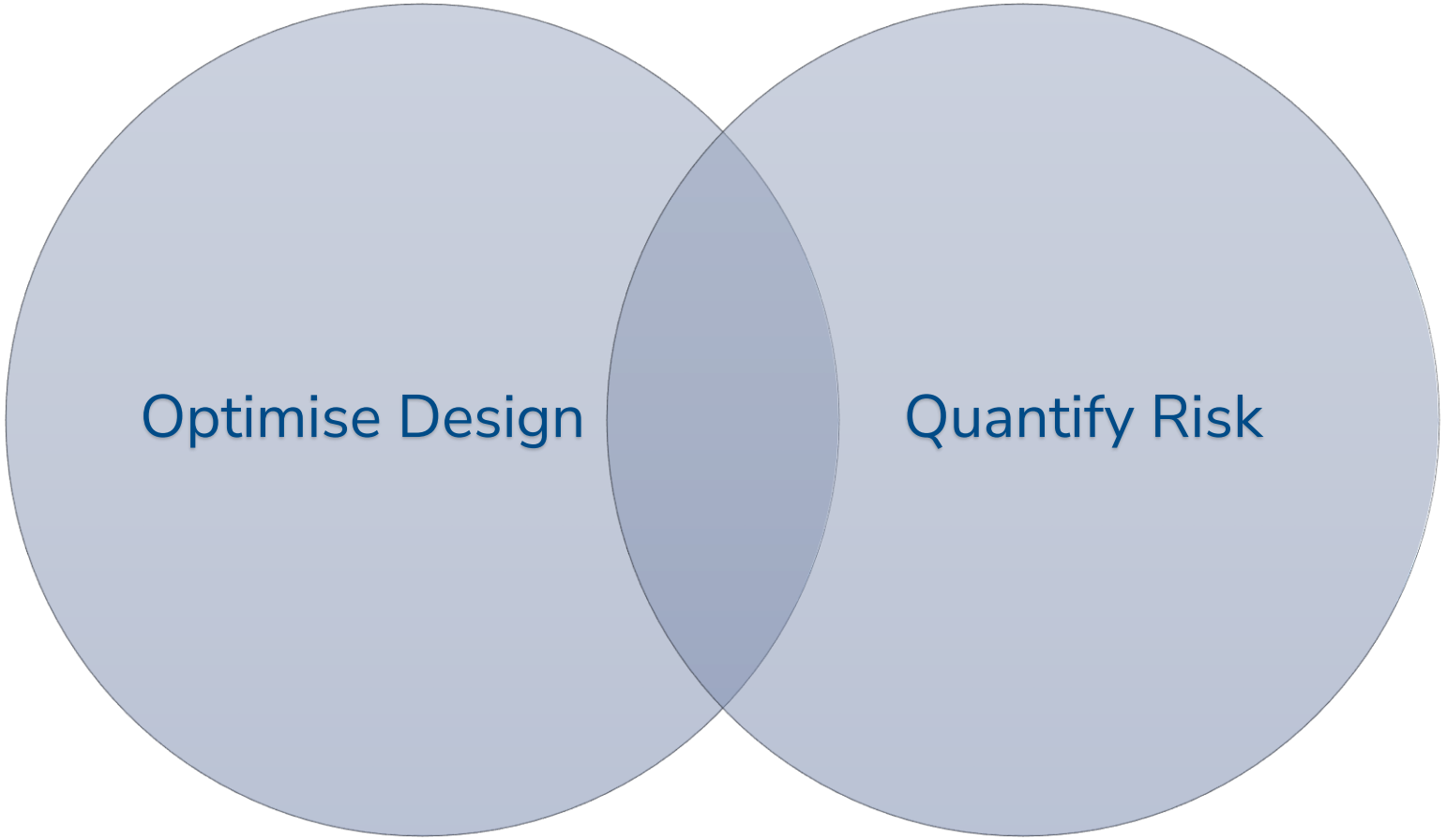
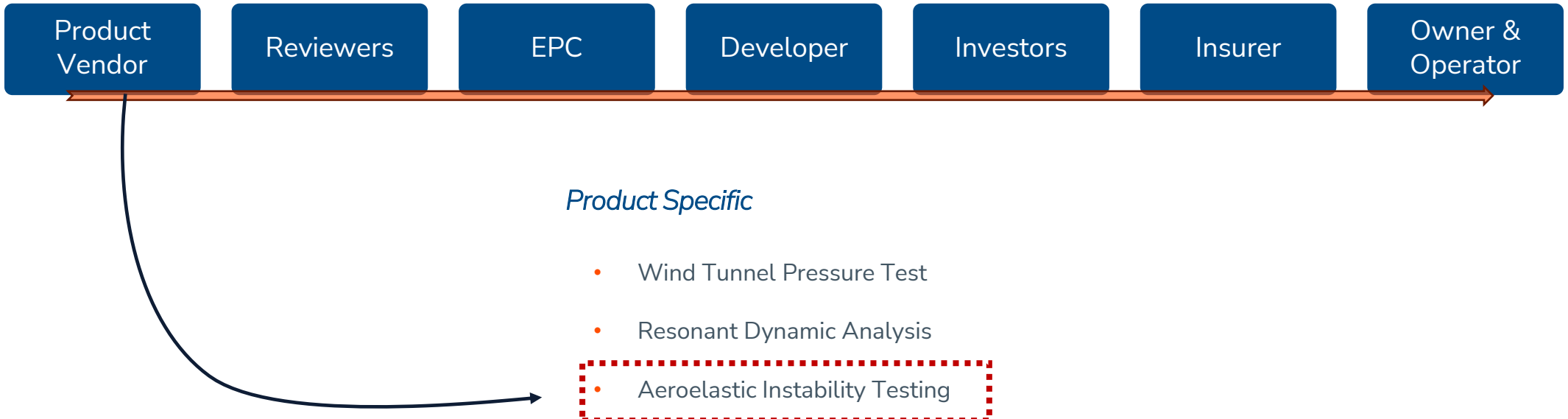


***Figure**: CPP services across different sectors*


Optimise Design
Quantify Risk

Wind-Induced Risk

Services Throughout Site Development



Product Specific

- Wind Tunnel Pressure Test
- Resonant Dynamic Analysis
- Aeroelastic Instability Testing
- Aeroelastic Loads
- Free Vibration (Pluck) Test

Wind Tunnel Testing

- *Atmospheric Boundary Layer Wind Tunnel*
- **Simulates the gustiness of the wind at model scale**

1. Fan drives the flow and turbulence is removed
2. Desired turbulence levels and type is added back in throughout the ‘fetch’
3. Model is tested with the desired approach flow

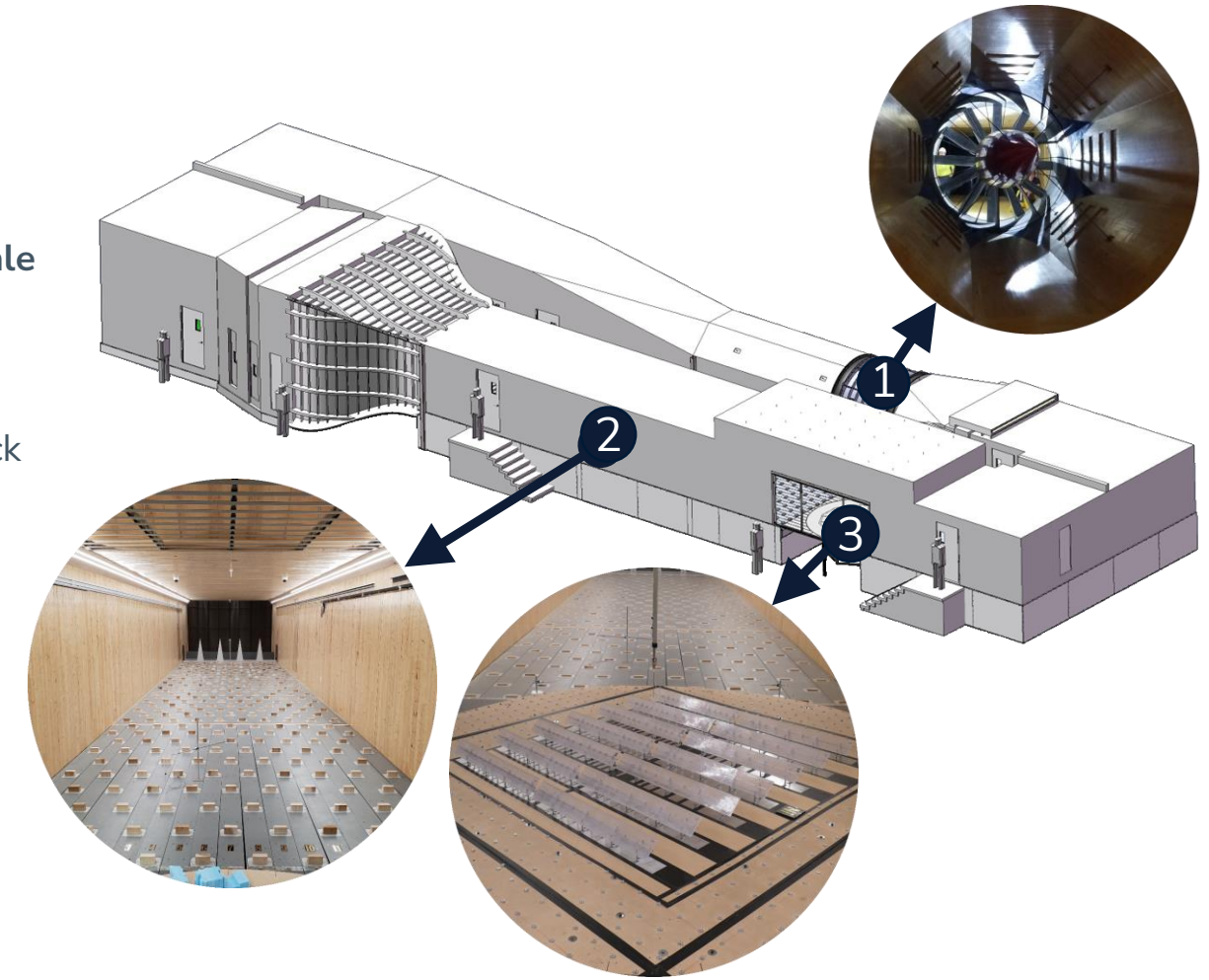
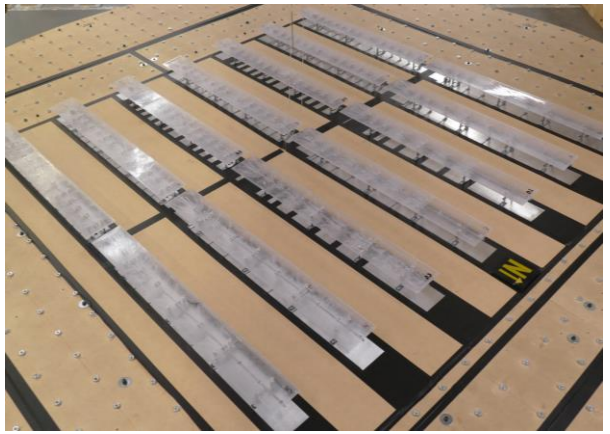
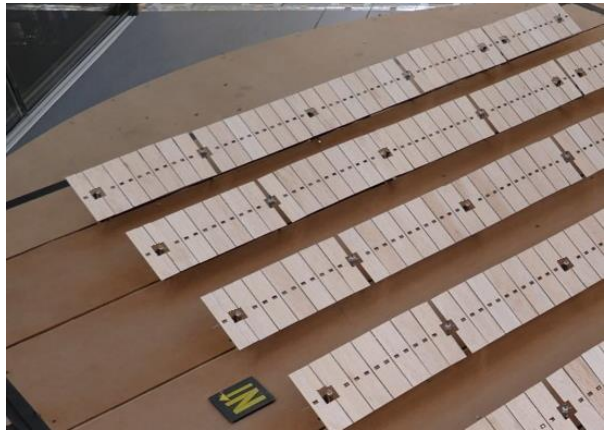


***Figure**: CPP atmospheric boundary layer wind tunnel*

Wind Tunnel Testing

- *Two types of models:*
- **Rigid Pressure Model**
  - Measures pressure on the panels and can be integrated for each component
  - Analytically used for dynamics
- **Flexible Aeroelastic Model**
  - Scaled to move like the real system
  - Selected mass, stiffness, and damping are modelled





***Figures**: Wind tunnel model types:*
Rigid Pressure Model (top)
Flexible Aeroelastic Model (bottom)

Torsional Instability

Video: *Tracker array experiencing torsional instability (LinkedIn)*

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)*

2-D Section Models:

- *Requires assumptions for the unstable fraction of the tracker*
- *Difficult to model the correct approach flow and cornering winds*
- *Cannot capture the 3D multi-row flow field*

Figure 8: Previous section model testing of SATs: Rohr et al., 2015 (left and centre), Quintela et al., 2020 (right)

3-D Torsion-Only Models:

- *Scaling geometry: 1:20-1:40*
- *Scaling velocity: 1:3.5 – 1:5.5*
- *Scaling structural properties:*
  - Torsional stiffness
  - Mass moment of inertia
  - Damping

Figure 6: Close-up of a generic SAT aeroelastic model (top) and multi-row SAT models in the wind tunnel (bottom)

Testing

- *Open country approach*
- *Multi-rows to model the flow field*
- *Full-scale wind speed range*
- *±30° Wind direction normal to the tracker axis*

***Figure**: Testing setup*

Aeroelastic Instability Testing

- *Scaled model that moves like the full-scale system in torsion*
- *Guidance in defining the stow strategy and design wind speed*

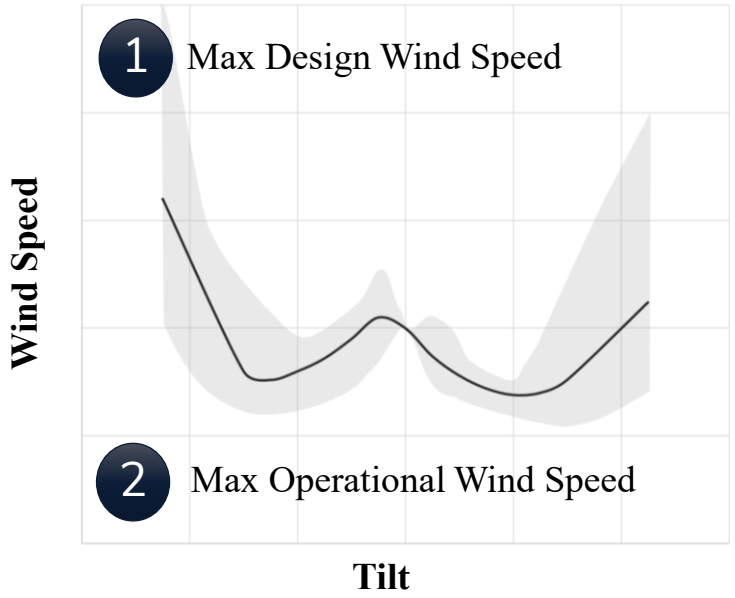
Single-Drive at 0°

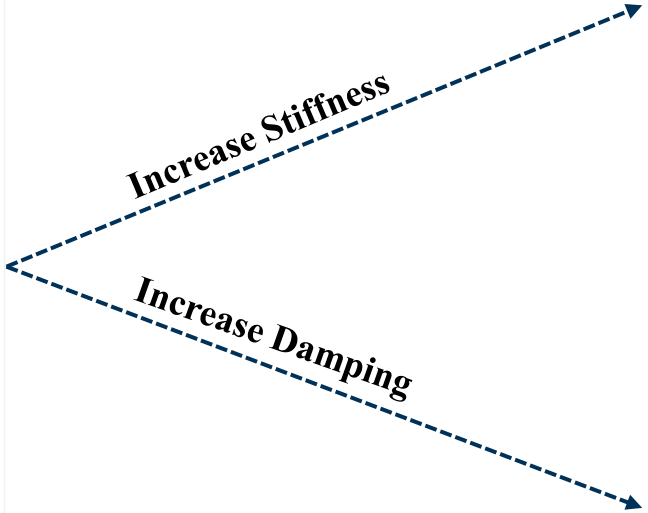
Multi-Drive at 0°

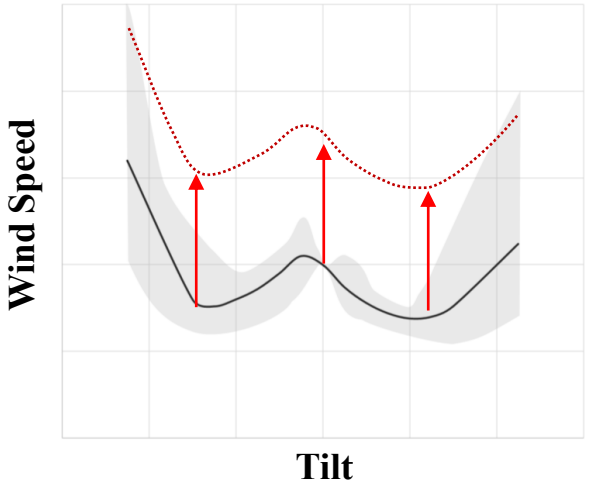
***Videos**: Torsional instability tests of wind tunnel models*

Avoiding Instability

- *Increase stiffness and stow flat*
- *Increase damping and stow high*







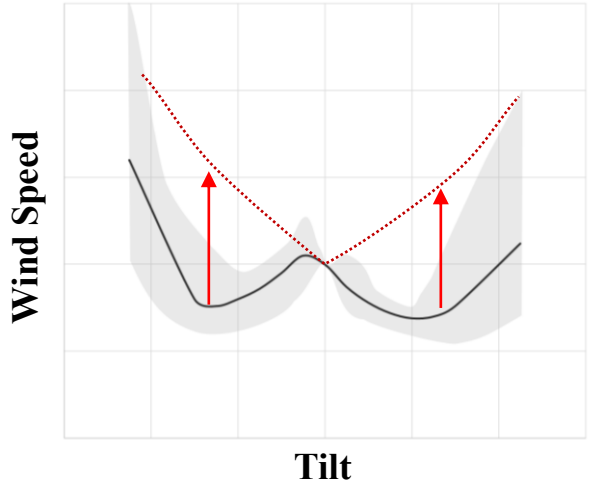


***Figure**: Sample trend for critical wind speed with tilt*

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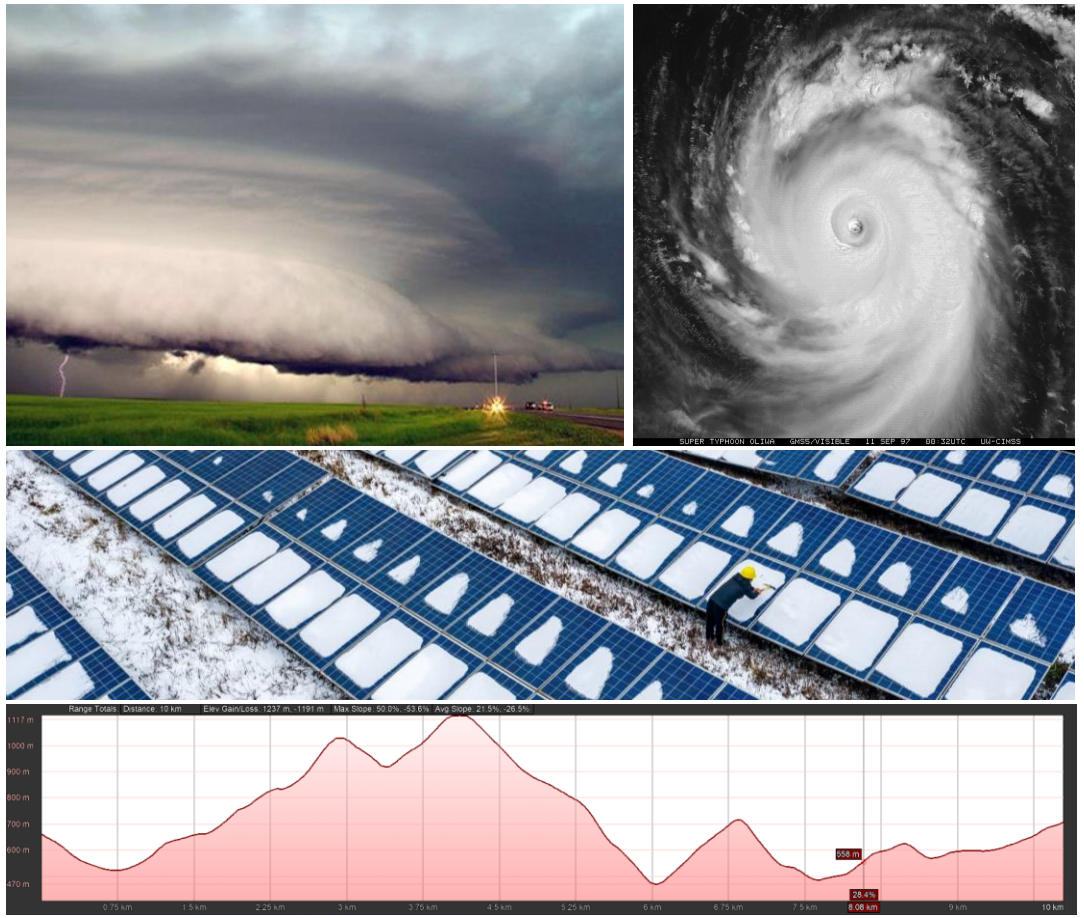
Site-Specific Analysis

- *Risk is always > 0%, minimise it by:*
- Understanding storm types
- Site-Specific pressure study
- Return period vs O&M costs
- Combination of wind/snow/hail
- Topography
  - Wind speed-up + Loss of shelter
- Ramp Rates
- Sand Issues



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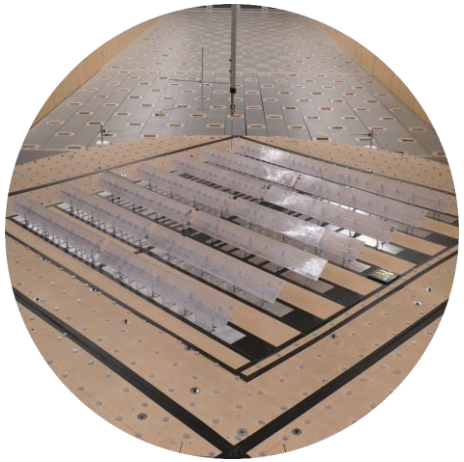
Key Takeaways

- *Quantify risk and optimise the system*
- *Wind tunnel testing to:*
  - Ensure the structure can withstand static/dynamic loads
  - System is stable otherwise the rest doesn't matter
- *Site-specific analysis to assess risk for a particular **system** on a particular **site***

WIND CLIMATE ANALYSIS

WIND TUNNEL TESTING



SCALE WIND TUNNEL MODELING

CPP WIND ENGINEERING CONSULTANTS

Thank You

Any questions?

CPP WIND ENGINEERING CONSULTANTS

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cppwind.com

Your Speaker

Juan Esquivel
PV Solution Manager

Case study 1: Hungary 20 MW

Special Requirements:

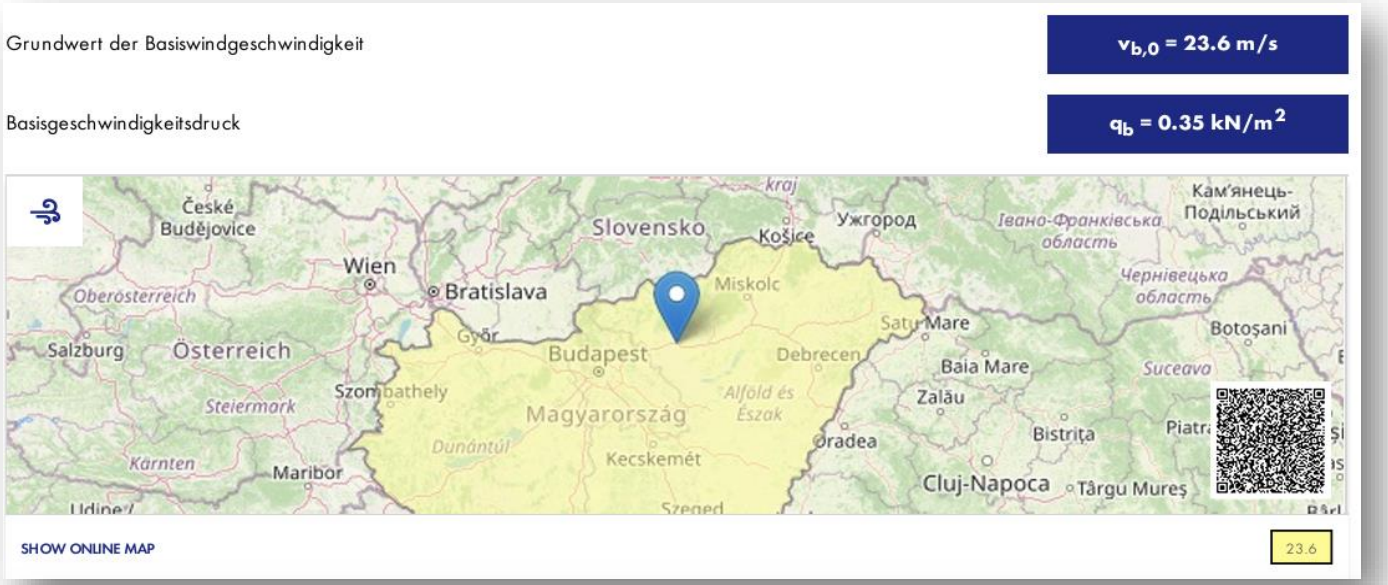
- Minimize civil works
- Structural calculations for highest clearance
- Longest table configuration
- Table wind side zonification

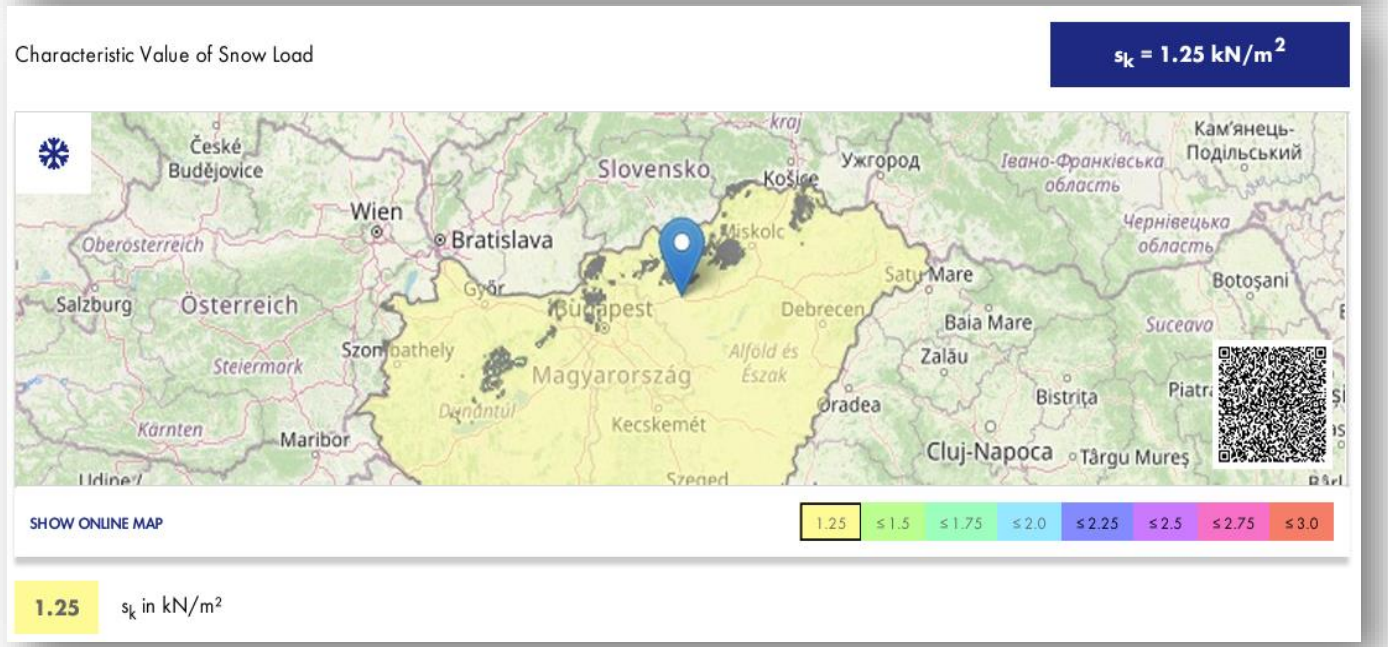

ZOOM INTO EZTRACKER


AERIAL VIEW

Project Parameters:

- Wind load: 23.6 m/s
- Snow load: 1.25 kN/m2
- Design Code: Eurocode
- WTT: wind zone division





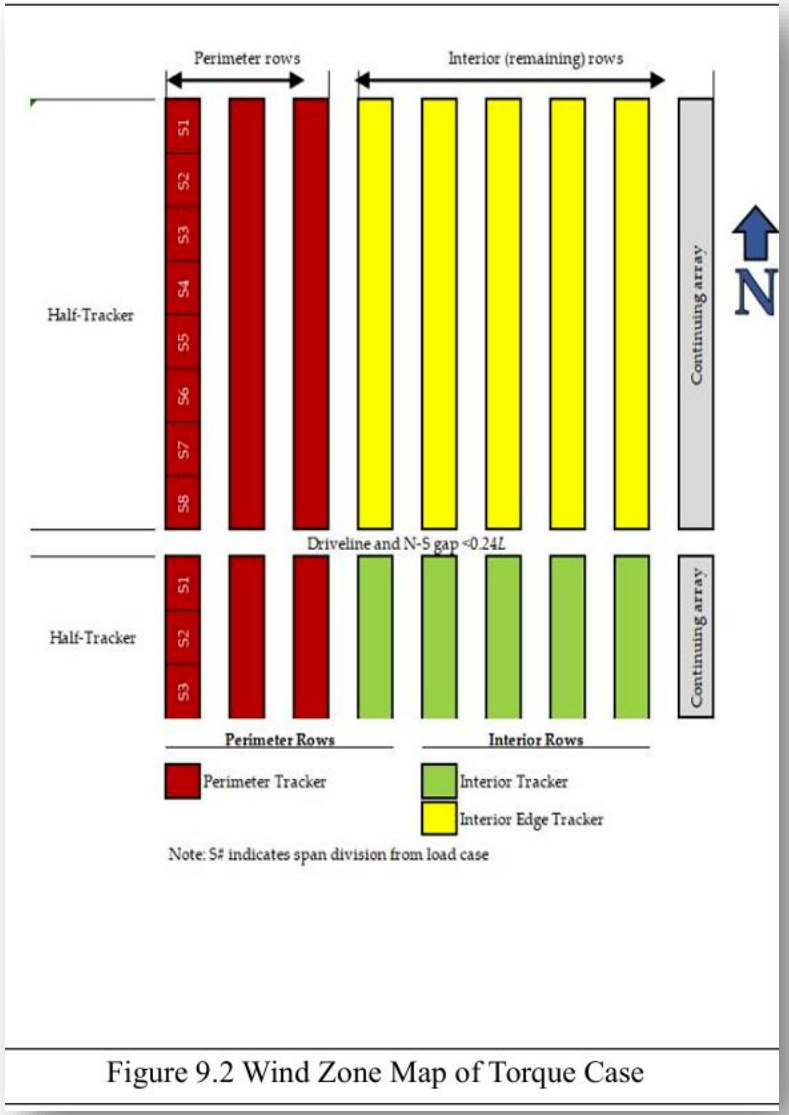


Figure 9.2 Wind Zone Map of Torque Case

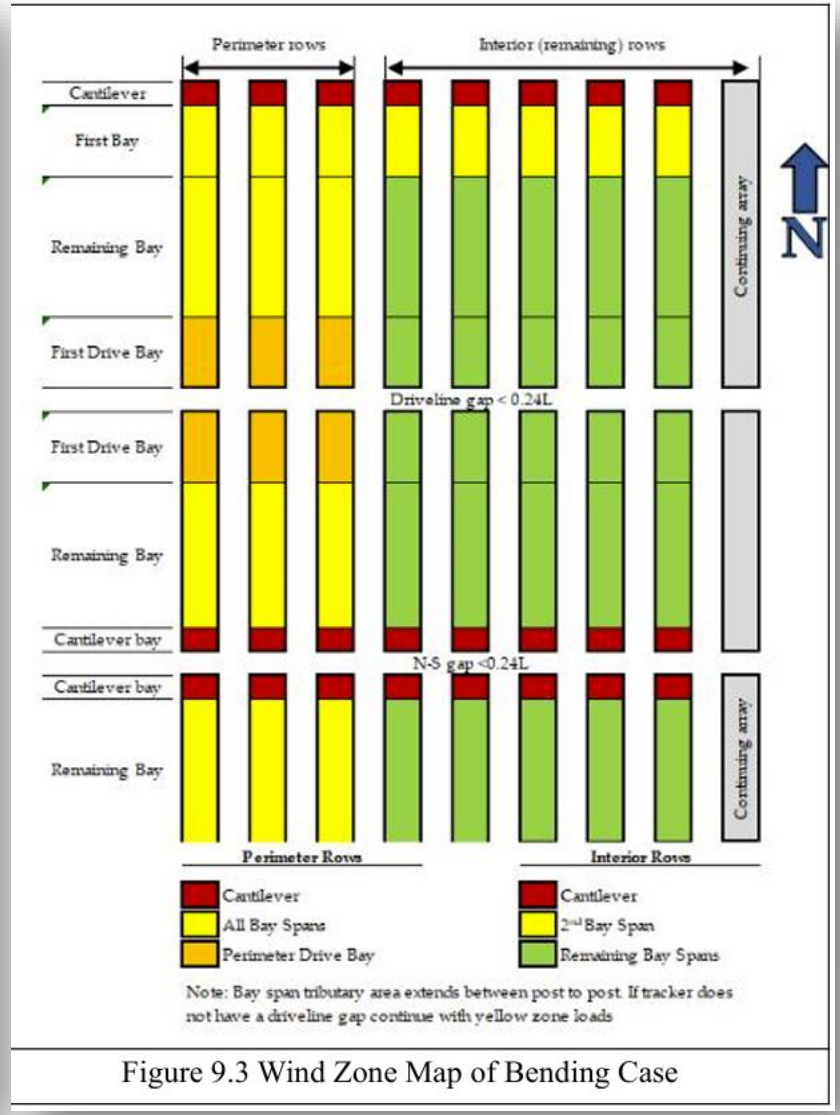
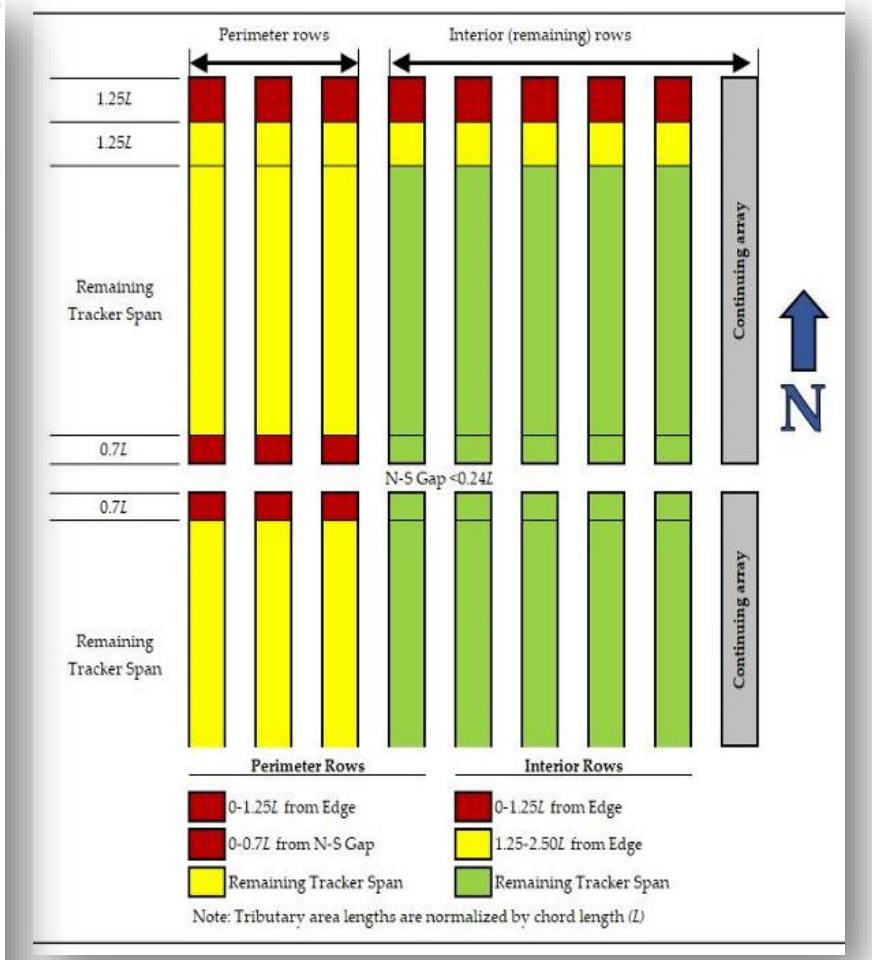


Figure 9.3 Wind Zone Map of Bending Case

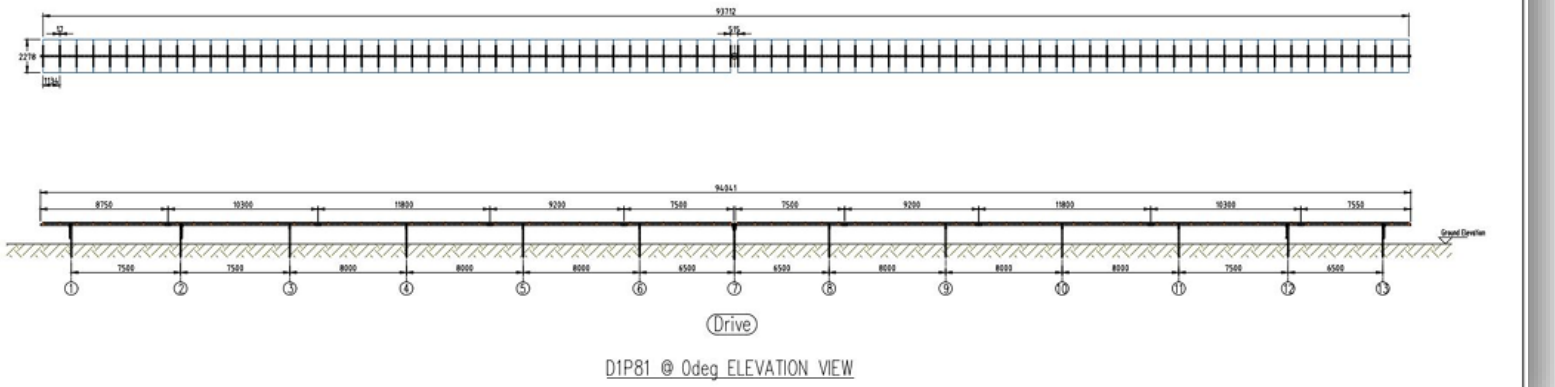


ezTRACKER®

D1P Single-Axis:

- 100% Direct Ramming
- Civil works: 1632 m3 (cut) + 998 m· (fill)
- Communications: Astronomical algorithm and closed loop control (RS485 and Zigbee)
  - 128 TCU wireless control by 1 MCU
    (2 MCUs in total)
- Stow: 30º

System Type	Single-Axis Tracker
Drive Type	Slew Drive
Tracking Angle	±60 Deg
Protect Wind Speed	18m/s (3s gust at 10m height),equa to 12.6m/s (10min average measured at 10m height)
Stow Angle	30 Deg
Module Quantity Per Tracker	81 Pcs
Tracker Length X Width	93712 X 2278 mm
Rotation Height	1314 mm
Foundation Type	Ramming Post
The depth under ground	Driver post :2100mm; standard post:1600 mm
Module Length X Width X Thickness	2278 X 1134 X30 mm
Module Weight	32kg



D1P81 @ 0deg ELEVATION VIEW

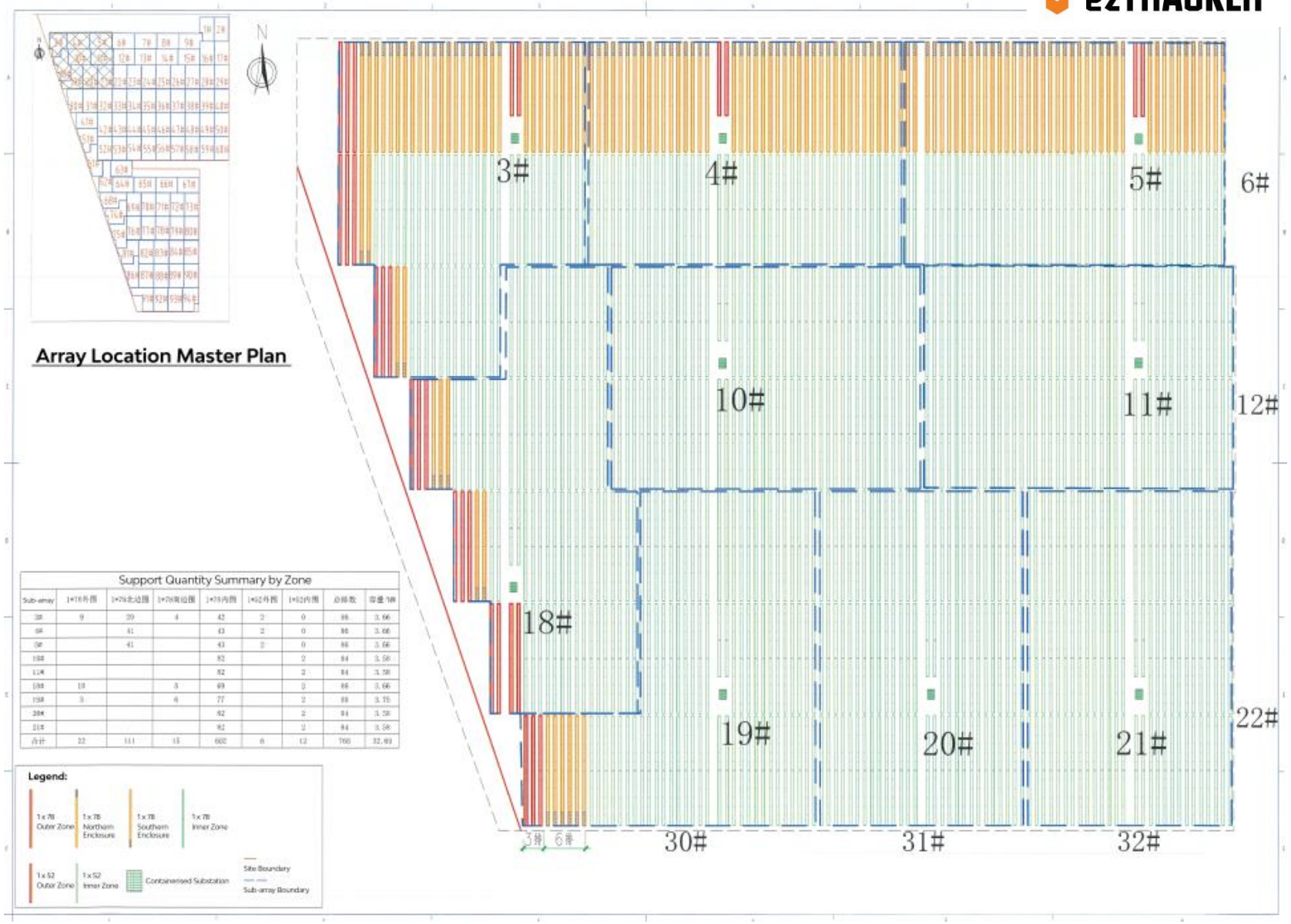
Case study2: Qinghai China 336 MW

Located on the desert.

It combines green desertification control with stock farming to promote sustainable development.

Project Parameters:

- Wind load: 18m/s
- Snow load: 0.20 kN/m2
- Design Code: GB50009-2012
- WTT: Table zonification



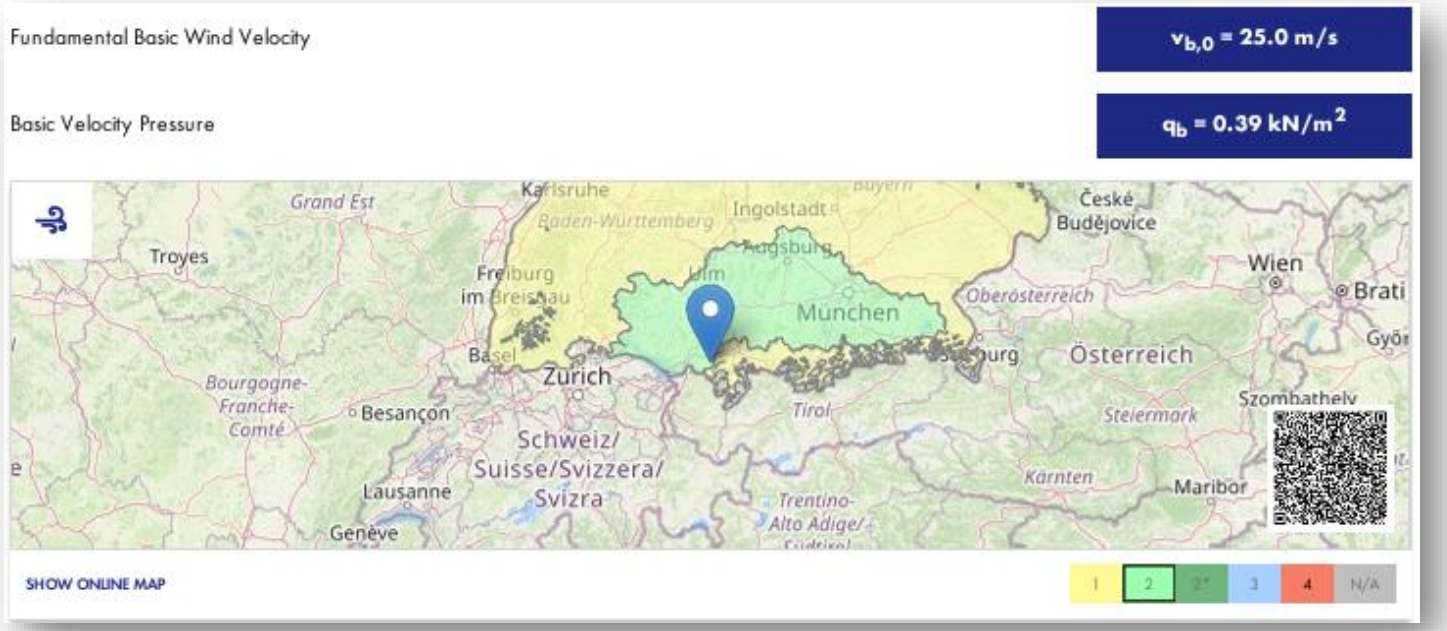
Case study3: Jungensberg (German Alps)

Requirements:

- No civil works requirement
- Structural calculation for 1,4m clearance in some tables
- Challenge: Structural calculation for high clearance against high snow load (4.8 kN/m2)

Project Parameters:

- Wind load: 25 m/s
- Snow load: 4.81 kN/m2
- Design Code: Eurocode
- WTT: wind zone division



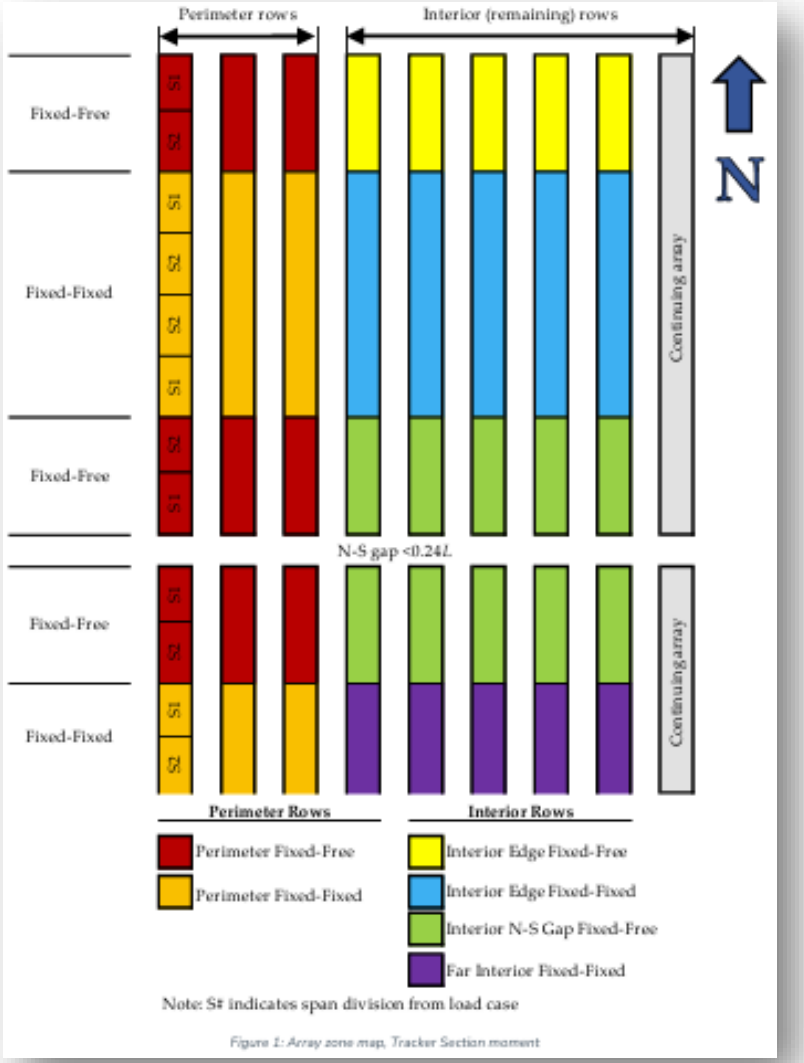


Figure 1: Array zone map, Tracker Section moment

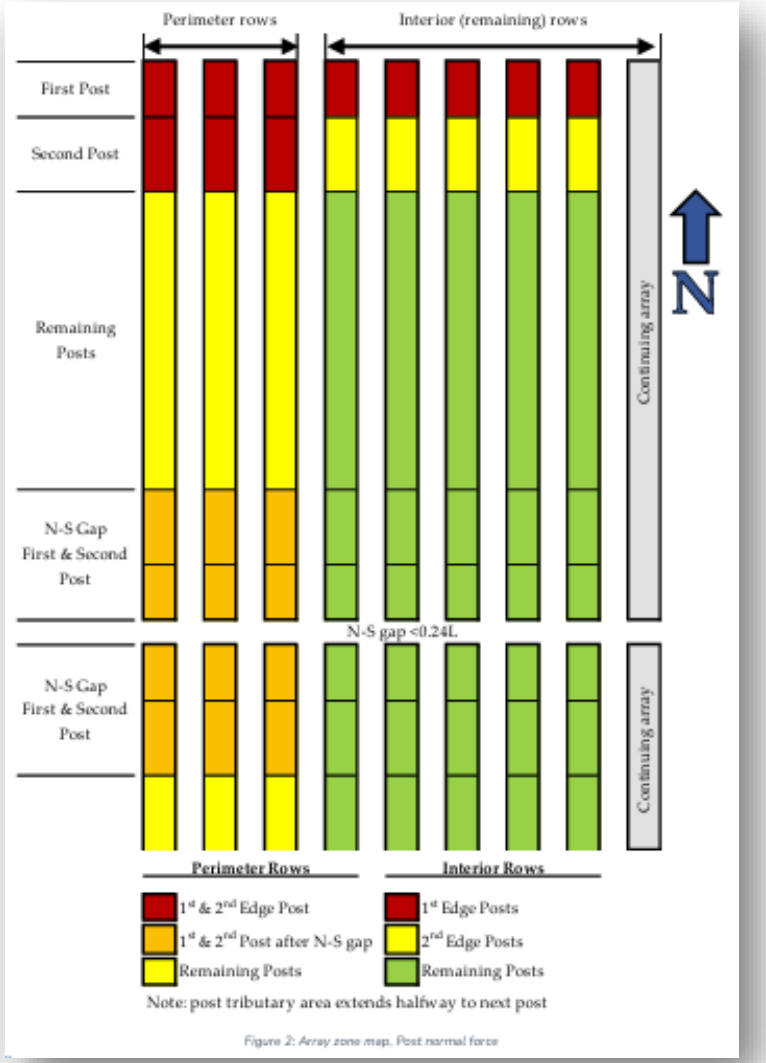


Figure 2: Array zone map, Post normal force

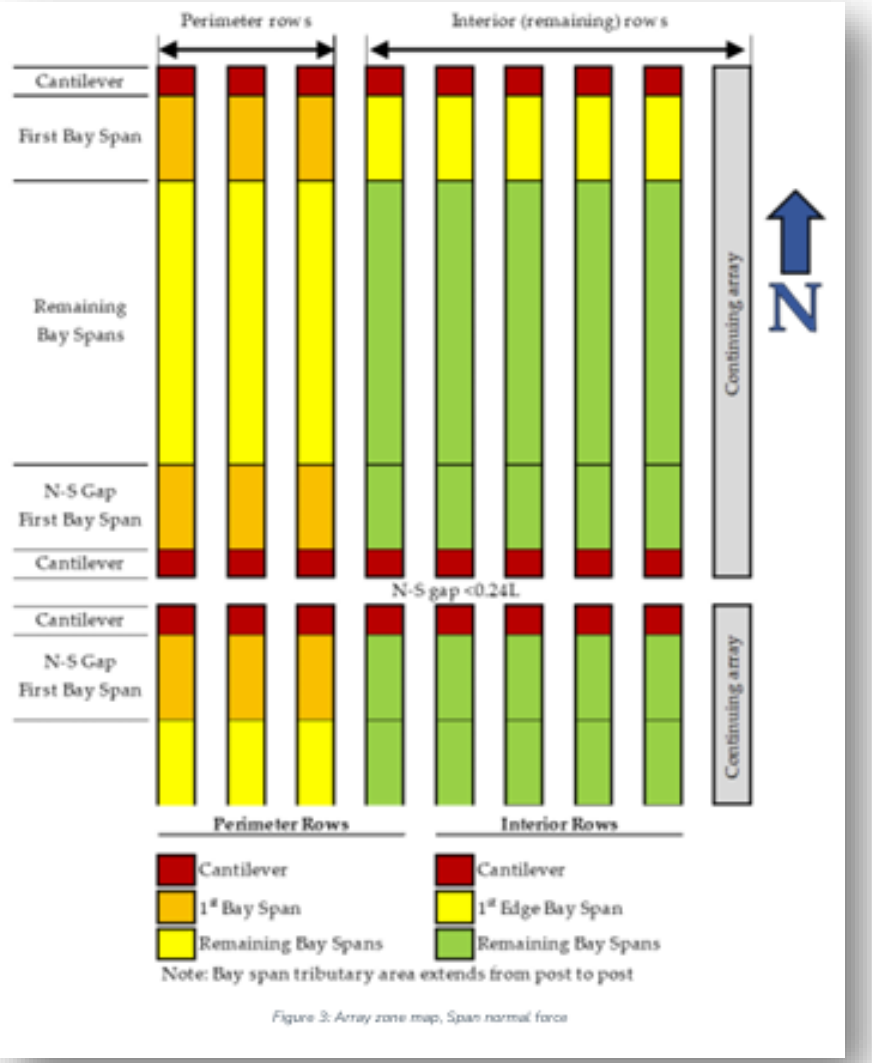
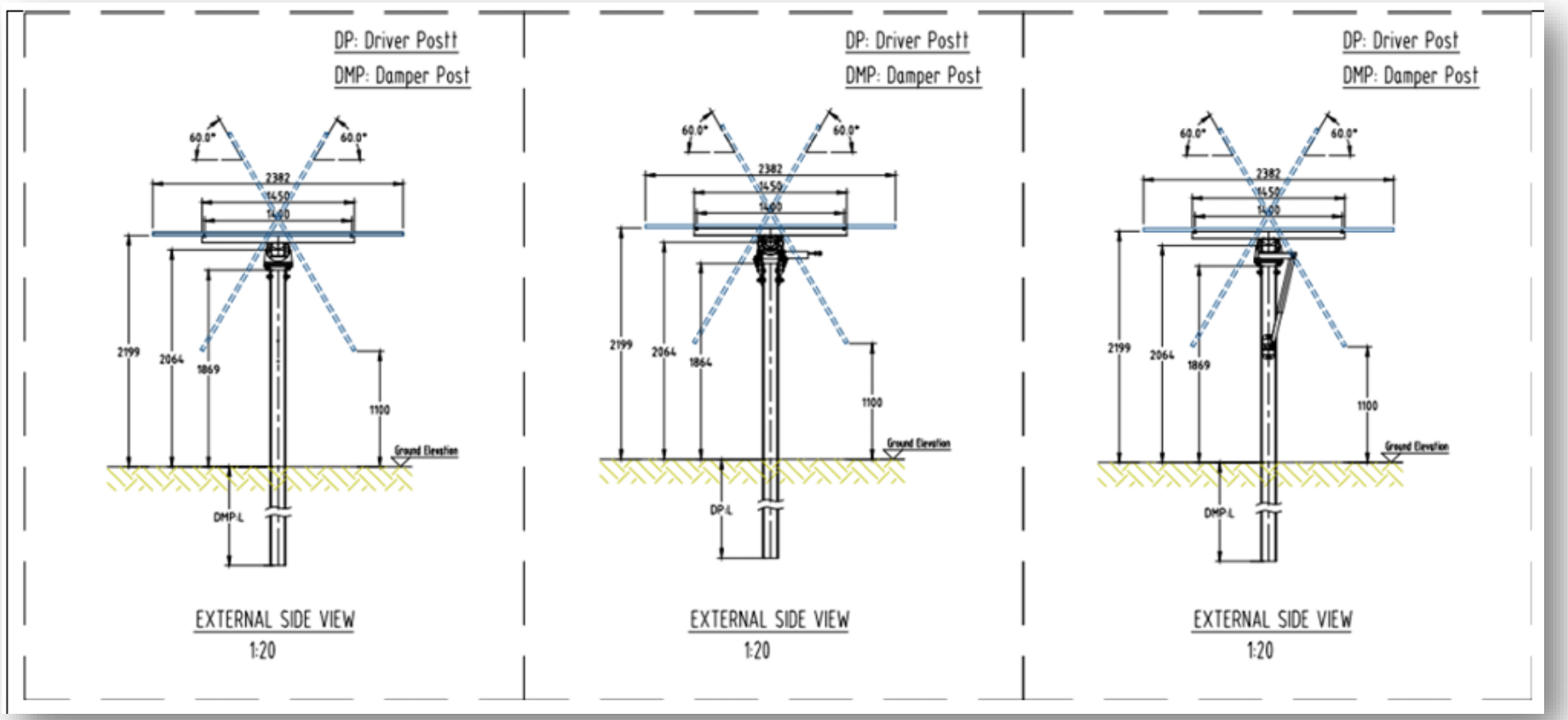


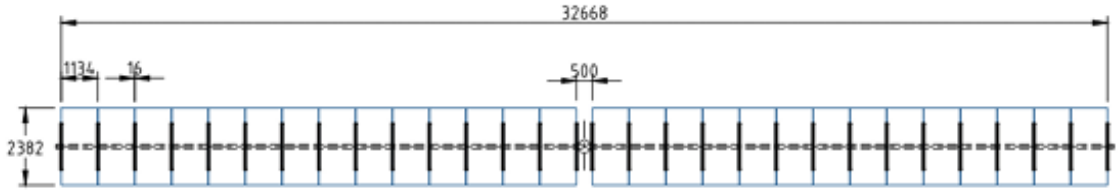
Figure 3: Array zone map, Span normal force

D1P Single-Axis

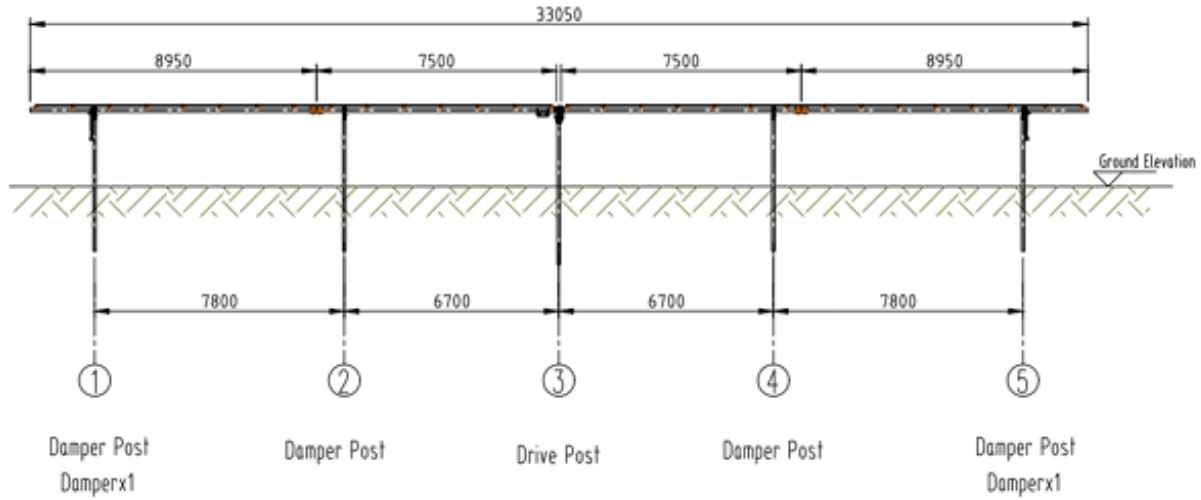
- 100% Direct Ramming
- Civil works: 0
- Communications: Astronomical algorithm and closed loop control (RS485 and Zigbee), 70 TCU wireless control by 1 MCU
- Stow Position: 5º



System Type	Single-Axis Tracker
Drive Type	Slew Drive
Tracking Angle	±60 Deg
Protect Wind Speed	11.3m/s (10min average measured at 10 m height)
Stow Angle	5 Deg
Module Quantity Per Tracker	28 Pcs
Tracker Length X Width	32668X 2382 mm
Rotation Height	2064 mm
Foundation Type	Ramming Post
Module Length X Width X Thickness	2382 X 1134 X30 mm
Module Weight	33.5kg

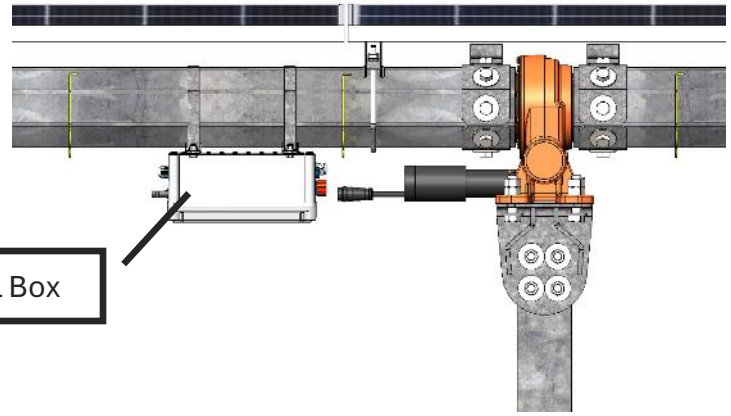


D1P28 EXTERNAL SINGLE POINT DRIVE TRACKER PLAN

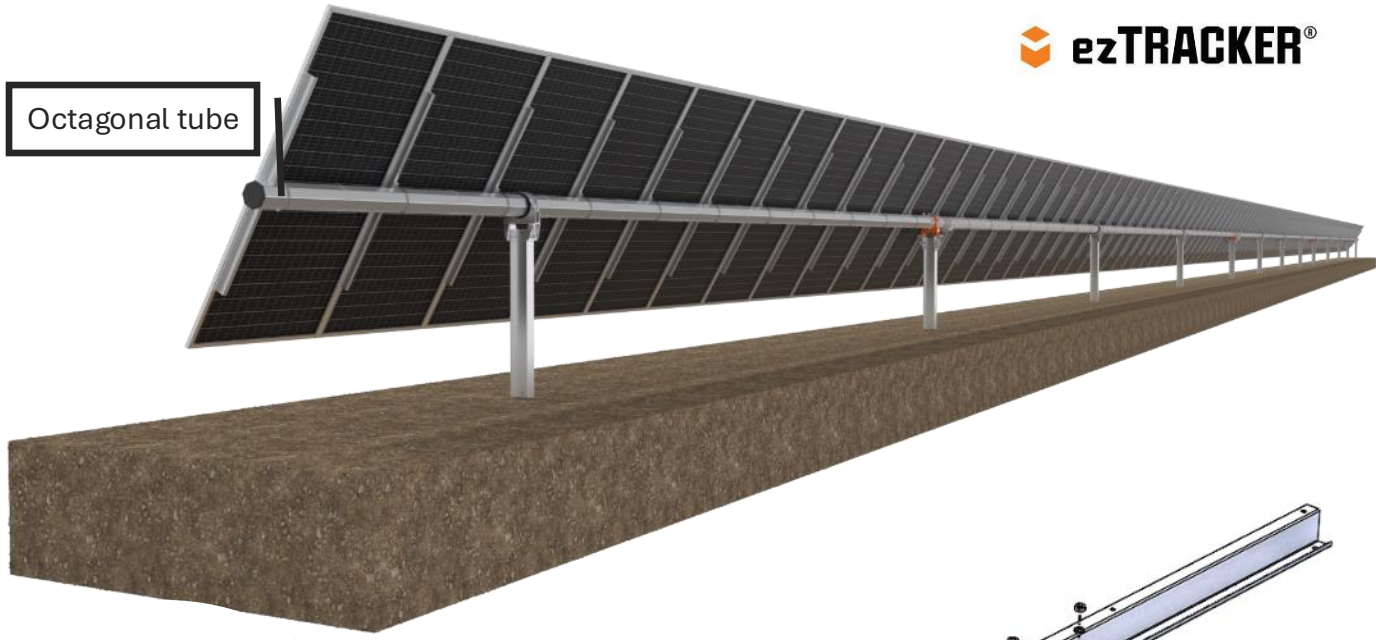


D1P28 EXTERNAL SINGLE POINT DRIVE TRACKER ELEVATION

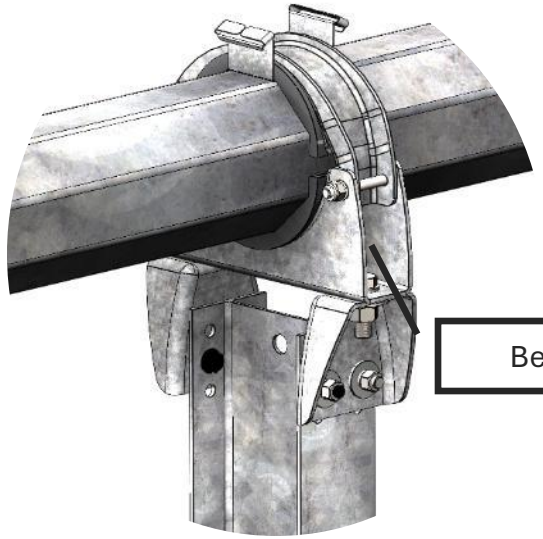
Overview of Key Structural Design D1P120



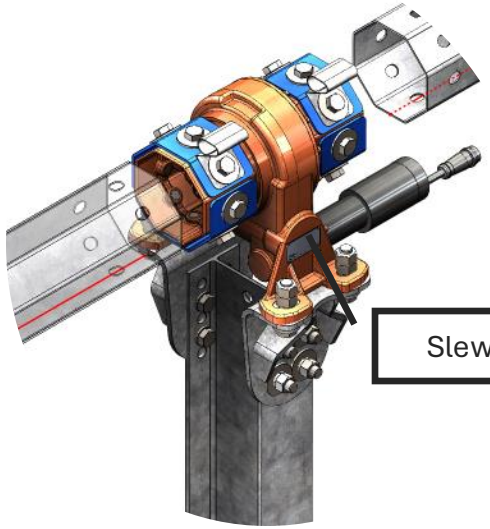
Control Box



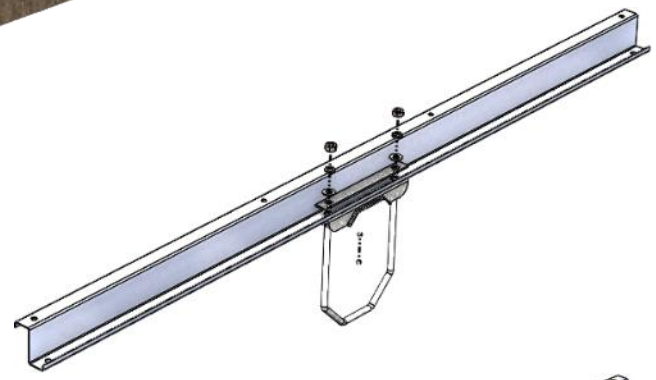
Octagonal tube

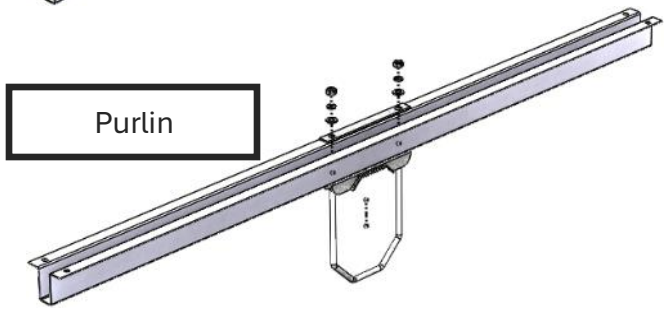


Bearing

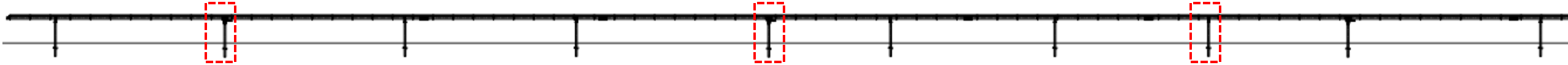


Slew Drive

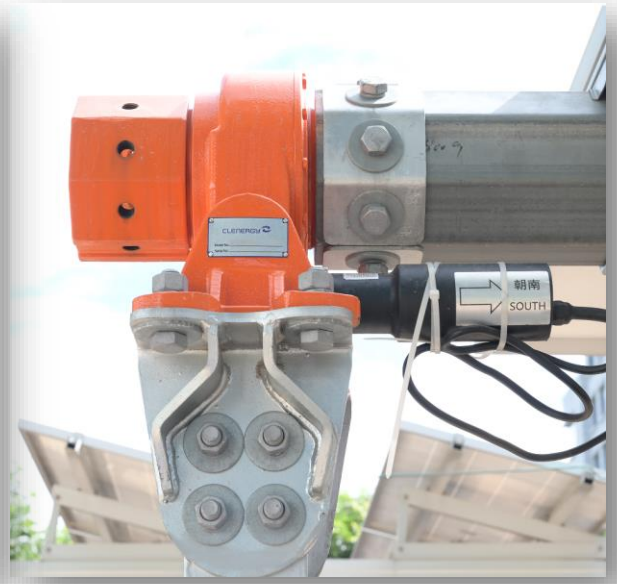




Purlin



Details of Key Structural Design of D1P120



Purlin OM & Purlin Z
- S550GD steel
- Zn-Al-Mg coating
- Pre-drilled holes

Slew Drive & Post
- Q355B Steel Brackets
- HDG Steel
- S350GD Clips
- Zinc-plated

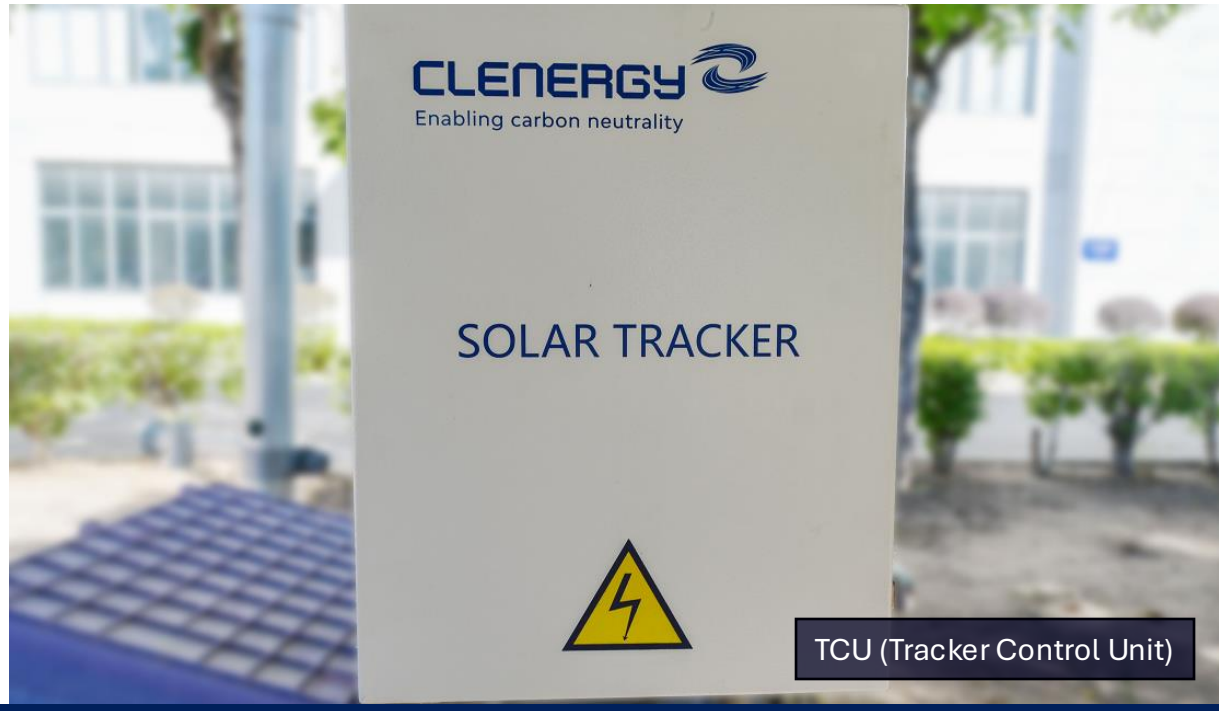
Octagonal Tube
- S550GD steel
- Multi-facet design
- Zn-Al-Mg (MAC) Coating

Bearing & Post
- S390GD steel
- HDG Steel
- Zinc-plated

Structural design elements of D1P120

- IP65 Rated
- UV-proof
- Dust-proof wind-resistant
- Extreme temperature-tolerant

NCU (Network Control Unit)



TCU (Tracker Control Unit)

Key structural design elements of D1P120

Flexible customization: Various selections regarding on size and materials are available for torque tubes, post and purlin

Torque tubes

- Available from OCT150*2.5 to OCT150*5.0

Post

- Available from W6*6.2 to W8*28

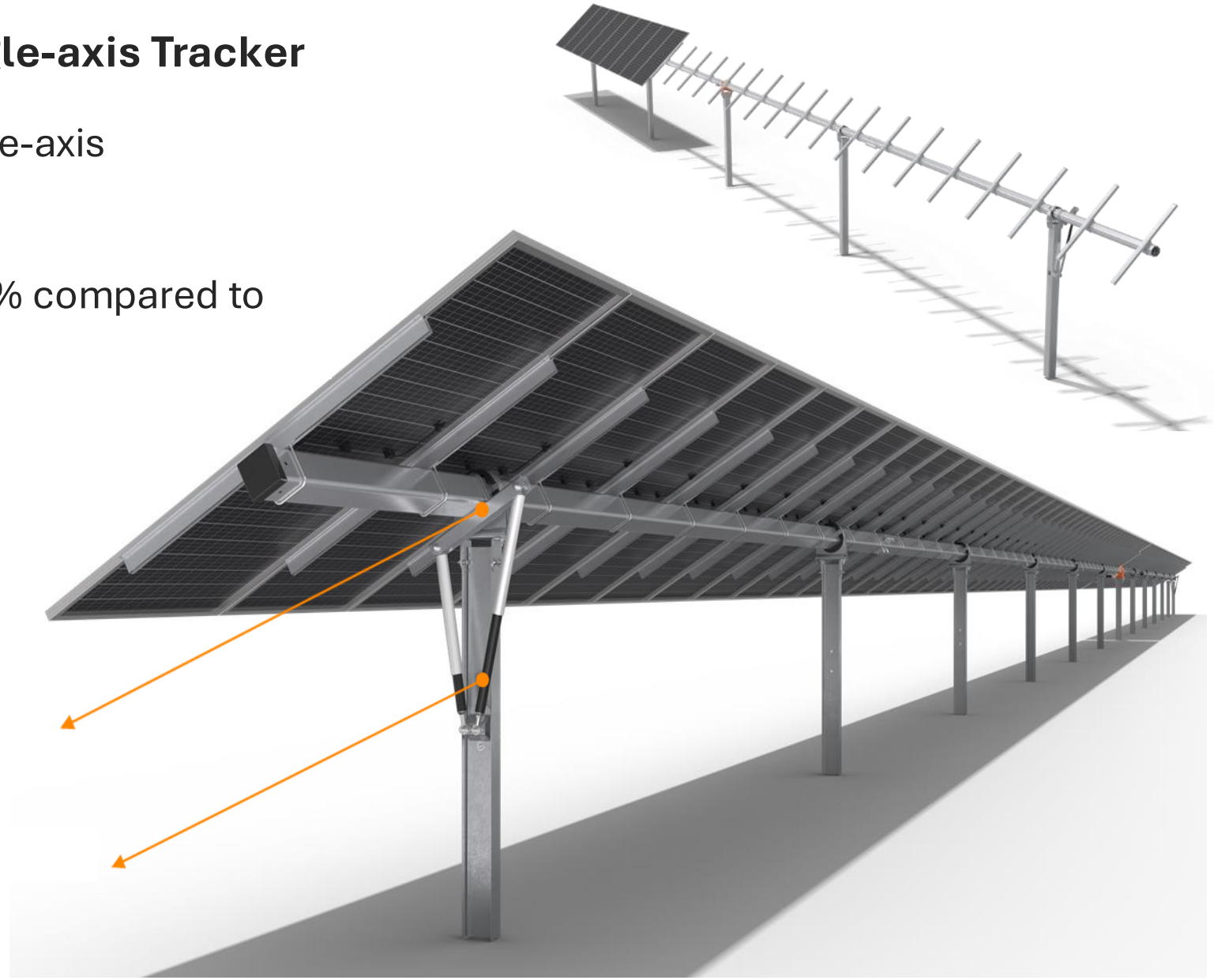
Purlin

- Available from OMG50*30*25*1.5 to OMG70*30*25*2.0

D1P One Portrait Horizontal Single-axis Tracker

- High-performance horizontal single-axis
- Utility-scale photovoltaic projects
- Portrait module layout
- Increases energy yield by up to 25% compared to fixed-tilt systems.

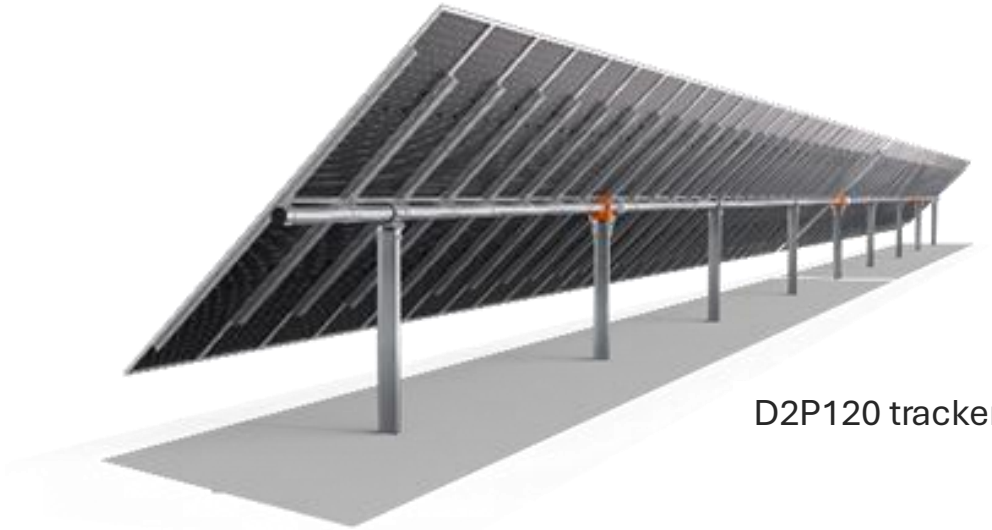
- 30 degree stow position
- Damper for stability and protection



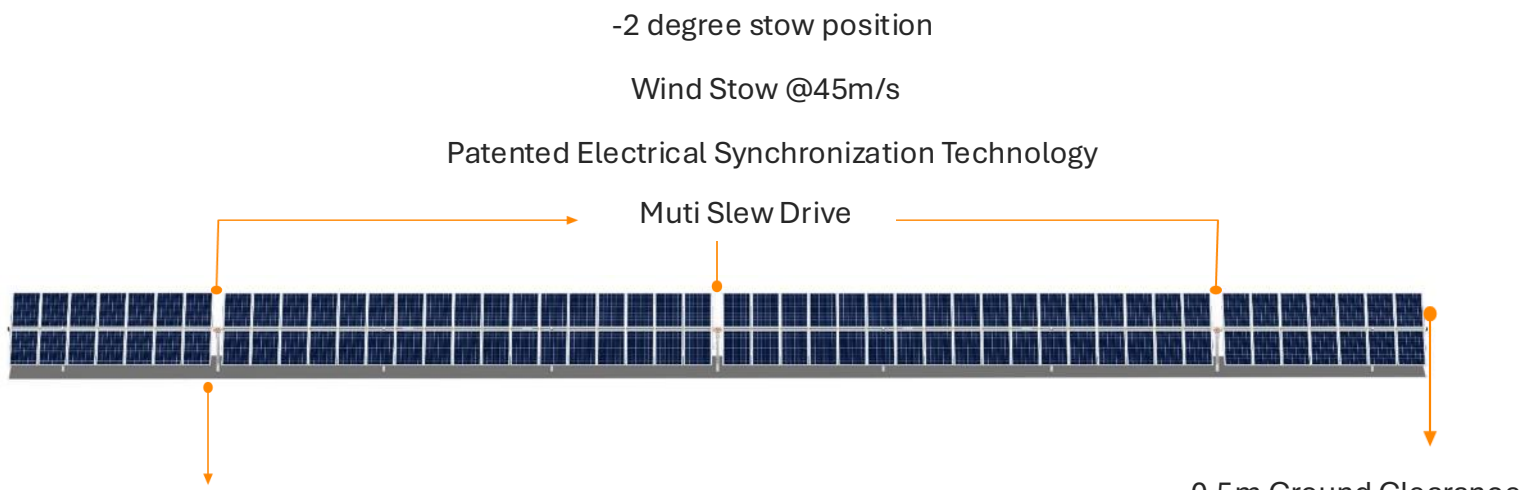
D1P120 One Portrait Smart
D2P120 Two Portrait Smart

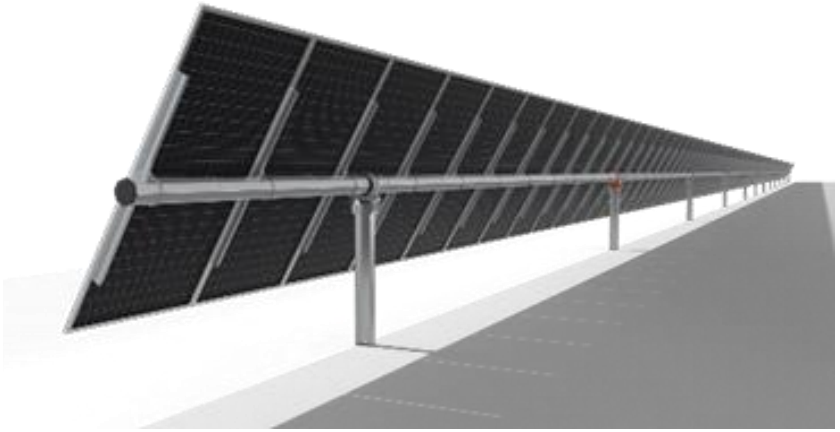
High system stability throughout the life cycle.
Maximizing the energy output for solar plants.

- -2 degree stow position
- Multi-drive system for efficiency and safety



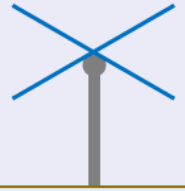
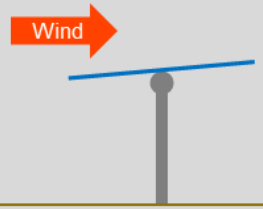
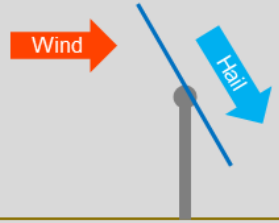
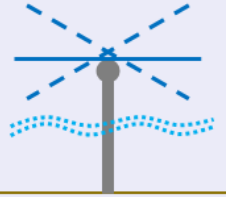
D2P120 tracker





D1P120 tracker

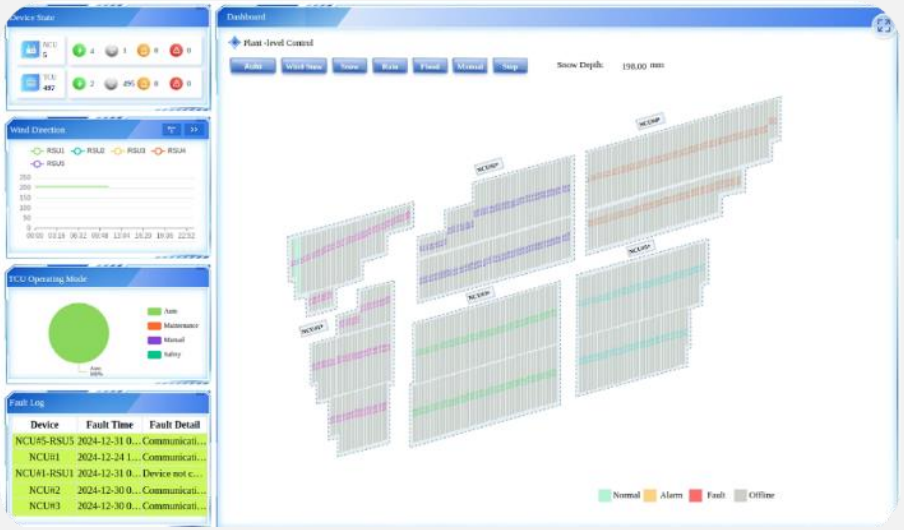
Safety Stow Strategy

Normal Tracking	Limit Tracking（optional）	Wind Stow	Snow Stow	Hail Stow	Flood Mode	Cloudy Mode
V_{3s} < 16m/s	12m/s≤V_{3s} < 16m/s	11m/s≤V_{3s}≤60m/s	0.3kPa≤P_{snow}	Weather Forecast	According to the water level	Low radiation intensity
±60deg Tracking	±30deg limit Tracking	5deg Stow	60deg Stow	60deg Stow	0deg Stow or Dynamic Limit Tracking	0deg Stow
						
Tracking and back-tracking based on astronomical algorithms	Balancing system security and power generation, improving the response speed of the wind stowing	0.5s from NCU monitoring wind speed to TCU receiving wind speed signal max. 8min from 60deg to stow position	Automatically triggered by sensors Or one click startup through SCADA system	One click startup through SCADA system when receiving hail warning weather forecast	Automatically triggered by sensors Or one click startup through SCADA system	Automatically triggered by sensors

ezTracker SCADA for Better Management

Main functions:

- Map-based Visualization
- Real-time Monitoring & Control
- Automated Alerts
- Preventative O&M



Map-based Visualization

- System Status
- Energy Production
- Alarms
- Environmental Data

Real-time Monitoring & Control

- Auto: Auto-tracking, Farming, Night, Idle
- Manual: Manual, Stop
- Maintenance: Rain, Cloudy, Flood
- Safety: Wind Stow, Snow
- Fault Notifications

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THANK YOU!

End of Part 3

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pv magazine webinars

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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. 👀 💡

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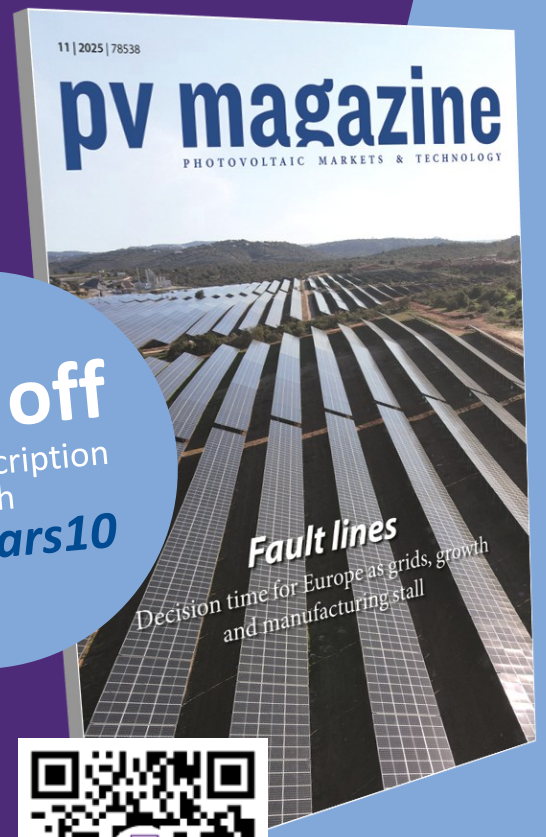

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9:00 am – 10:00 am EST, New York City

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6:00 pm – 7:00 pm AEDT, Sydney

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