IDEEMATEC – THE NEW DEFINITION OF UNLINKED TRACKING

IDEEMATEC is a leading provider of solar trackers with +12 years of experience and more than 1.5 GW of systems in operation on 6 continents.

Our outstanding technological innovations and over 50 patents deliver valuable benefits – through max. uptime availability over the entire lifespan of a power plant.

#maximum economics #bifacial-ready technology #safeguarding advantage

IDEEMATEC AT A GLANCE

INSTALLED TRACKER	PRODUCTION CAPACITY P. WEEK	EXPERIENCE IN TRACKERS	TRACKERS IN OPERATION	COUNTRIES CONTINENTS	MARKET LEADER JORDAN WITH	MARKET LEADER MIDDLE EAST AUSTRALIA
+2 GW	+40 MW	+ 12 YEARS	+ 52.000	25 / 6	+ 480 MW	

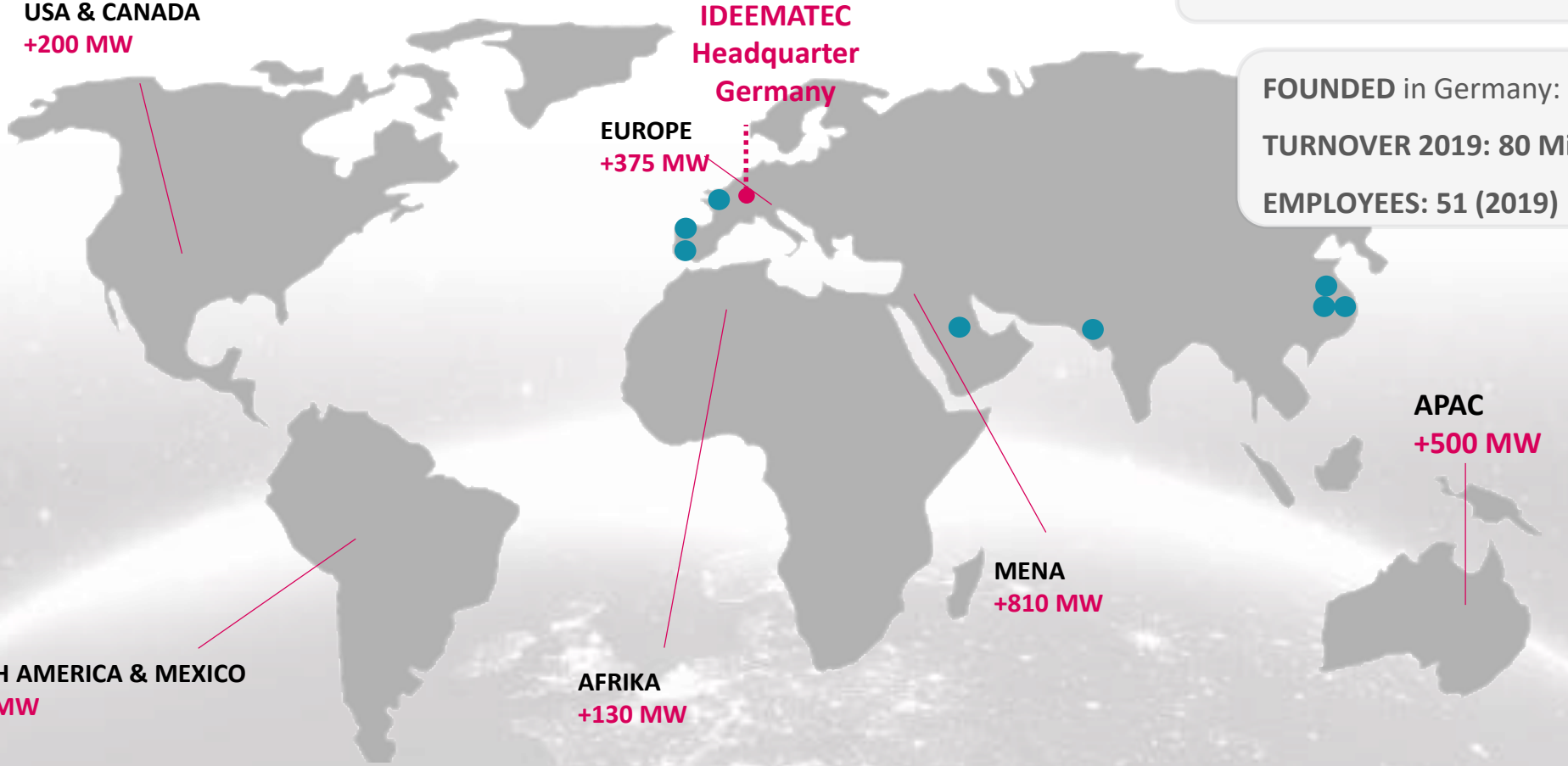
WORLDWIDE PRESENCE – COMPANY PROFILE

+2 GW installed
safeTrack Horizon trackers H3/H4

FOUNDED in Germany: **2003**

TURNOVER 2019: 80 Mio €

EMPLOYEES: 51 (2019)

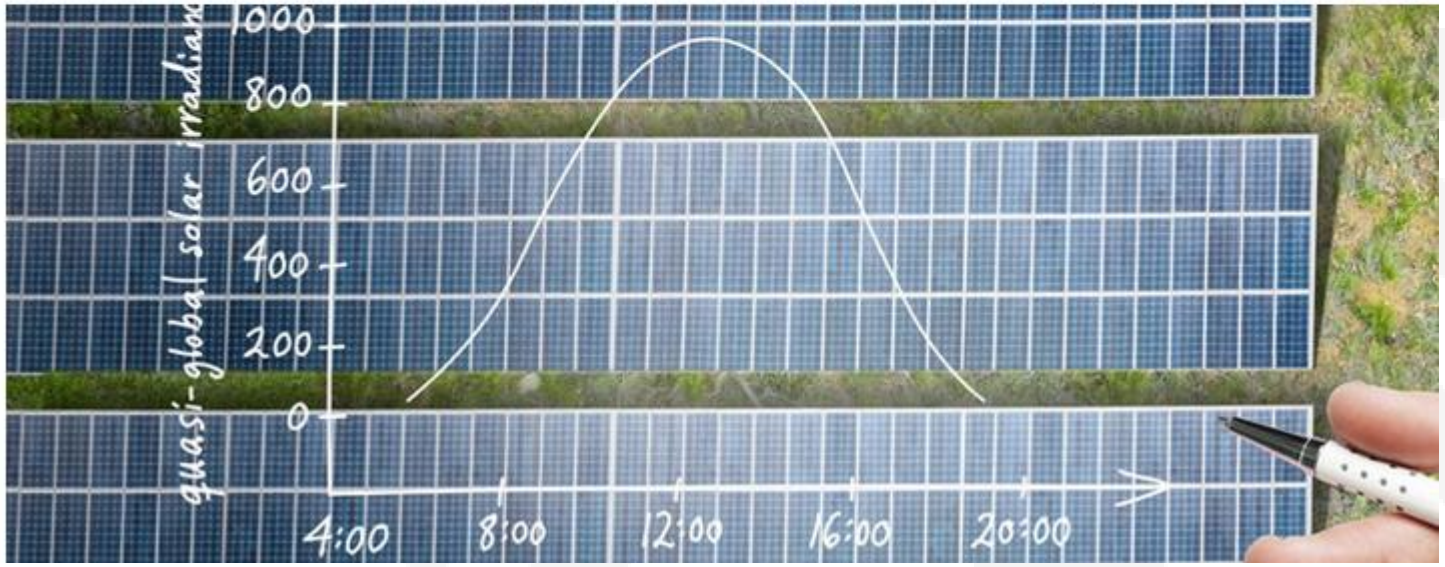


CERTIFIED FACILITIES

Investors focus:

“A low-risk investment with steady and predictable cash flows for 20 to 30 years.

Tracker Bankability



“The significance of different **tracker architectures** and electrical balance of system components is often not understood.”

“This lack of **rigorous analysis** about the risks and costs posed by utilizing particular components – especially electrical and **structural balance of system (BOS) equipment** – is a genuine threat to the growth and health of the industry.”

“These are supposed to be **20 to 30 year assets**”

Main Trends in Bankability

Figure 4: Occurrence of technical risks of PV systems during operation

by Solarbankability.eu

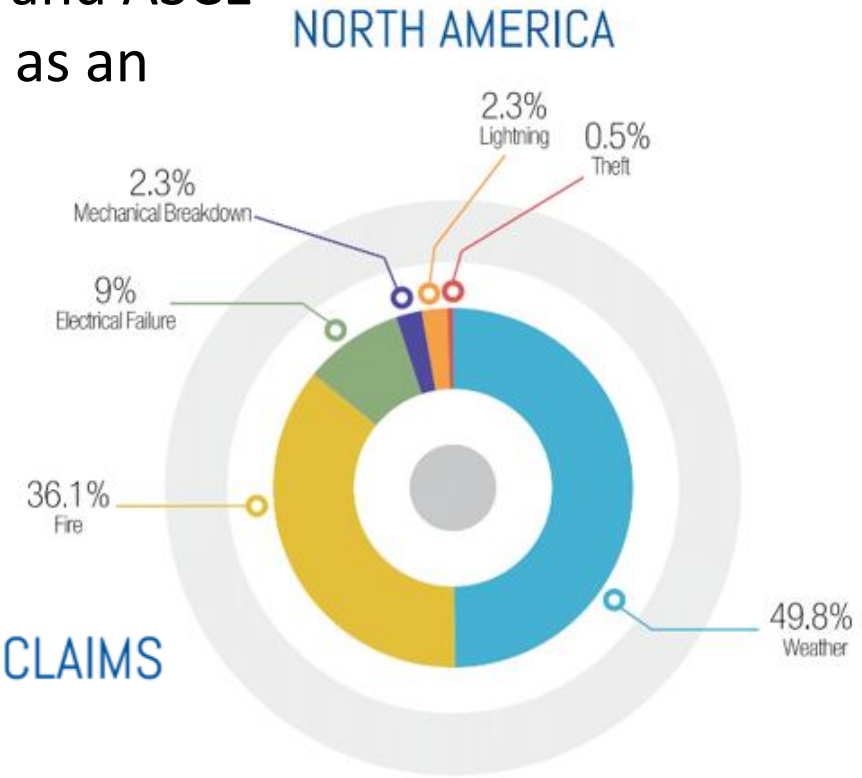
How the solar industry is responding to the increasing intensity of natural disasters

- Wind tunnel testing
- Compliance with UL standards:
  - UL 2703 (Grounding/Bonding Standard for Rack Mounting System)
  - UL 3703 (Standard for Trackers)
- ASCE7-10 (American Society of Civil Engineers - Minimum Design Loads for Buildings)
- Compliance with CE marking
- SO Certifications - ISO 9001, ISO 14001, and ISO 18001
- Compliance with Eurocodes and SANS
- Number of utility scale projects in operation
- Technical due diligence on independent engineering reports by recognized firms such as: Leidos, Black & Veatch, Garrigues, TUV SUD, to name a few.

by Triana Group

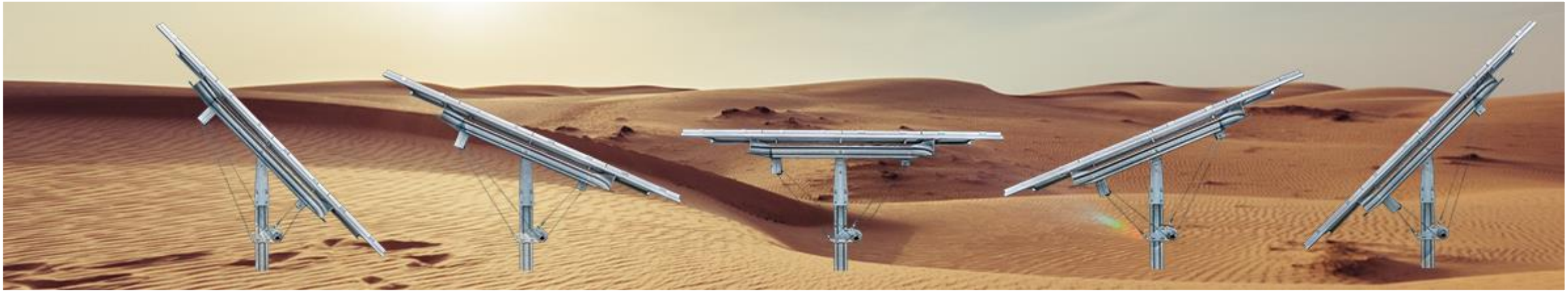
Wind tunnel testing: Perform a detailed review of the wind tunnel report, including the full range of tilt angles and wind directions tested in the wind tunnel. Ensure the report aligns with wind tunnel testing methodology and complies with ASCE 7 and ASCE 49 (or other accepted international standards), as well as an analysis of:

- Static wind loads
- Dynamic amplification
- Aeroelastic deflection
- Instability: torsional galloping (stall flutter)
- Instability: vortex lock-in
- Flutter and divergence



IDEEMATEC

SAFETRACK HORIZON – TECHNOLOGICAL BENEFITS



IDEEMATEC

SAFETRACK HORIZON – Jordan – Qweira – 105 MWp

IDEEMATEC

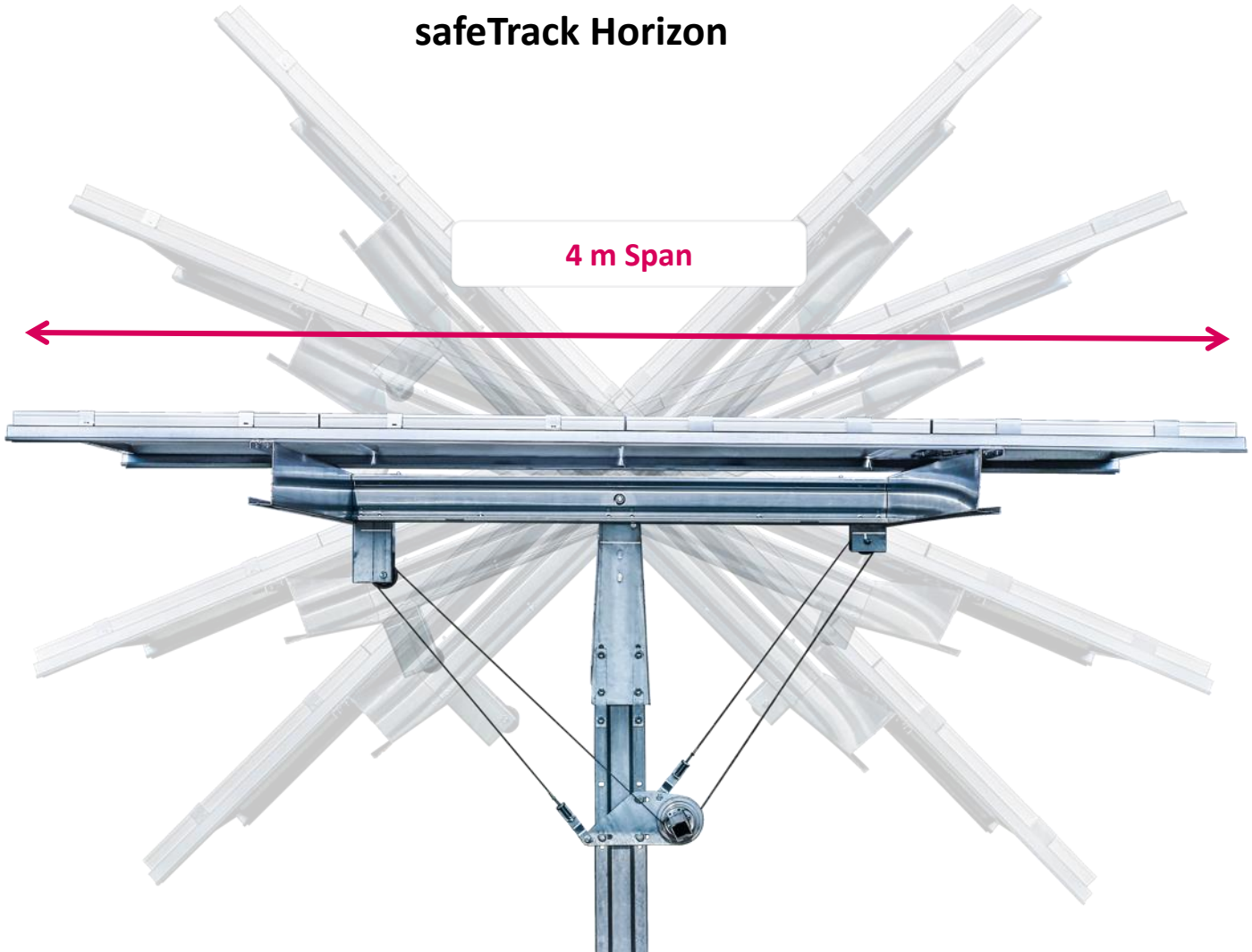
SAFETRACK HORIZON – Australia – Limondale – 350 MWp

IDEEMATEC

SAFETRACK HORIZON – Vietnam – Hado – 50 MWp

SAFETRACK HORIZON – Overview

- One Tracker: max. 6 tables
- One table: 30 m
- One tracker: max. 180 m length
- One tracker: one motor/gearbox
- 180 posts per MW

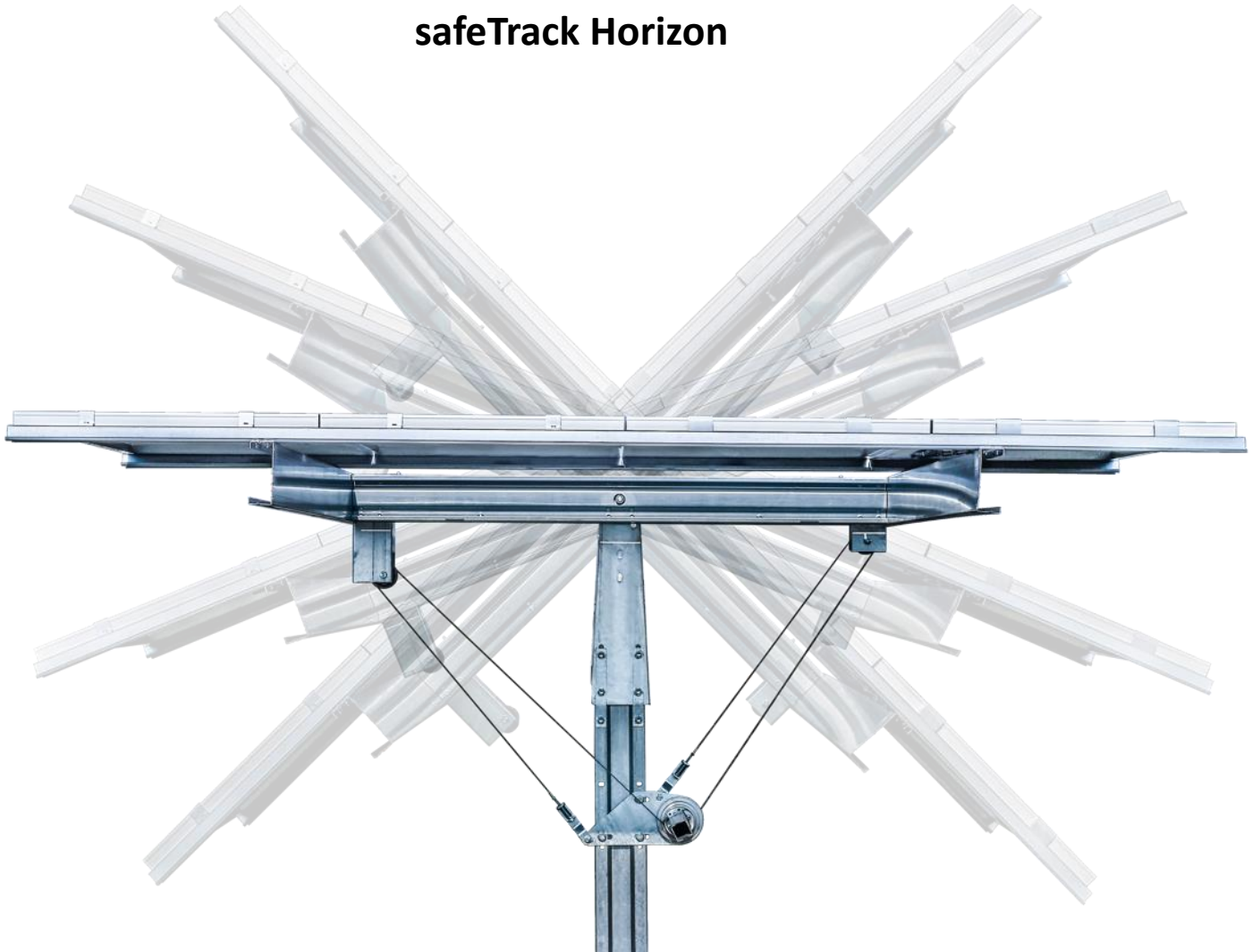


SAFETRACK HORIZON – OUTSTANDING CONSTRUCTIVE FEATURES

- Patented steel rope technology
- Table fixation with ropes
- Geometry of rope system reduces forces
- High transmission between table and drive tube

- Patented self-adjusting-spring-system
- Load transfer by tension
- Ropes have a damping effect
- Unique technology such as in crane systems

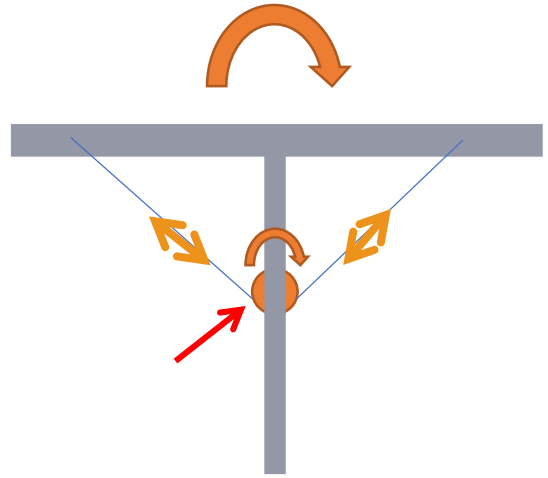
safeTrack Horizon



SAFETRACK HORIZON – UNIQUE ROPE TECHNOLOGY

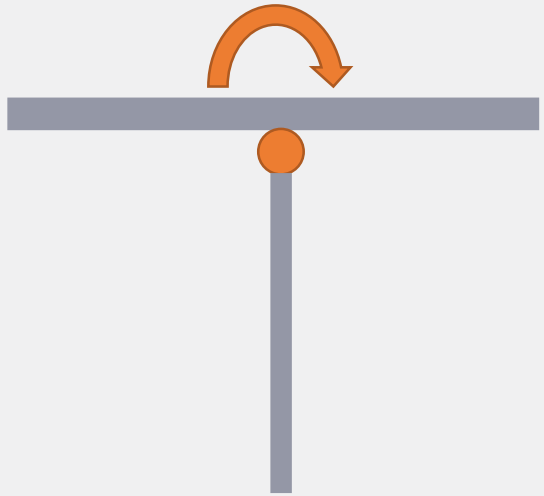
IDEEMATEC safeTrack Horizon

- High winch ratio leads to less torsional moment on driving tube!
- Winch transmission ratio is 1:28
- Low risk of torsional galloping!!!



Standard „Torque Tube“ Tracker

- Modules mounted directly on driving tube
- Admission of the full table moment through driving tube
- High risk of torsional galloping!!!

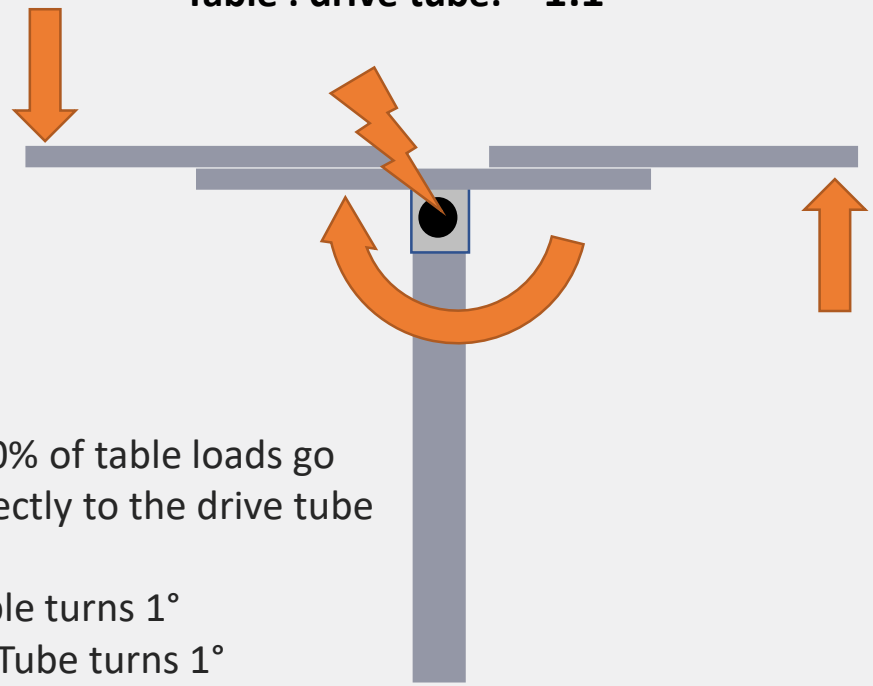


SAFETRACK HORIZON – UNIQUE ROPE TECHNOLOGY

Standard „Tube“ Tracker

Gear transmission ratio

Table : drive tube: = 1:1

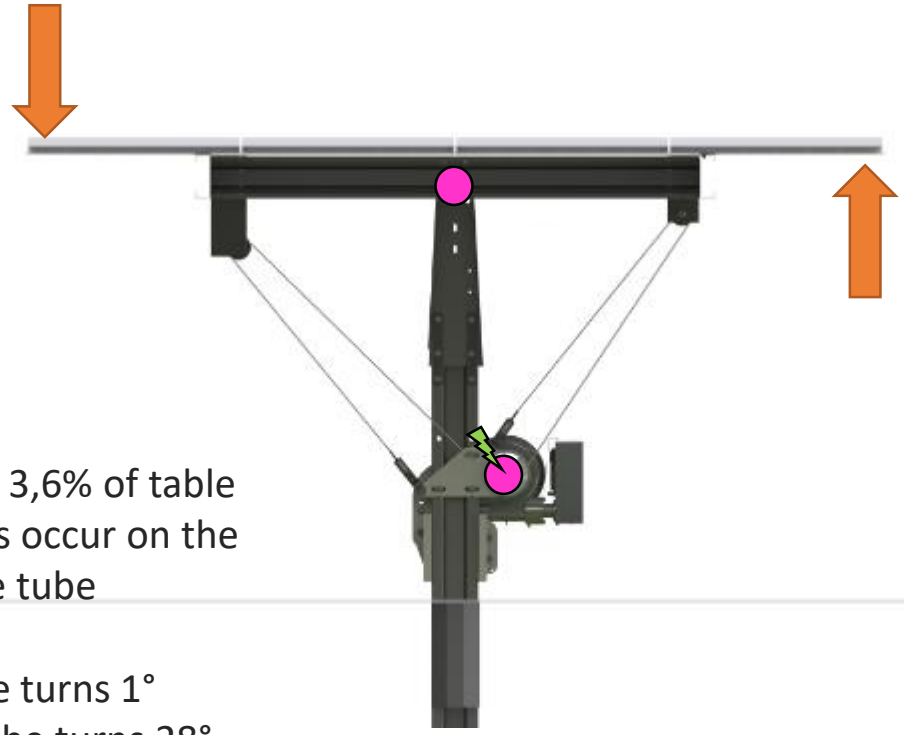


- 100% of table loads go directly to the drive tube
- Table turns 1°
  → Tube turns 1°

IDEEMATEC safeTrack Horizon

Gear transmission ratio

Table : drive tube = 1:28 !!

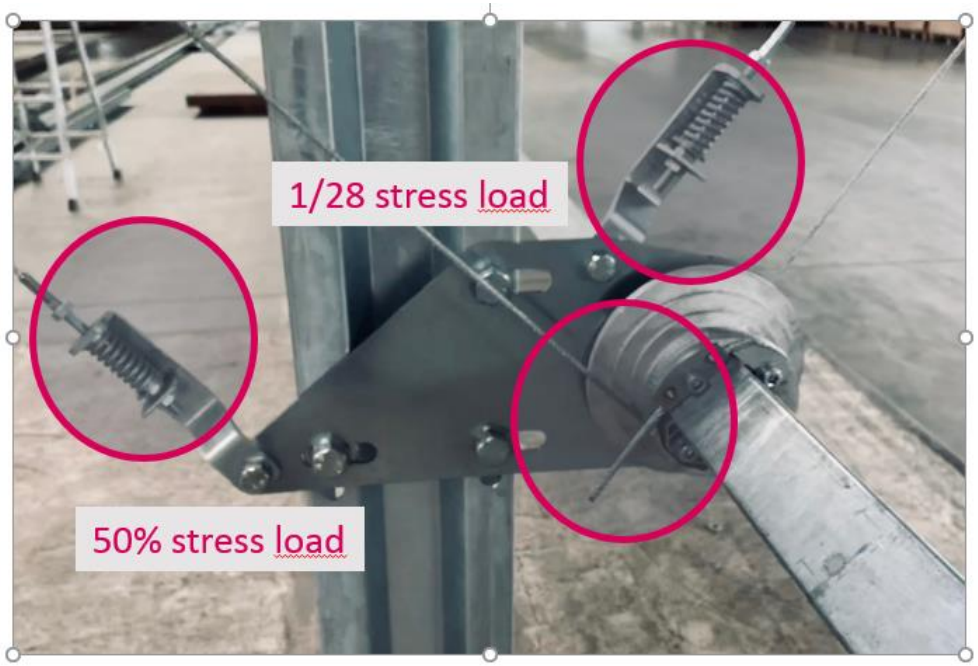


- Only 3,6% of table loads occur on the drive tube
- Table turns 1°
  →Tube turns 28°

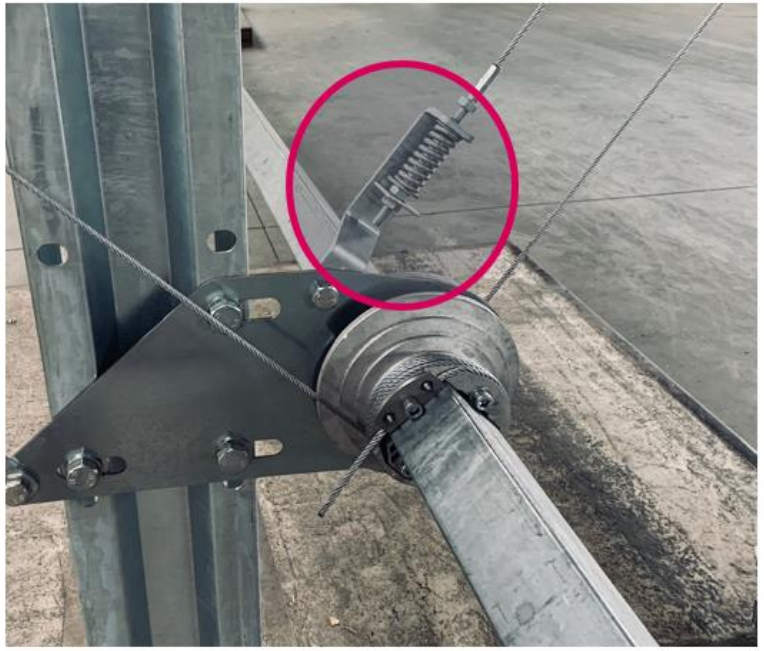
IDEEMATEC

SAFETRACK HORIZON – UNIQUE ROPE TECHNOLOGY

8 x Dampers per 30 m table



Reduction of forces

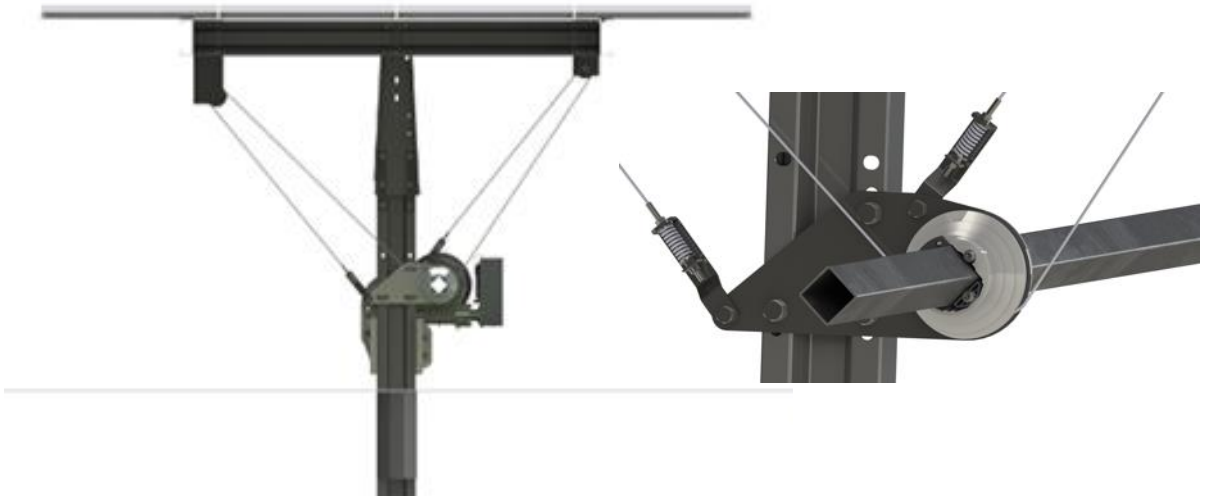


Unique spring system for adjustment

Benefit of the unique rope design

- → Very low forces on gear box and tubes
- → high damping ratio
- → stiff table without axis flexibility
- → easy rotation impossible
- → flat table over whole 180m without twists on the tracker ends
- → 0° position as stow position possible

STOW-POSITION at 0°
-> easy to define
-> easy to reach



Stow Position

→STOW-POSITION at 0°

→easy to define, easy to reach, no special hardware

→lowest static forces on components

→STOW-POSITION at inclination (20-30°)°

→additional sensor for wind direction

→higher static forces on components

→more loss of energy

Wind Engineering by Ideematec – Following two ways:

STATIC & DYNAMIC

STATIC WIND TUNNEL STUDY
Output:
design factors [-]

STRUCTURAL CALCULATION
Output:
Final tracker design

NORMS
&
STANDARDS

DYNAMIC WIND TUNNEL STUDY
Output: onset velocity [m/s]

MODAL ANALYSIS
Output: Natural frequency [Hz]

DESIGN APPROACH

PROCESS FOR A SAFE TRACKER DESIGN

NORMS & STANDARDS
Output: Velocity pressure [KN/m²]

STATIC WIND TUNNEL STUDY
Output: Design factors [-]

STRUCTURAL CALCULATION
Output: Final tracker design

MODAL ANALYSIS
Output: Natural frequency [HZ]

DYNAMIC WIND TUNNEL STUDY
Output: Onset velocity [m/s]

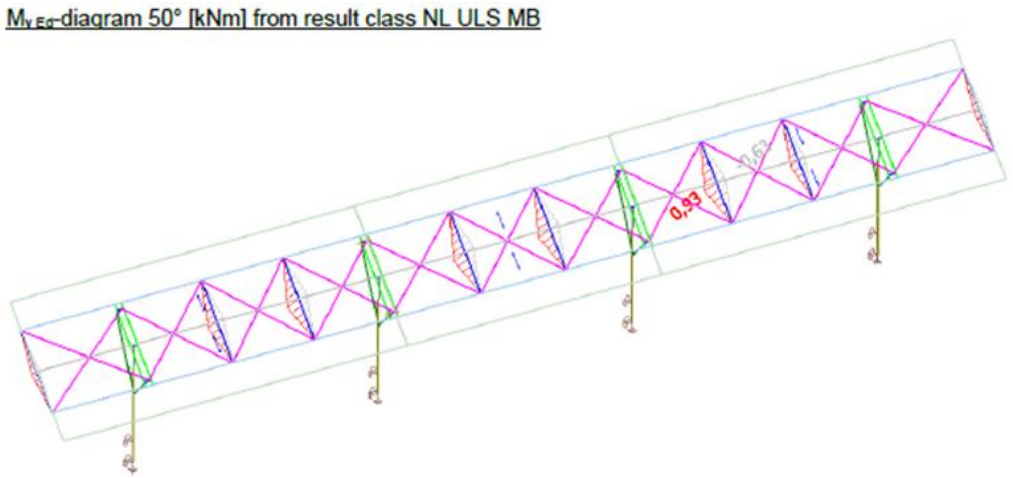
FINAL CHECK:
Onset Velocity > design velocity
= OK

NORMS & STANDARDS

Figura AN.1 – Mapa de isotacas de la velocidad básica fundamental del viento $v_{b,0}$

- Local Wind Maps with wind speeds in m/s
- Regulations for factors
- Regulations for calculation approach
- Formulas
- OUTPUT: Velocity pressure in KN/m²

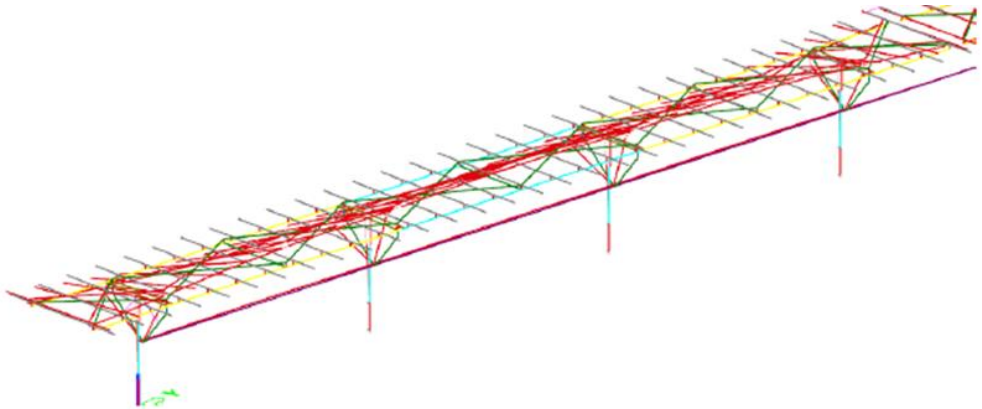
STRUCTURAL CALCULATION



- Input values: velocity pressure, design factors, geometry
- Comprehensive Calculation according to defined norms
- Contains tension and stability investigations
- Calculation of every load carrying component
- OUTPUT:

  project specific design with material type and thicknesses

MODAL ANALYSIS



- Investigation of dynamic behaviour
- Determination of natural modes and natural frequencies
- Minimum natural frequency

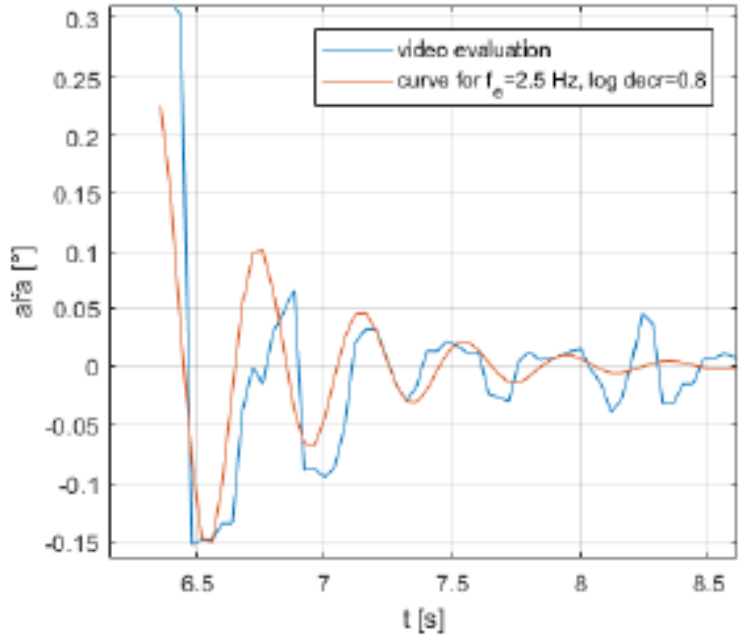
  for 6-Table-Tracker (180 m): 1.7 Hertz
- OUTPUT: natural frequency [Hertz]

DAMPING DECREMENT

- Measurements were conducted on a REAL SYSTEM

- Cut of rope in order to determine the damping decrement

- Determination of 0.8 as damping decrement



WACKER INGENIEURE
WIND ▪ ENGINEERING

- Founded in 1992
- 3 own wind tunnels
- Own model fabrication shop
- Own CFD-department
- More than 20 employees
- Largest private owned company in Germany in this sector
- More than 2.500 projects

ADDRESS
Gewerbestr. 2
75233 Birkenfeld

PHONE
+49 |0|7082 | 94 44 3 - 0

E-MAIL
Info@wacker-ingenieure.de

WEBSITE
www.wacker-ingenieure.de

WACKER INGENIEURE
WIND ▪ ENGINEERING

ADDRESS
Gewerbestr. 2
75233 Birkenfeld

PHONE
+49 |0|7082 | 94 44 3 - 0

E-MAIL
Info@wacker-ingenieure.de

WEBSITE
www.wacker-ingenieure.de

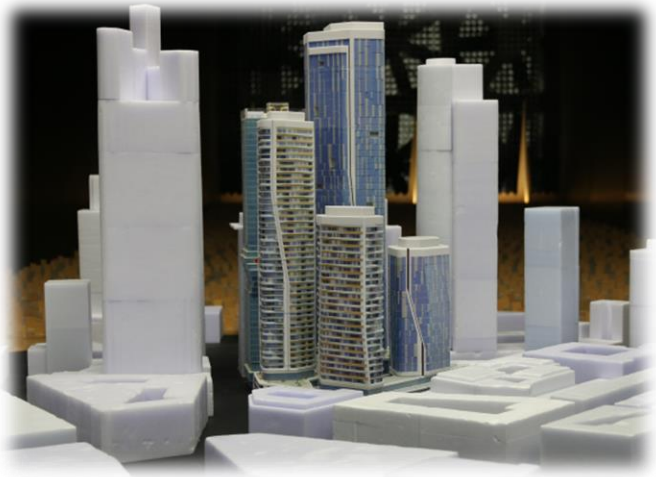
Present Projects:

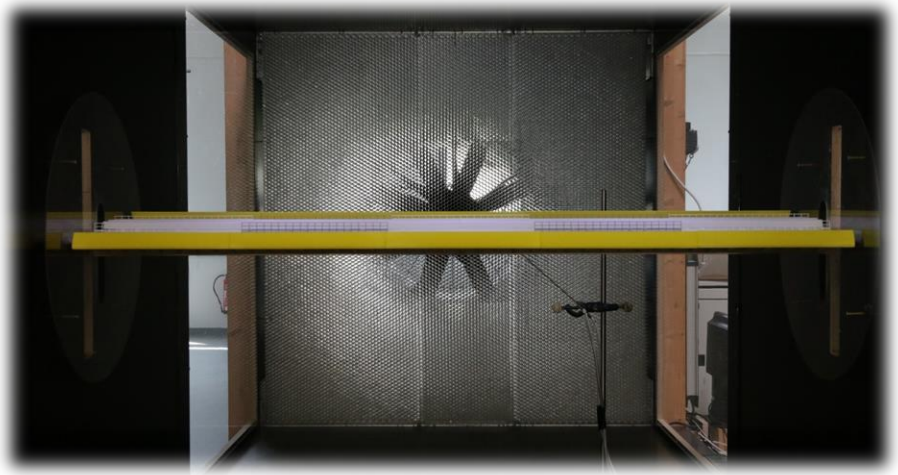
- Stadium Real Madrid, Madrid Spain
- Pattullo Bridge, Vancouver, Canada
- Elbtower Hamburg, Germany (H = 250 m)
- Wrappring Arc de Triomphe, Paris, Christo

Main Projects:

- Stadium Maracana, Rio de Janeiro, Brazil
- Allianz Arena Munich
- New Camp Nou Stadium, Barcelona, Spain
- 2020 Tower Dubai, UAE (H =300m)
- Clock Tower Top (H=600 m); Makkah, Saudi Arabia
- 3rd Orcinoco Bridge Venezuela
- 4th Panama Bridge, Panama

Rigid model study	Dynamic model study
➢ Basic wind tunnel procedure ➢ Static wind loads ➢ Dynamic wind load due to buffeting ➢ No information about self induced vibrations	➢ Typically done in addition to rigid model tests ➢ Typical structures are tall buildings and bridges, structures which are prone to dynamic wind effects ➢ Dynamic section model tests or full- aeroelastic model tests ➢ Information about vortex shedding an d aerodynamic instabilities like galloping or flutter





CFD: Results depend very strong on experience of user and used turbulence model. Our office do not use CFD for the prediction of design wind loads. According to some wind load standards the usage of CFD is not allowed for the determination of design wind loads.

STATIC WIND TUNNEL STUDY

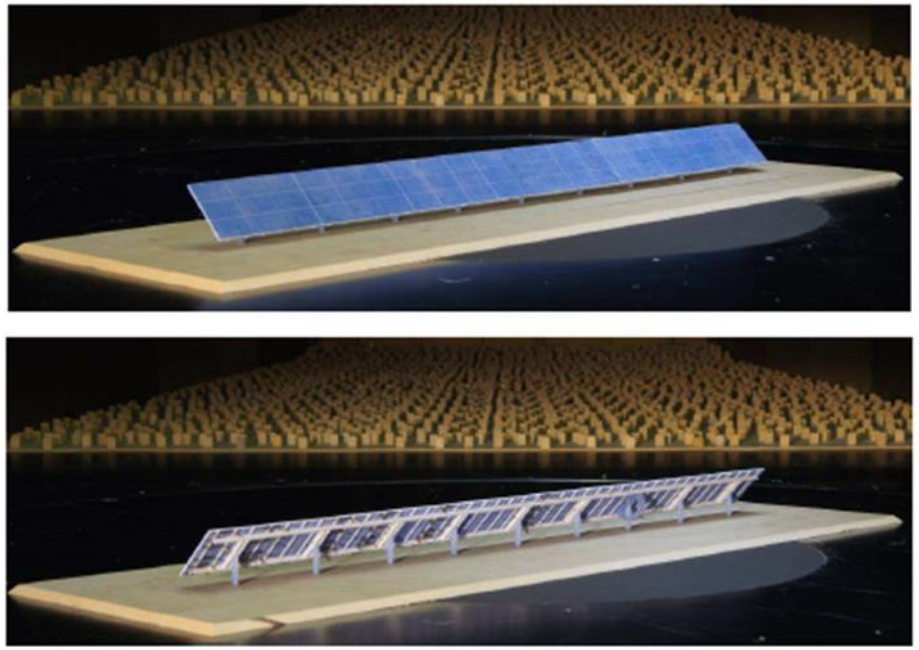
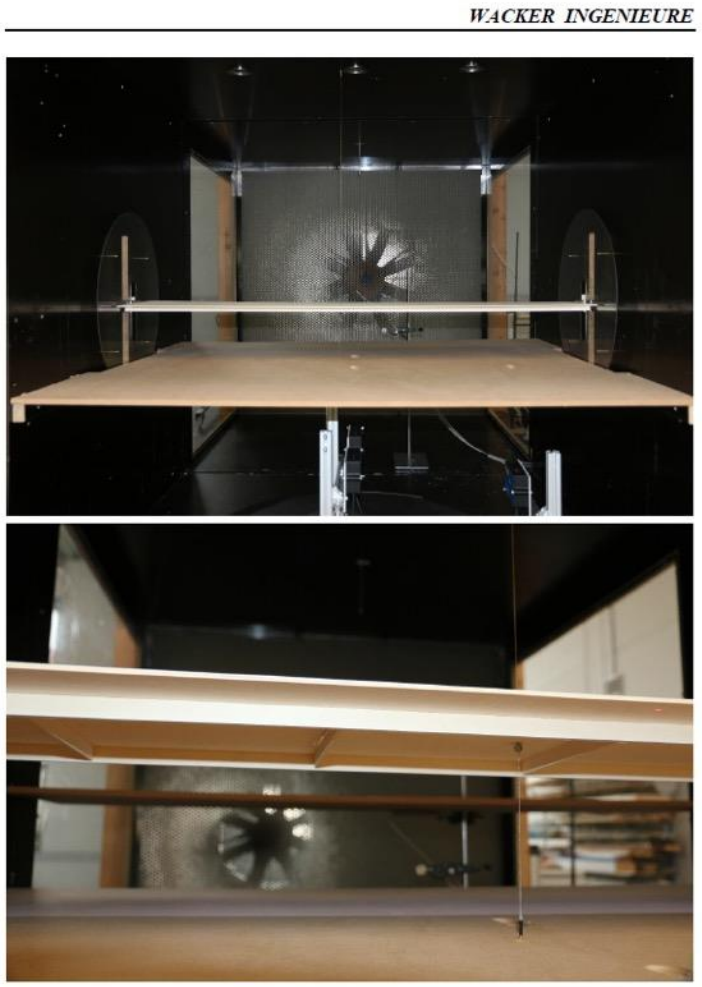


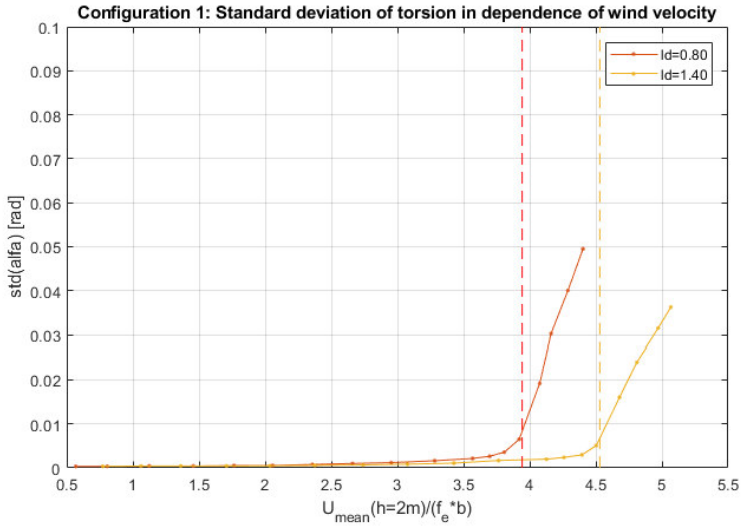
Fig. 3.1: Wind tunnel model (scale 1:40) of the PV-tracker system; Elevation 45°

- Norms only provide factors for freestanding monopitch roofs
- Determine pressure factors for static considerations
- Scaled model on a turntable with pressure taps on back and front side
- Measurements for inclinations up to 60°
- Measurements for all wind directions
- OUTPUT: Design factors [-]

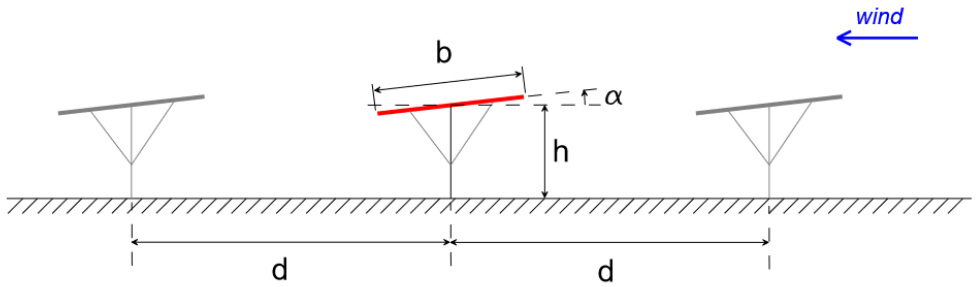
DYNAMIC WIND TUNNEL STUDY



- Investigation of dynamic behaviour in wind tunnel
- Aeroelastic section model test for stow position at 0°
- Investigation of dynamic instabilities such as galloping
- OUTPUT: Onset velocity for instabilities [m/s]

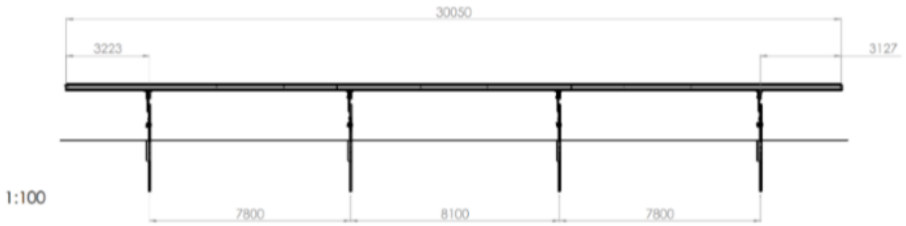


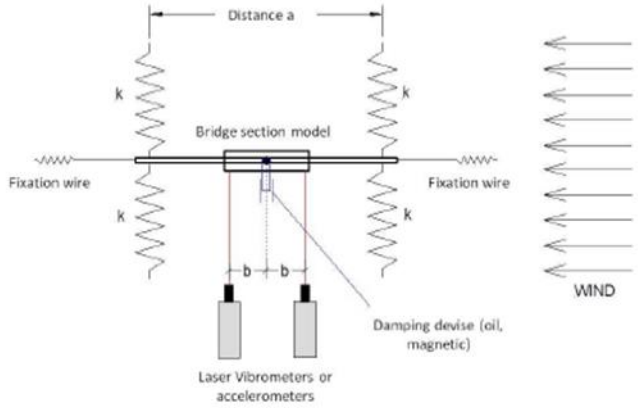
DYNAMIC WIND TUNNEL STUDY – GEOMETRY



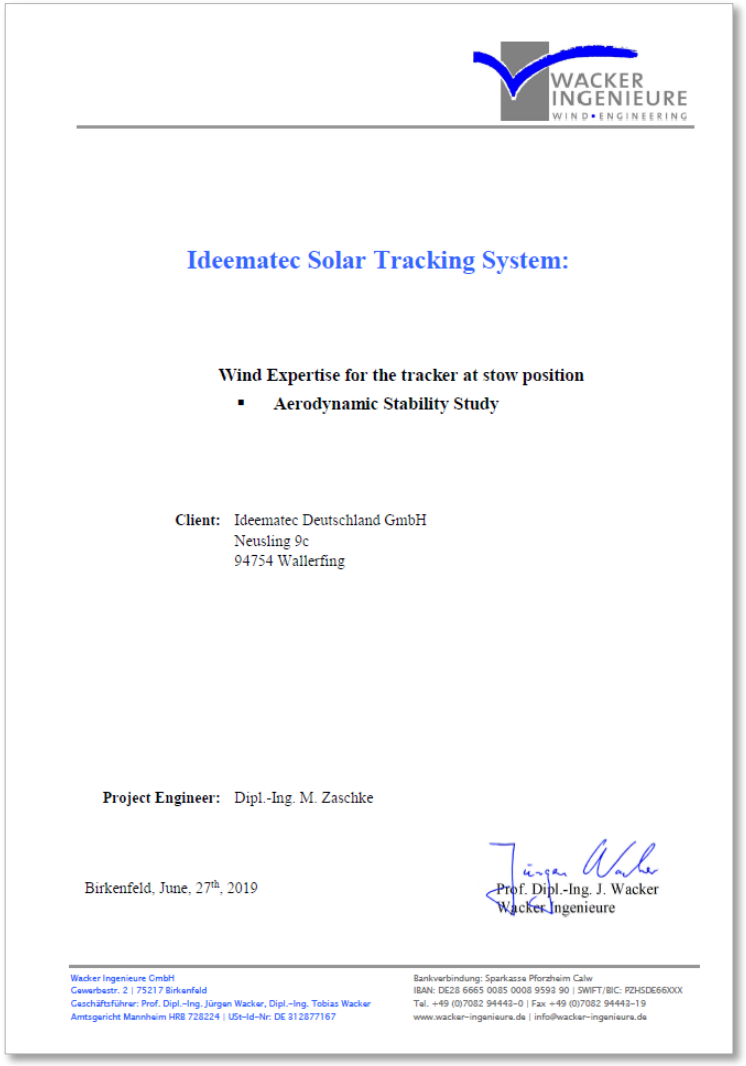
h =	2 m
b =	3.93 m
d =	10 m
α =	-2°, 0°, +2°
length of single table L =	29.3 m

Deviations of +-2° are covered





DYNAMIC WIND TUNNEL STUDY – RESULTS



WACKER INGENIEURE
WIND • ENGINEERING

Ideematec Solar Tracking System:

Wind Expertise for the tracker at stow position

- **Aerodynamic Stability Study**

Client: Ideematec Deutschland GmbH
Neusling 9c
94754 Wallerfing

Project Engineer: Dipl.-Ing. M. Zaschke

Birkenfeld, June, 27th, 2019

Prof. Dipl.-Ing. J. Wacker
Wacker Ingenieure

Wacker Ingenieure GmbH
Gewerbestr. 2 | 75217 Birkenfeld
Geschäftsführer: Prof. Dipl.-Ing. Jürgen Wacker, Dipl.-Ing. Tobias Wacker
Amtsgericht Mannheim HRB 728224 | USt-Id-Nr: DE 312877167

Bankverbindung: Sparkasse Pforzheim Calw
IBAN: DE28 6665 0085 0008 9593 90 | SWIFT/BIC: PZHSDE66XXX
Tel. +49 (0)7082 94443-0 | Fax +49 (0)7082 94443-19
www.wacker-ingenieure.de | info@wacker-ingenieure.de

→ **Stowing in 0° position safe and stable**

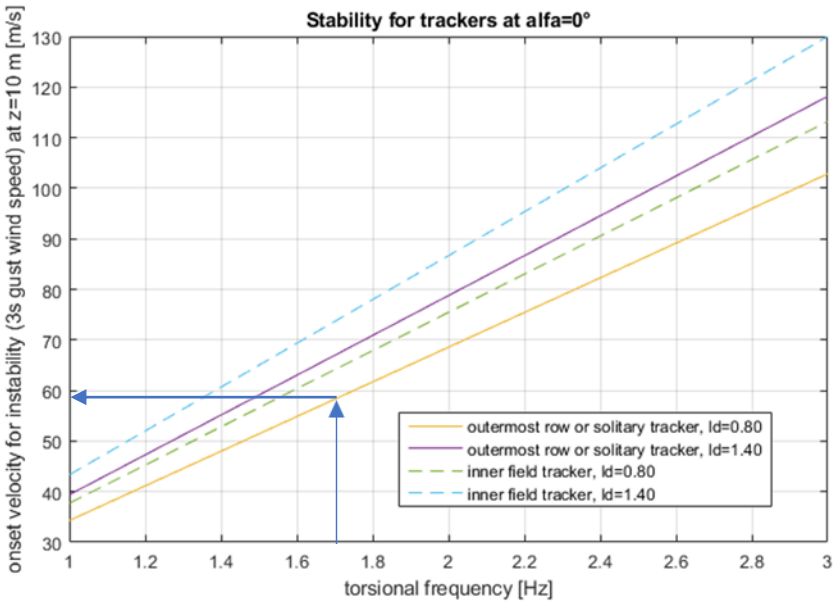
→ **Onset wind velocity for dynamic instability much higher than static design wind velocity**

→ **No dynamic amplification factors necessary**

→ **Static Design is safe in EVERY SITUATION**

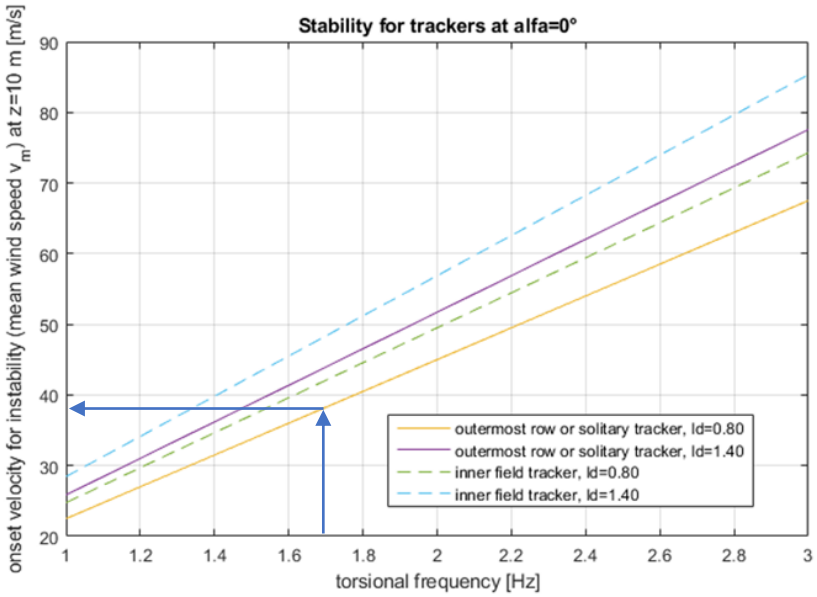
DYNAMIC WIND TUNNEL STUDY – FINAL CHECK STANDARD SYSTEM

3 sec gust



1.7 Hertz → 60 m/s

10 min mean



1.7 Hertz → 38 m/s

-> Safety factor much higher than 1.25 as required

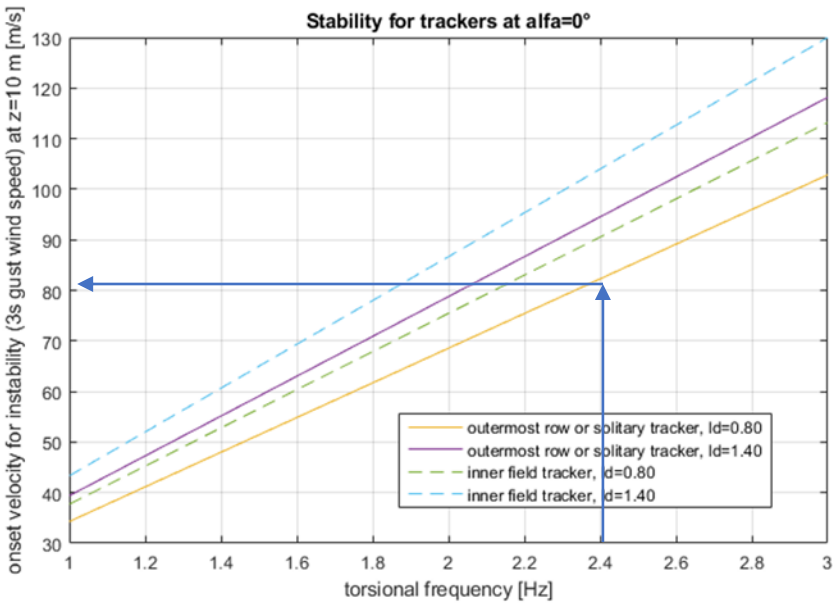
Final check: compare to design wind speed.

Typical design wind speed 10 min mean: 25 m/s

→ 38 m/s >>>25 m/s → Galopping EXCLUDED!

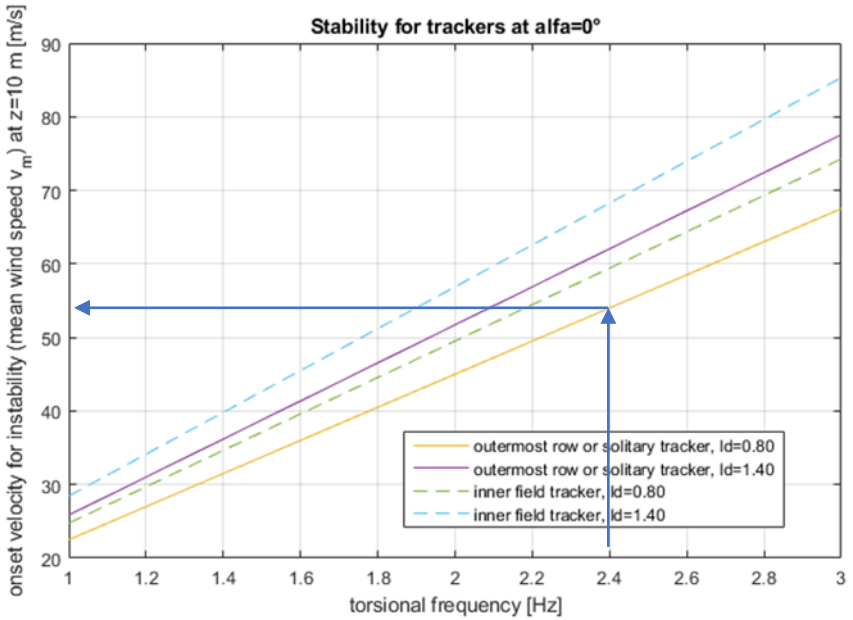
DYNAMIC WIND TUNNEL STUDY – FINAL CHECK HIGH WIND SYSTEM

3 sec gust



2.4 Hertz → 80 m/s

10 min mean



2.4 Hertz → 54 m/s

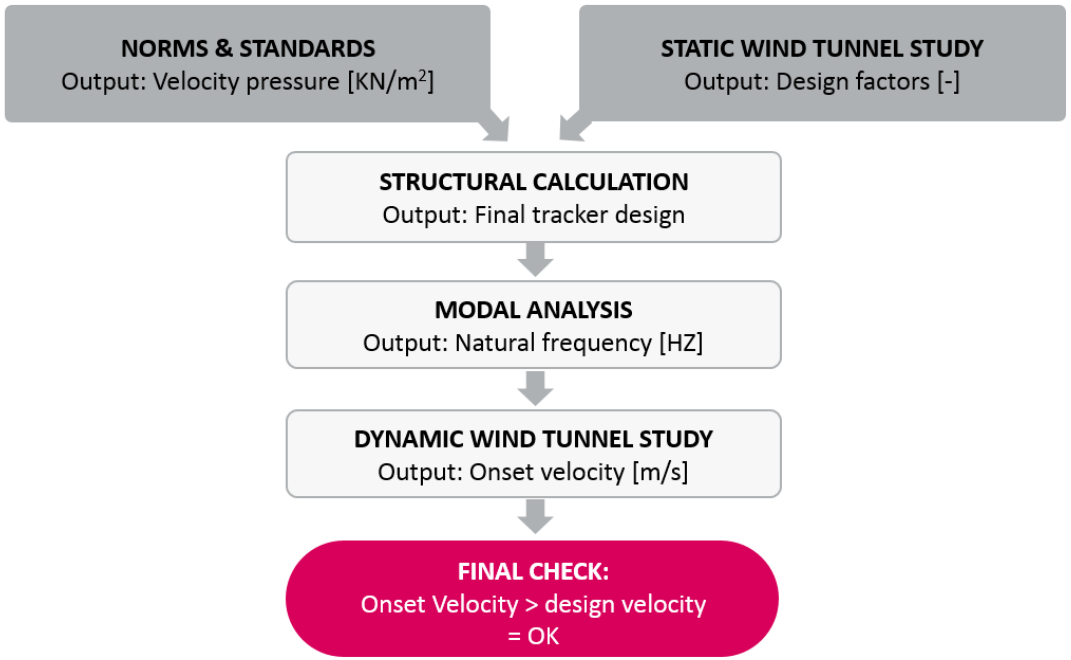
-> Safety factor much higher than 1.25 as required

Final check: compare to design wind speed.

Typical design wind speed 10 min mean: 30 m/s

→ 54 m/s >>>30 m/s → Galopping EXCLUDED!

DYNAMIC WIND TUNNEL STUDY –> CONCLUSION



WITH IDEEMATEC'S APPROACH
AND UNIQUE ROPE STRUCTURE

-> TORSIONAL GALOPPING IS EXCLUDED FOR EVERY LOCATION AT 0° STOW POSITION!

→ Increasing design wind speed

→ Stronger structure

→ Higher natural frequency

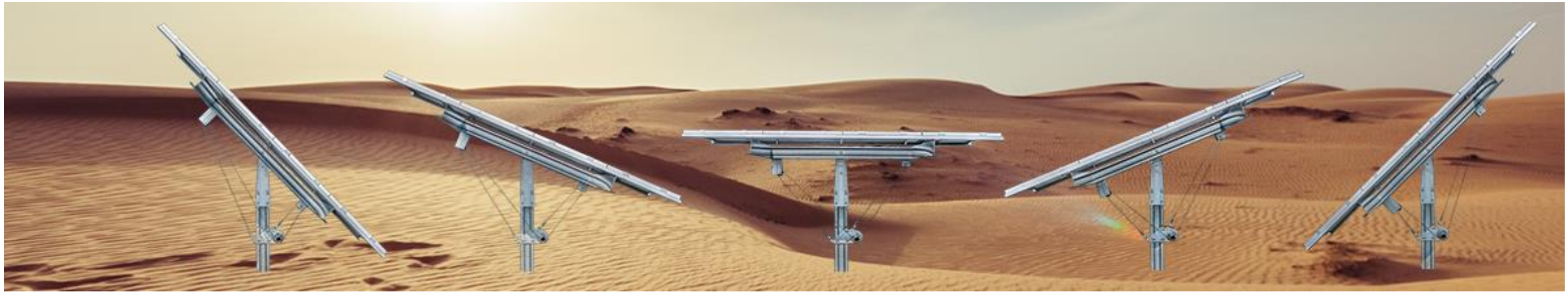
→ Higher Onset wind speed for dynamic instabilities!!!

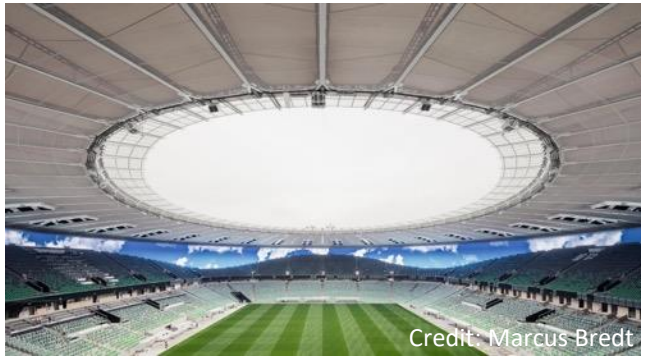
DYNAMIC WIND TUNNEL STUDY – PEER REVIEW

Conducted by Schlaich Bergermann Partner, Stuttgart

SBP SAYS THAT:

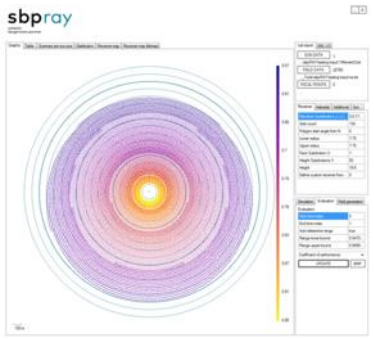
- **the natural frequency of Ideematec's safeTrack Horizon is HIGH in comparison to other tracker manufacturers!**
- **the approach of the aeroelastic wind study is CONSERVATIVE in comparison to other sectional wind tunnel test results.**

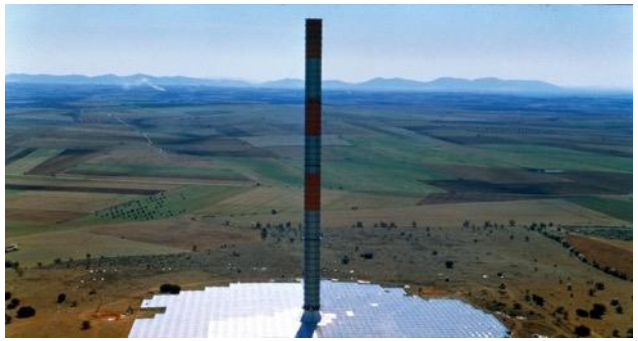


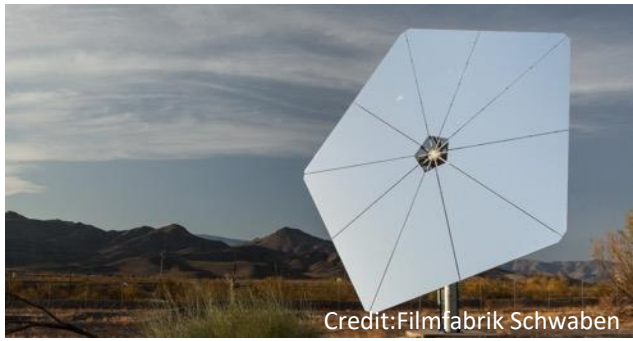


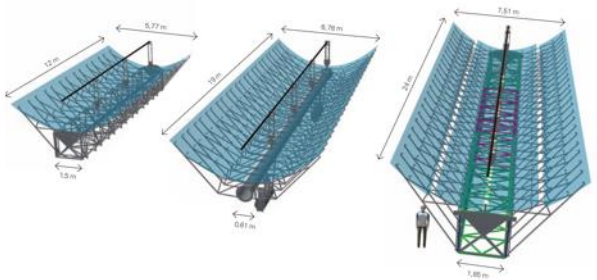
sbp
schlaich
bergermann partner

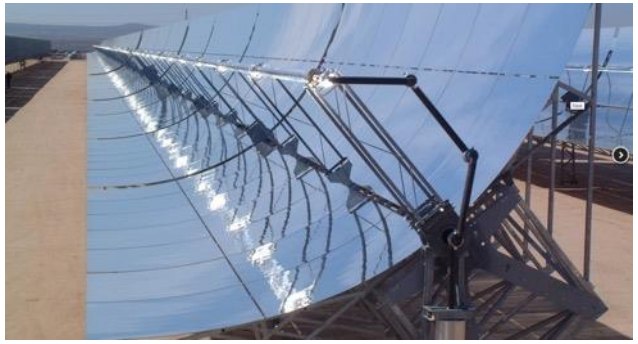
Structural engineering: roofs, stadiums, bridges, towers, sky scrapers, special structures

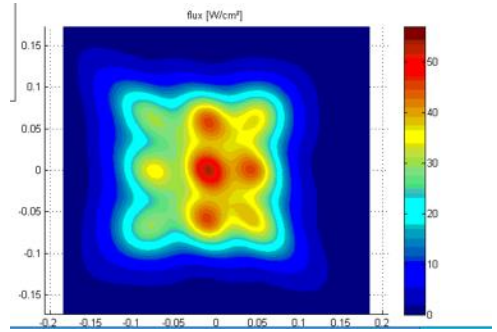












sbp
schlaich
bergermann partner

CSP technology: Parabolic trough, heliostat, dish-Stirling, updraft tower, ray tracing, solar field optimization

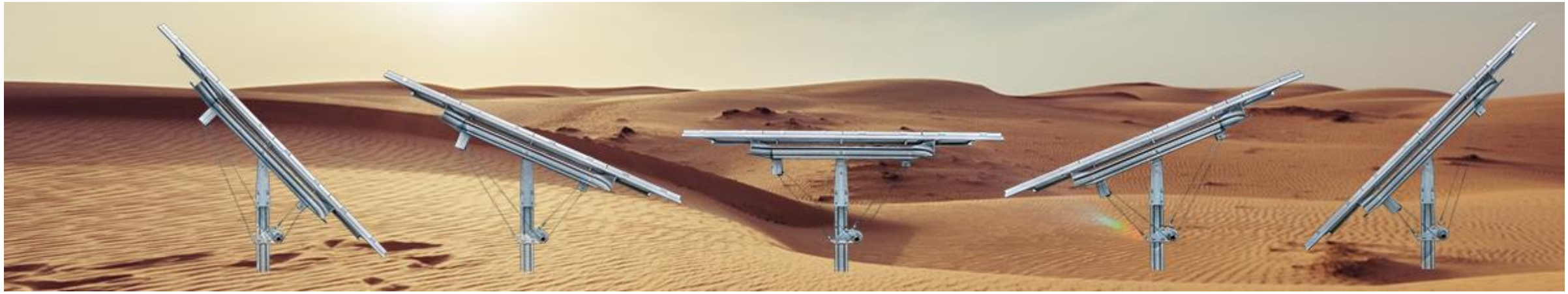
sbp service for PV tracker industry

- Reduce risk for suppliers, EPC and owners
- Structural design review (third party check)
- Root cause analysis
- Consulting on design methodology
- Technical support for owner and EPC
- System optimization
- 100% confidential due to non disclosure agreement

Project specific structural design review

- Design base (wind speed, safety factors, terrain category, solar field layout)
- Wind tunnel test (reasonable values and their application in design)
- Design method e.g. consideration of structural deformation, dynamic amplification
- Aeroelastic instability (torsional galloping/flutter)
- Reference calculation based on sbp expertise (FEA)
- Check of main members and connection details
- 12 PV tracker designs of 7 suppliers (5 of world’s top 10) checked or check ongoing

Main benefit of safeTrack Horizon Design and Design Approach:

-> Exclusion of torsional galloping !!!

THANK YOU!