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7 May 2026

10:00 am – 11:00 am | CEST, Berlin

12:00 pm – 1:00 pm | Dubai

1:30 pm – 2:30 pm | IST, Dehli

pv magazine
webinars

Will your solar plant survive the next storm? How to correctly identify wind load risk for solar installations



Matthew Lynas

Editor
pv magazine



John Wang

Head of R&D Engineering
Arctech




Parsa Enshaei

Associate Principal
CPP



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.  

“Behind The Panel Pressure”

Decoding the Structural Compatibility Between Trackers and Large-Format Modules

From the ashes, a **fire** shall be
woken, a **light** shall **spring**.



PPT by:

John Smart

VGM, Head of R&D Innovation

王敏杰

副总经理，产品中心



ARCTECH



Wind Damage



**Source: LinkedIn*



Purlin Issue? Module Issue?

1d ...
 All small purlins

2d ...
 How the racking attaches to the modules and the substructure makes a difference too. To save money some tracking systems only support a fairly narrow portion of the module frame. Supporting the module better help can definitely help.

1d ...
 It has nothing to do with the frame. It is your absolutely wrong mounting system. According to all installation manuals you need to support the module in four points on the long side. This project has failed to do so. So

for me it is obvious that with this mounting system would happen some day. The module mounting system holds only at a length of >2000mm. This is the issue of to high CAPEX grievance.



2d ...
 Interesting find. Typically, I feel like I've noticed the module frame is the limiting factor.

2d ...
 In last few years module framing thickness has drastically reduced as much as from 50mm - 30mm but at the same time module over all sq footage has increased, this has tremendously reduced the module structural integrity, not sure if making the substructure any

2d ...
 That's a great insight shows how the weakest link can shift with design improvements. Reinforced frames might soon become standard, not optional.

Anyone can make 100x stronger frame weakest element is lowest LCOE, high optimization, beating the competitors procurement success (?)





Wind Load Calcs + Panel Structure + Tracker Purlin Design

Wind Pressure
Stow Strategy

Double Glass
Aluminum Frame
(Steel Frame)

Purlin Length
Purlin Thickness
Purlin Material

Wind Tunnel Test
Local Wind Study

Compatibility
Testing



International
Electrotechnical
Commission

IEC 61215-2 v2021

Terrestrial photovoltaic (PV) modules –
Design qualification and type approval
– Part 2: Test procedures



Wind Load Calcs

+

Panel Structure

+

Tracker Purlin Design

Wind Pressure
Stow Strategy

Double Glass
Aluminum Frame
(Steel Frame)

Purlin Length
Purlin Thickness
Purlin Material

Wind Design Load

≥

Panel Design Load



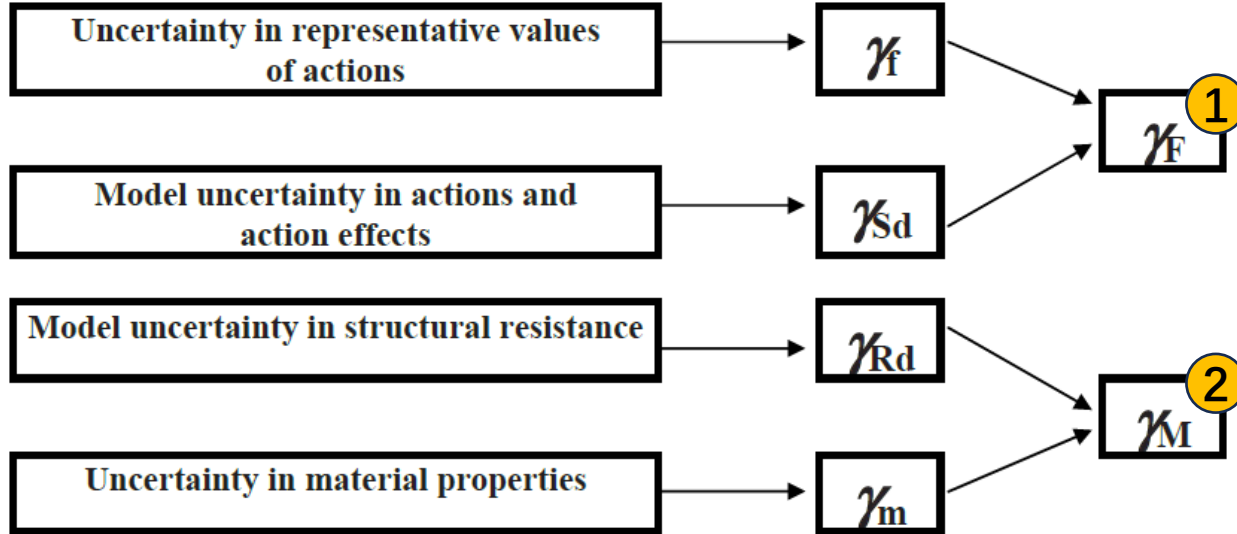
International
Electrotechnical
Commission

IEC 61215-2 v2021

Terrestrial photovoltaic (PV) modules –
Design qualification and type approval
– Part 2: Test procedures



Panel Design Load – Safety Factor



Two Safety Factors to be Considered:

- ① γ_F : *Uncertainty of wind actions*
- ② γ_M : *Uncertainty of structure/material*



EN 1990 v2002
Eurocode – Basis of structural design

$$\gamma_F \cdot E_{wind} < \frac{R_k}{\gamma_M}$$



IEC 61215-2 v2021
Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures

$$Design Load < \frac{Testing Load}{\gamma_m}$$



Panel Design Load – Safety Factor



IEC 61215-2

v2021

Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures



EN 1990

v2002

Eurocode – Basis of structural design

$$\text{Design Load} < \frac{\text{Testing Load}}{\gamma_m}$$

$$\gamma_m = 1.5$$

“ The manufacturer may specify higher [...] γ_m for certain applications. The design load(s) and γ_m are to be specified in the documentation of the manufacturer per each mounting method. ”

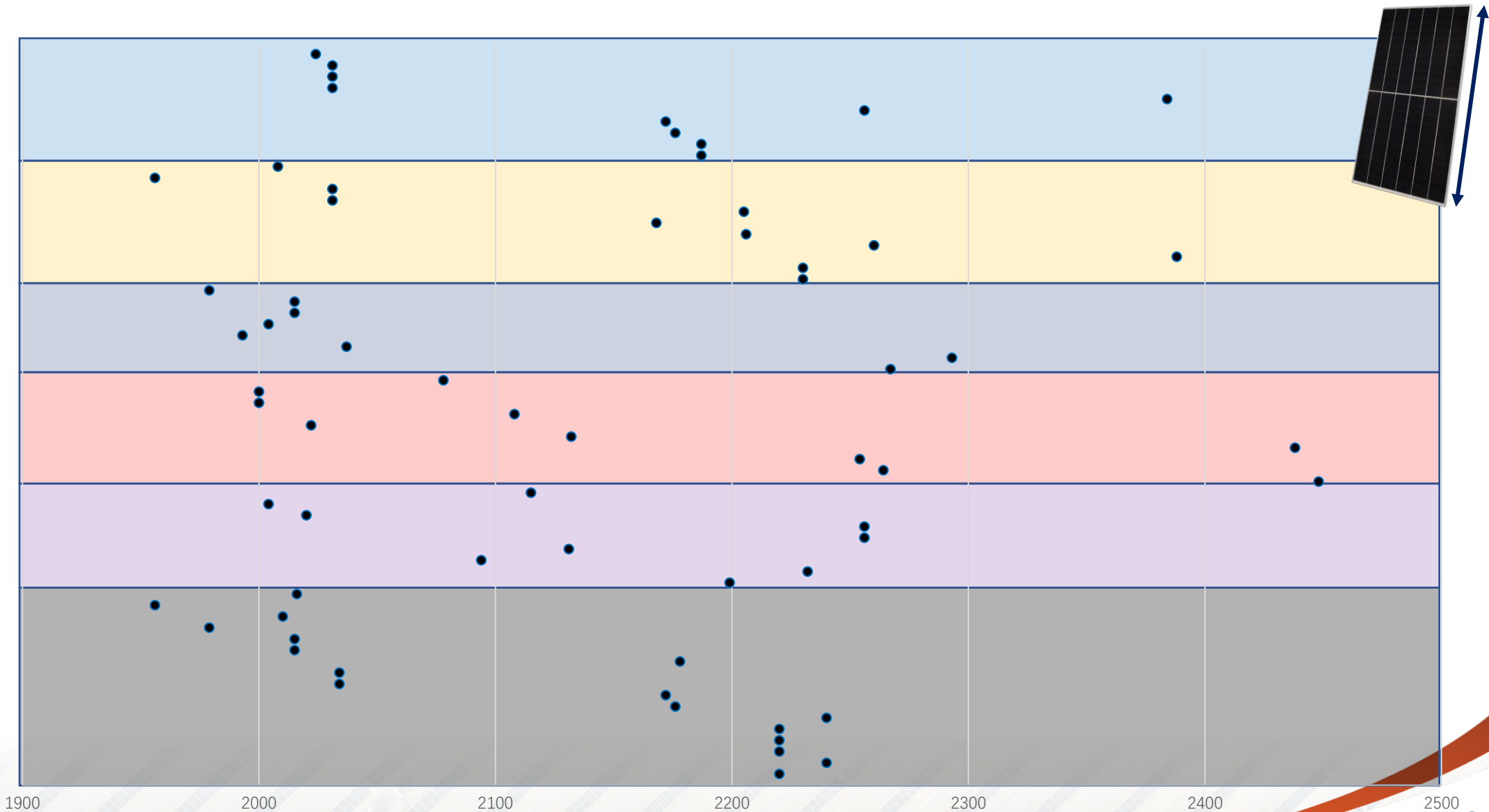
Testing Safety factor
 $\gamma_m = 1.5$

	γ_M	
	Float Glass	Rolled Glass
EN 13031-1: 2019	1.80	1.80
EN 16612: 2019	1.80	1.20
CEN/TS 19100-1: 2020	1.80	1.20
CNR-DT 201: 2013	2.50	1.35
NEN 2608: 2014	1.60	1.20
DIN 18008-1: 2020	1.80	1.50

Material safety factor
 $\gamma_M = 1.2 \sim 2.5$

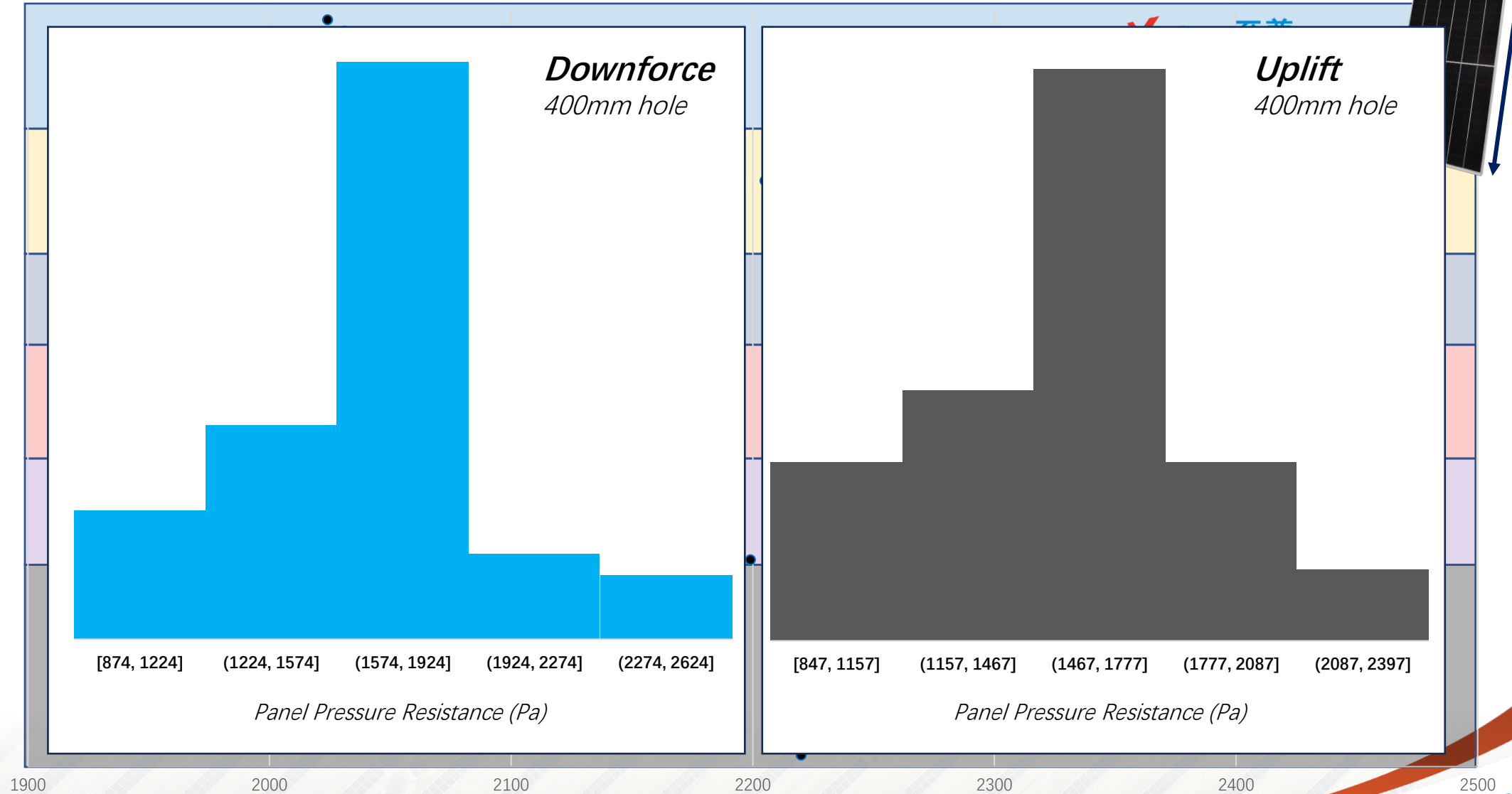
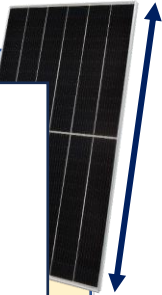


Panel Design Load – MQT16 Testing



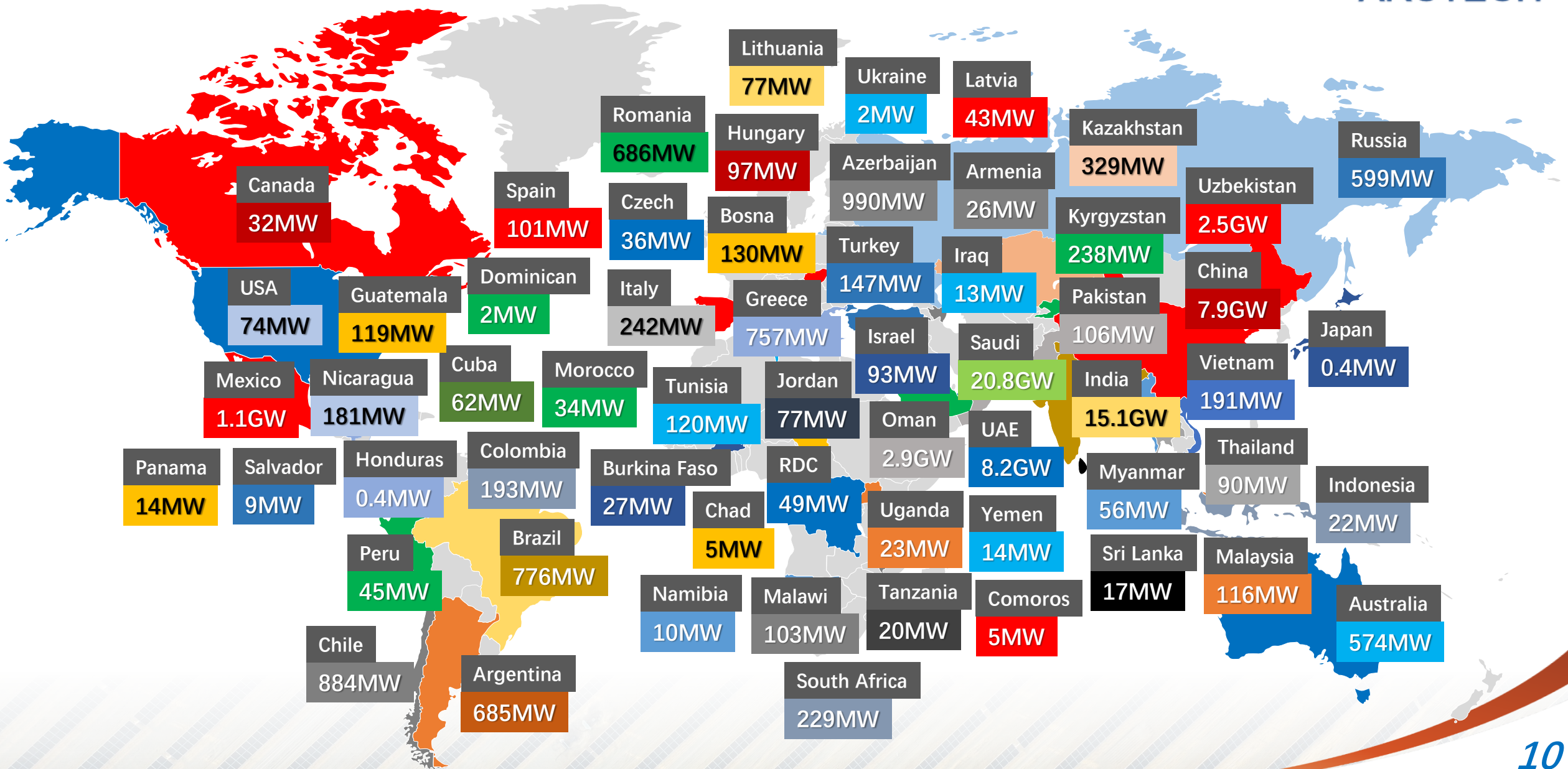


Panel Design Load – MQT16 Testing





Panel Design Load – Global Project





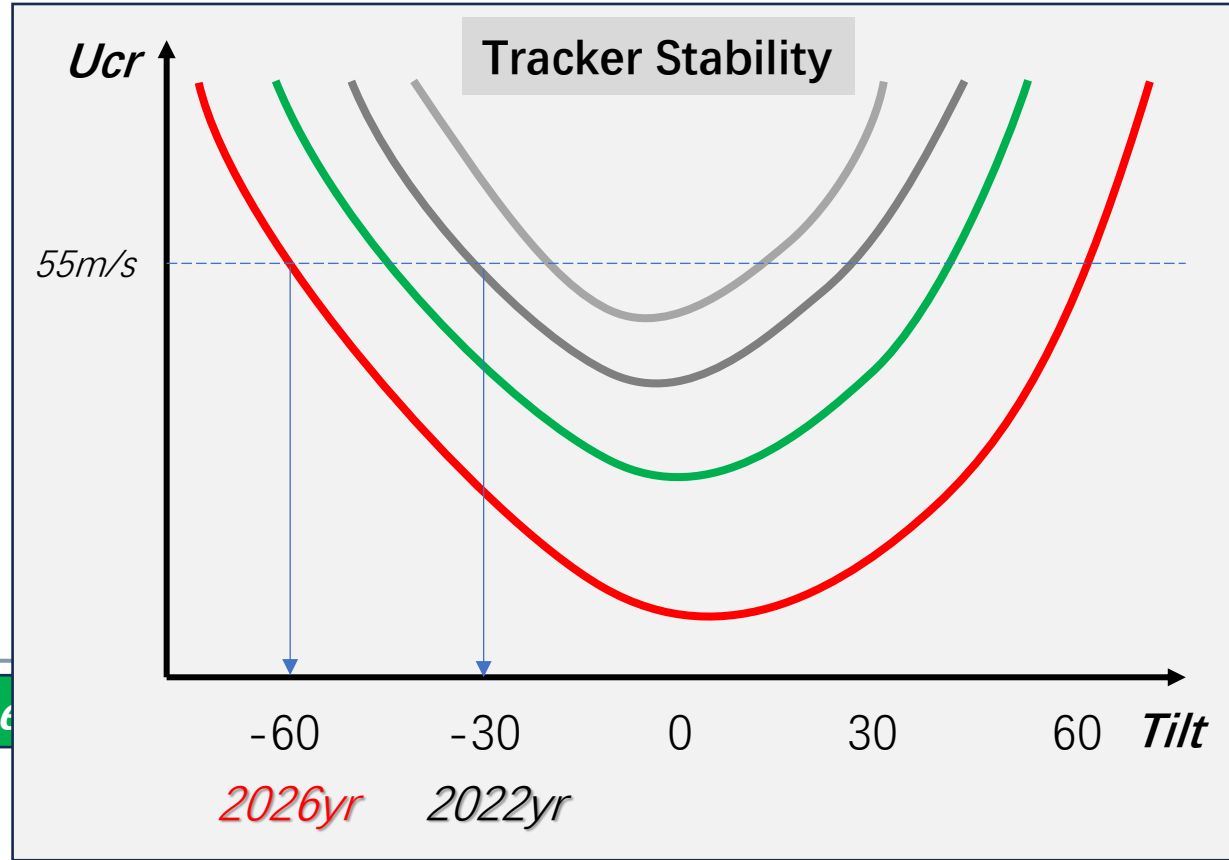
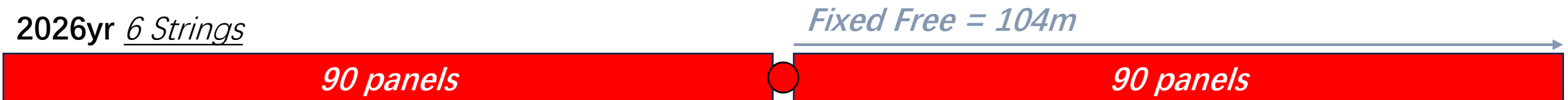
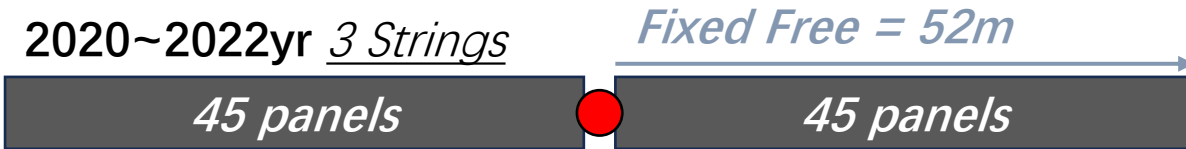
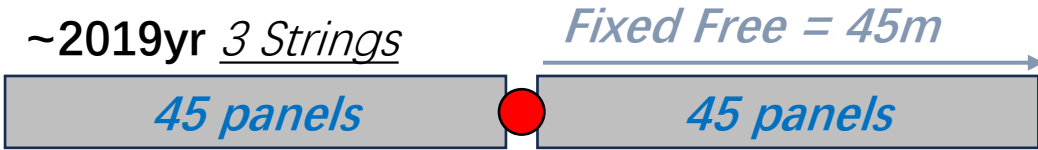
Panel Design Load – Rely on One Single Testing



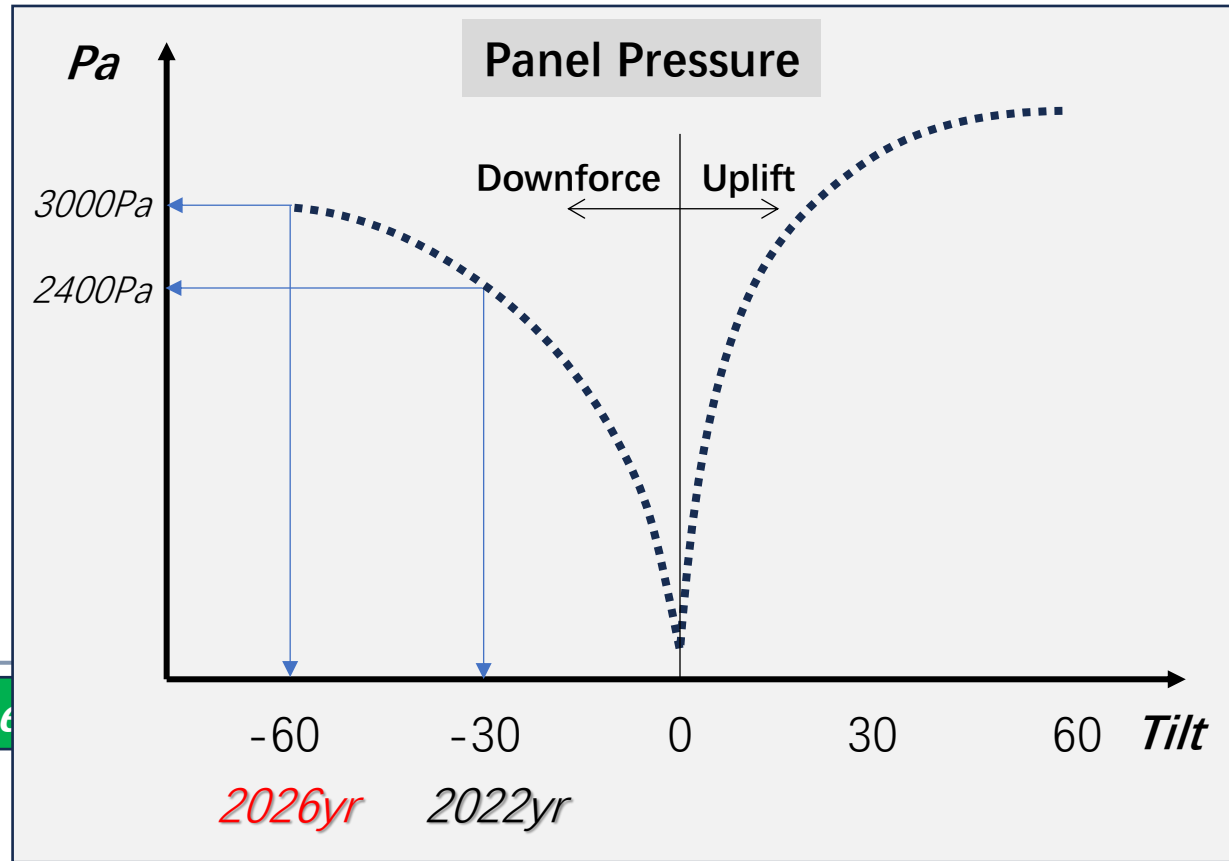
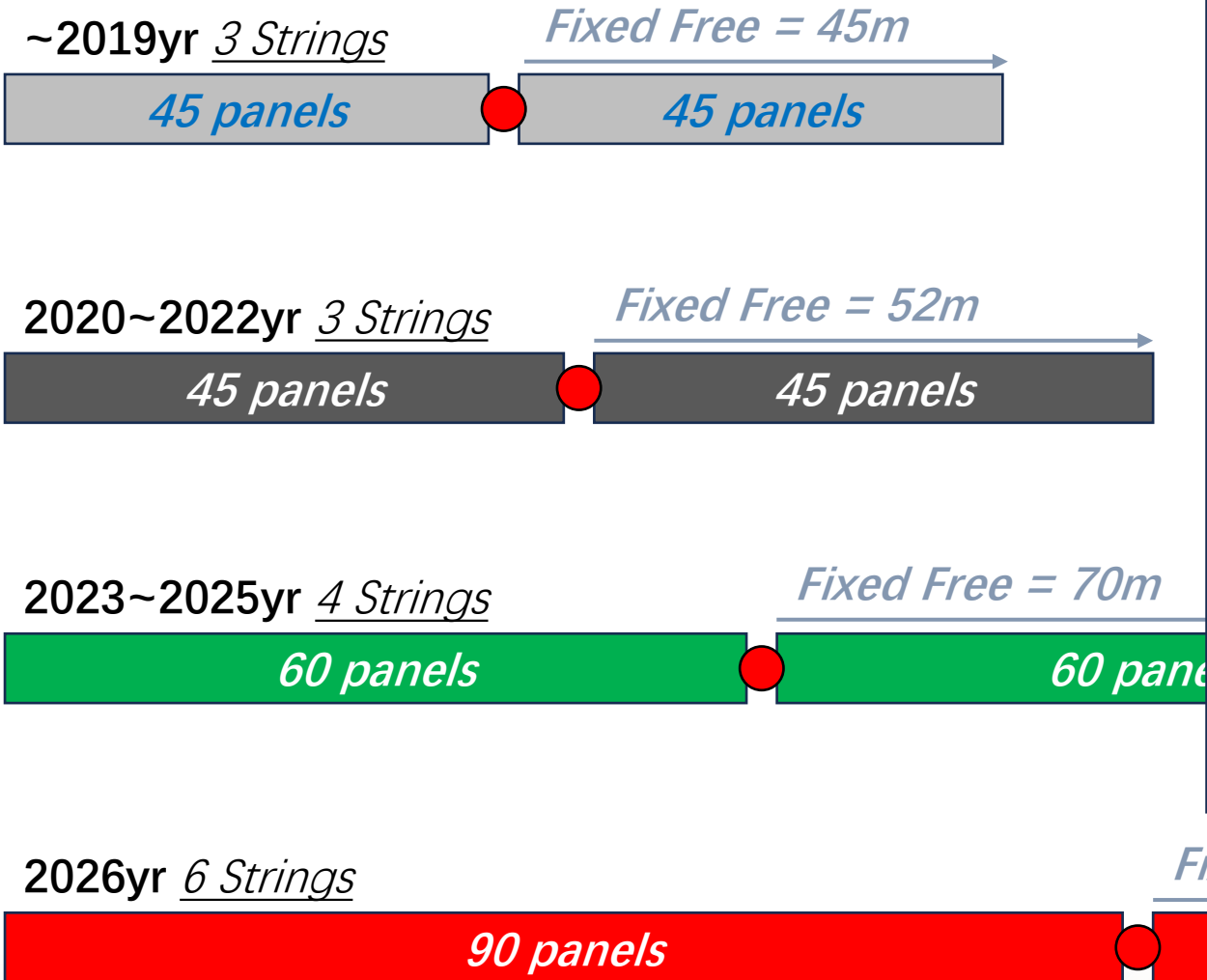
*GWs size project, hundred thousands of panels, are relied on **One Single Testing!***



Panel Design Load – Longer Tracker (Ucr)



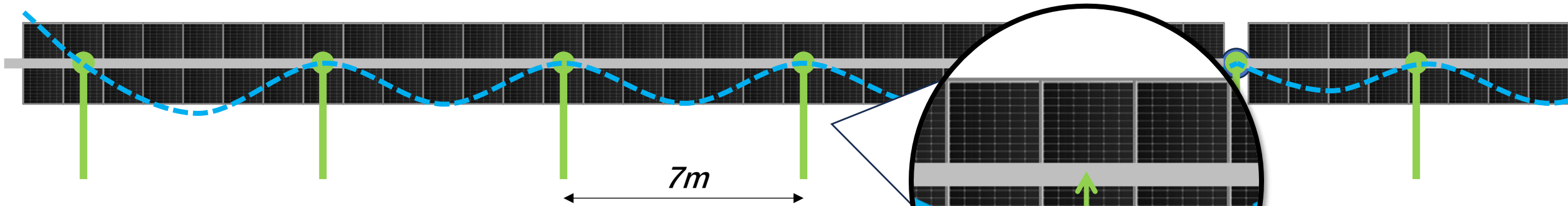
Panel Design Load – Longer Tracker (Panel Pressure)



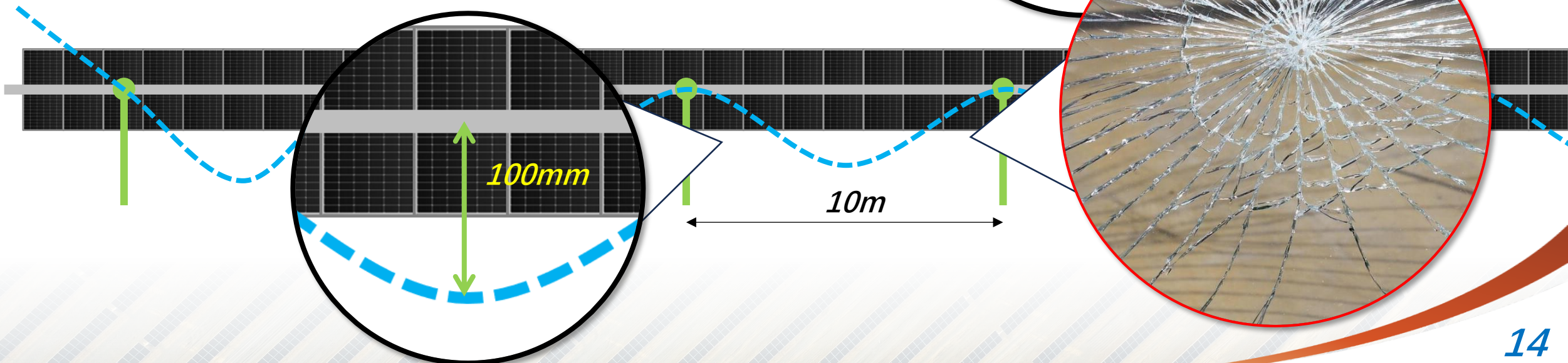


Panel Design Load – Longer Tracker (Post Span)

Post Span Design in 2022yr



Post Span Design in 2026yr, by the SAME Tube





Wind Load Calcs + Panel Structure + Tracker Purlin Design

Wind Pressure
Stow Strategy

Double Glass
Aluminum Frame
(Steel Frame)

Purlin Length
Purlin Thickness
Purlin Material

Wind Design Load

≧

Panel Design Load



- Multiple Test to Failure is required
- Material Safety Factor is needed
- Longer Tracker Design Trend



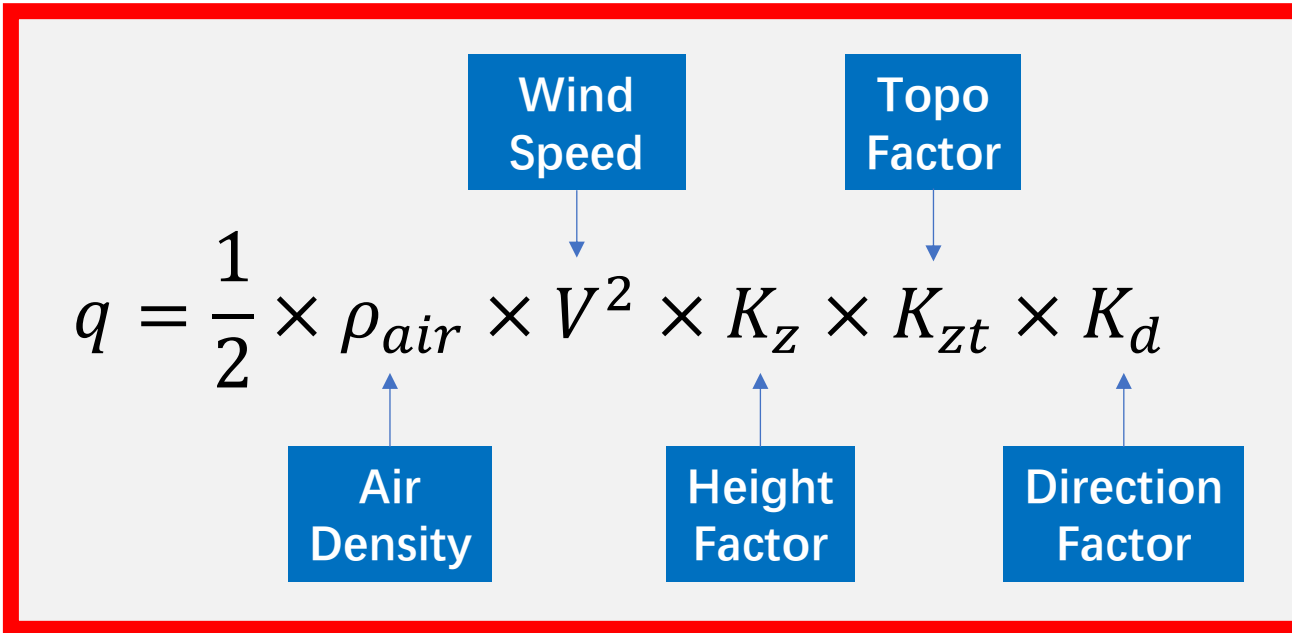
ASCE 7 v2022

Minimum Design Loads and Associated Criteria for Buildings and Other Structures

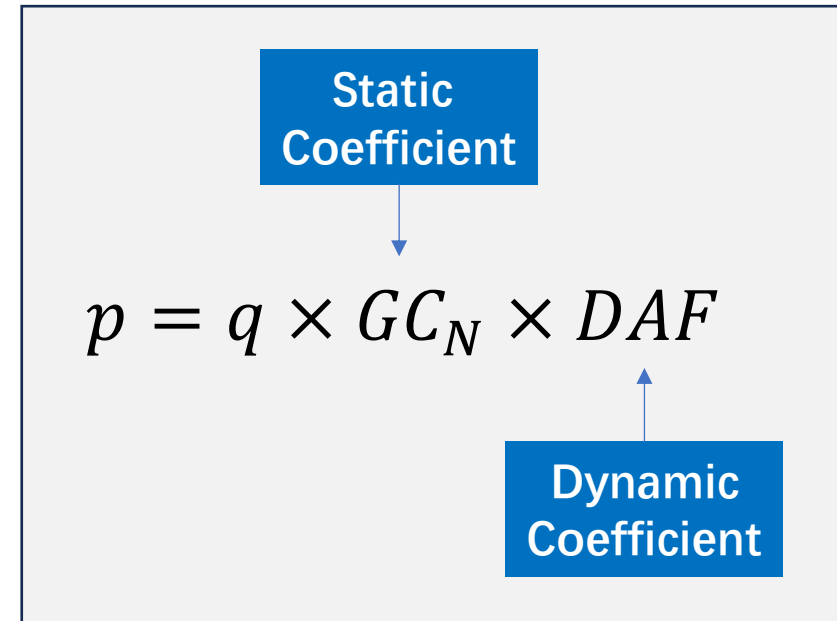


SBC301 v2024

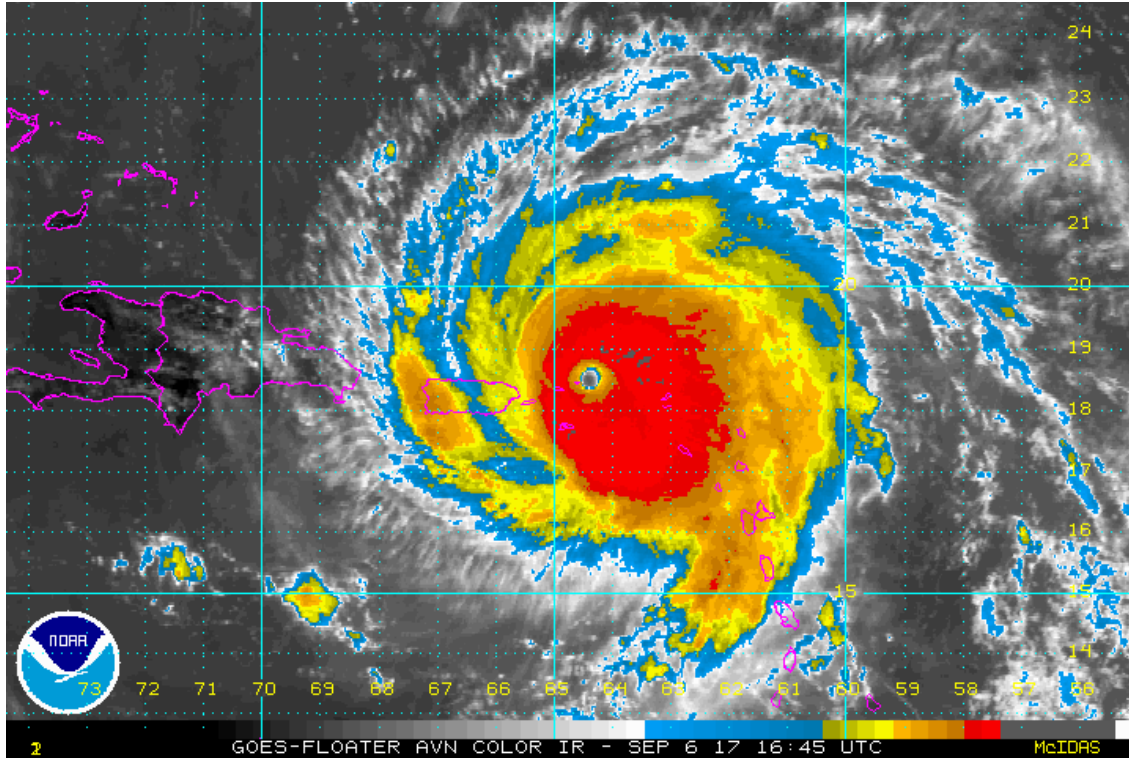
Saudia Loading Code, Code requirements



Velocity Pressure



Panel Wind Design Load



Hurricane

*Moving Slow (hourly)
Coastal Meteorology*

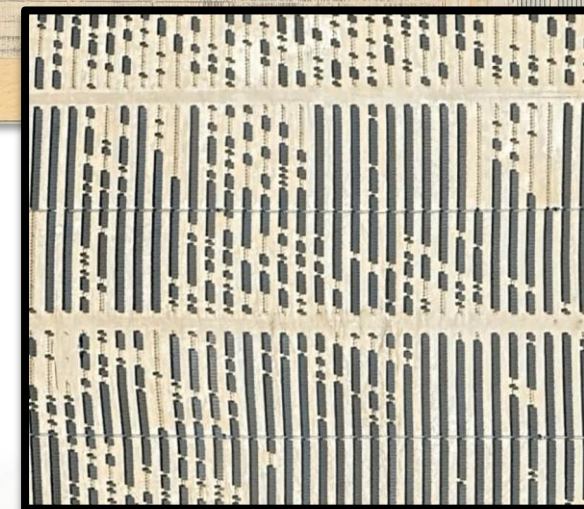
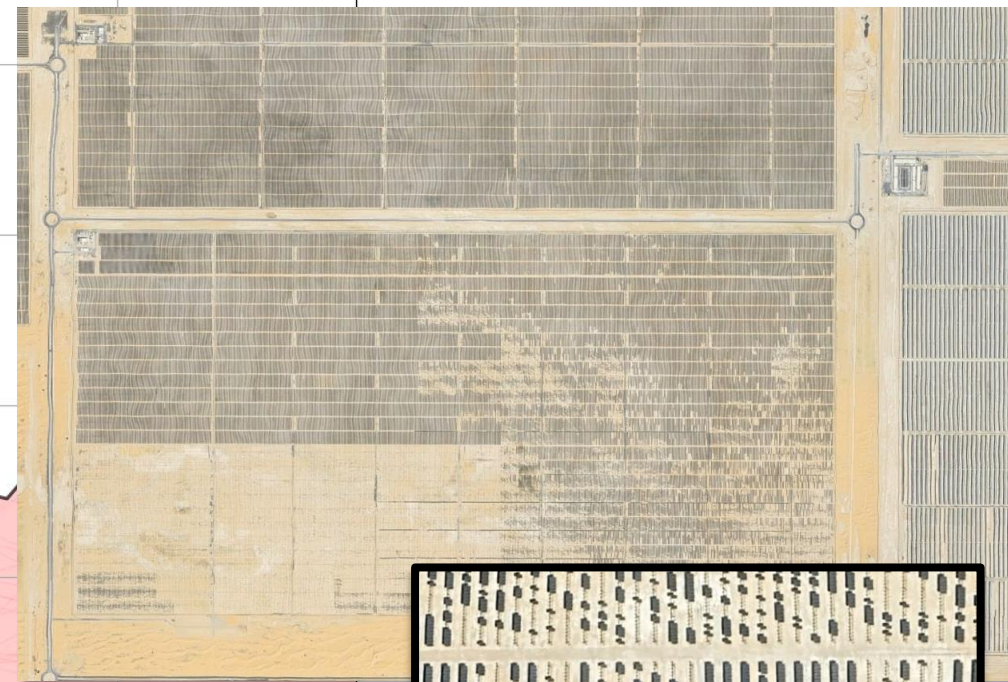
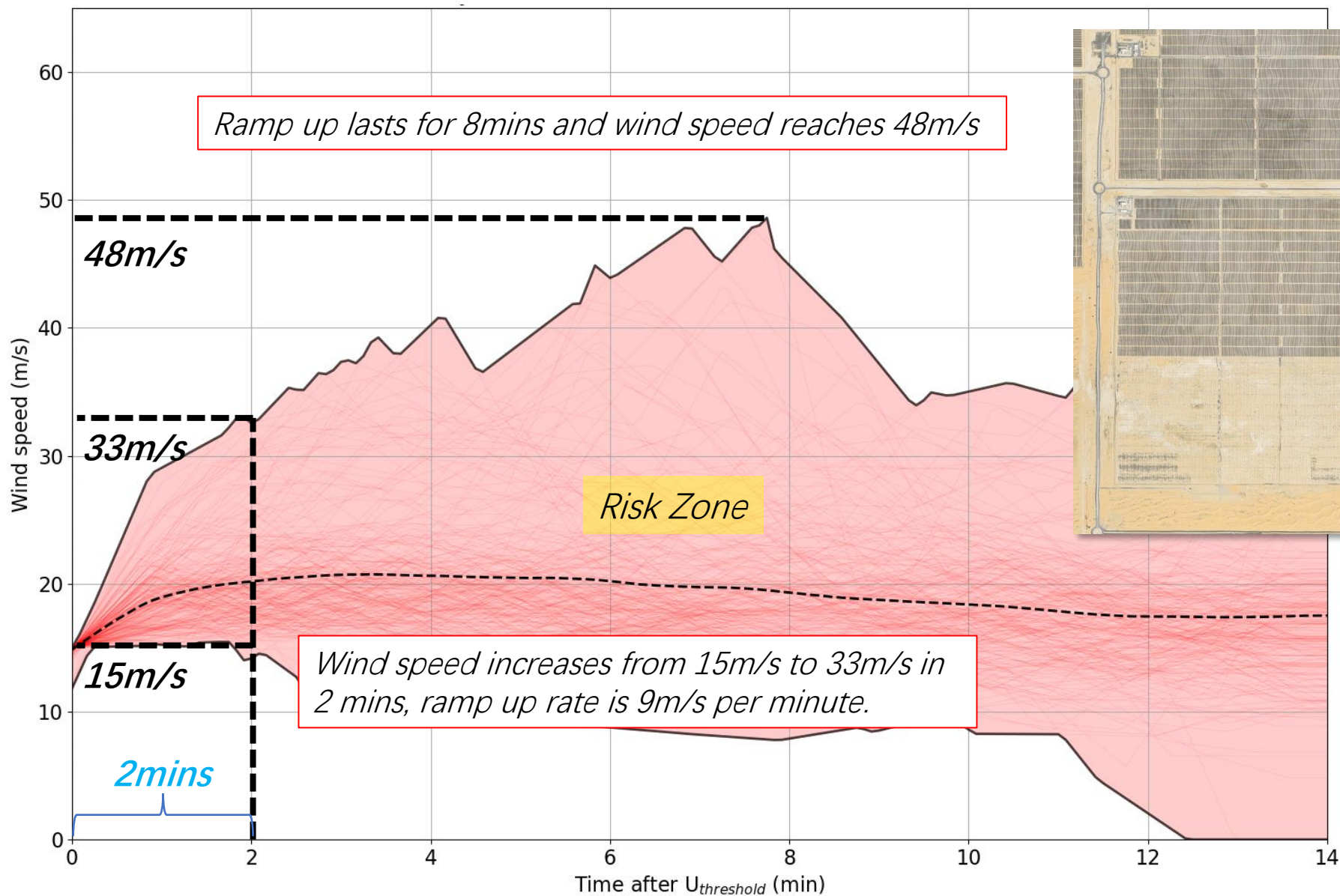


Thunderstorm

*Moving Fast (minutely)
Inland Meteorology*

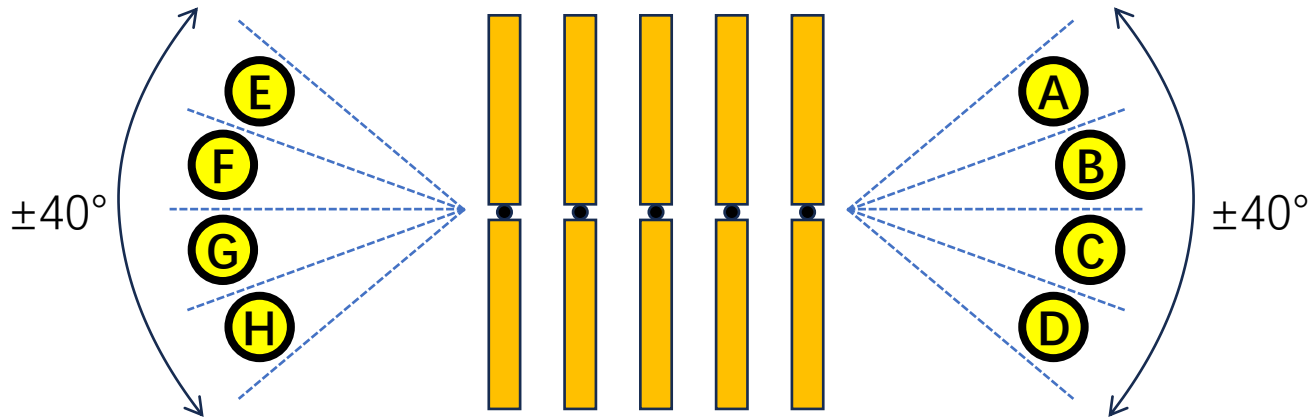


Wind Design Load – Ramp Up Rate





Wind Design Load – Wind Direction Changing



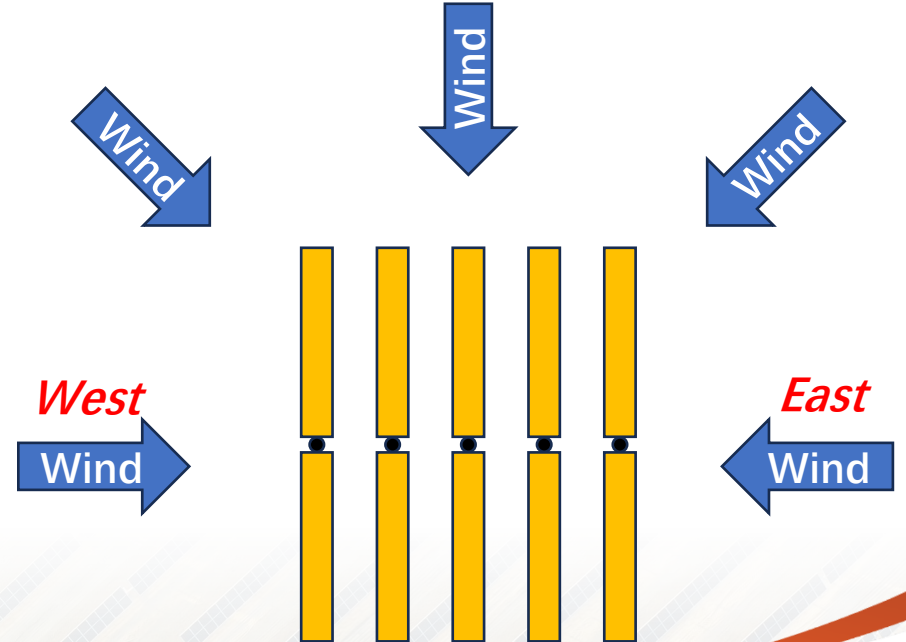
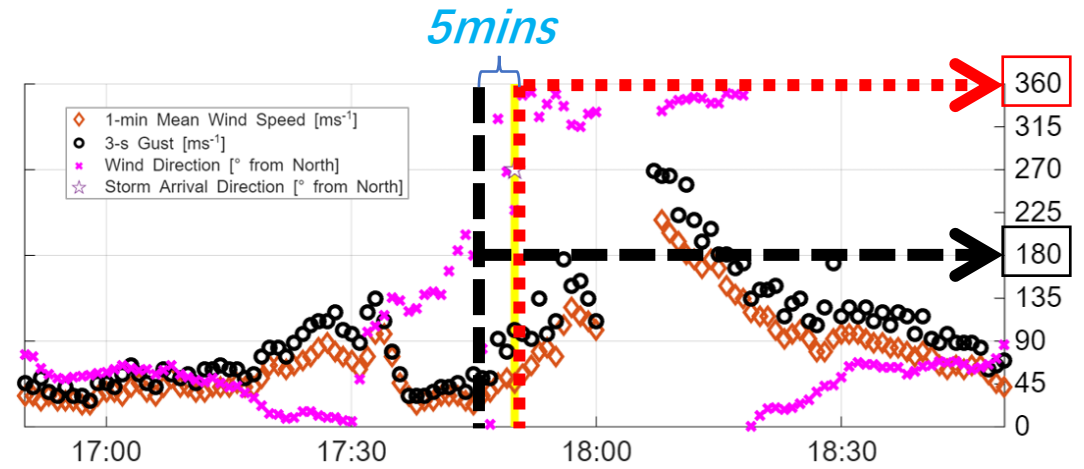
K_d for Wind Load



Coefficient & U_{cr}

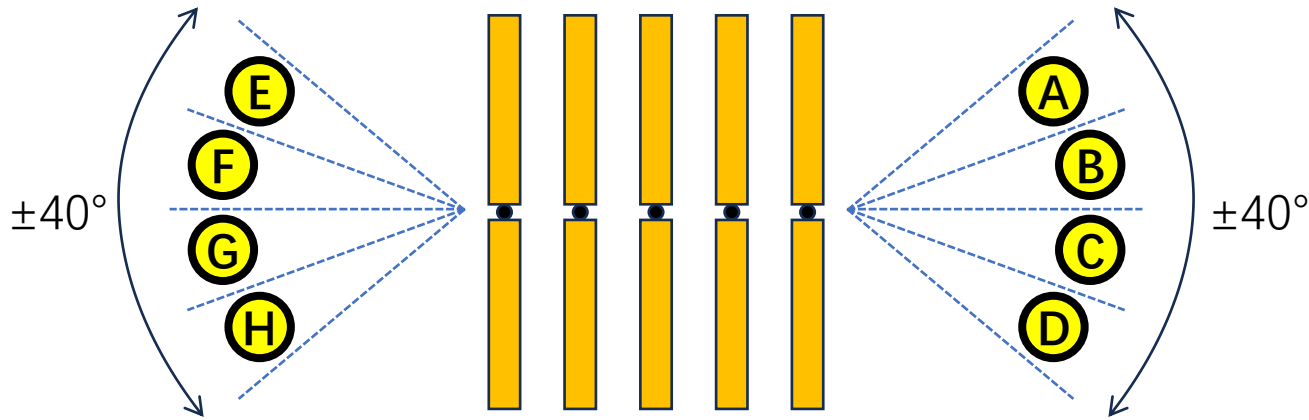


- Max { **A** **H** } -----> Max { **A** **H** }
- Max { **B** **G** } -----> Max { **B** **G** }
- Max { **C** **F** } -----> Max { **C** **F** }
- Max { **D** **E** } -----> Max { **D** **E** }





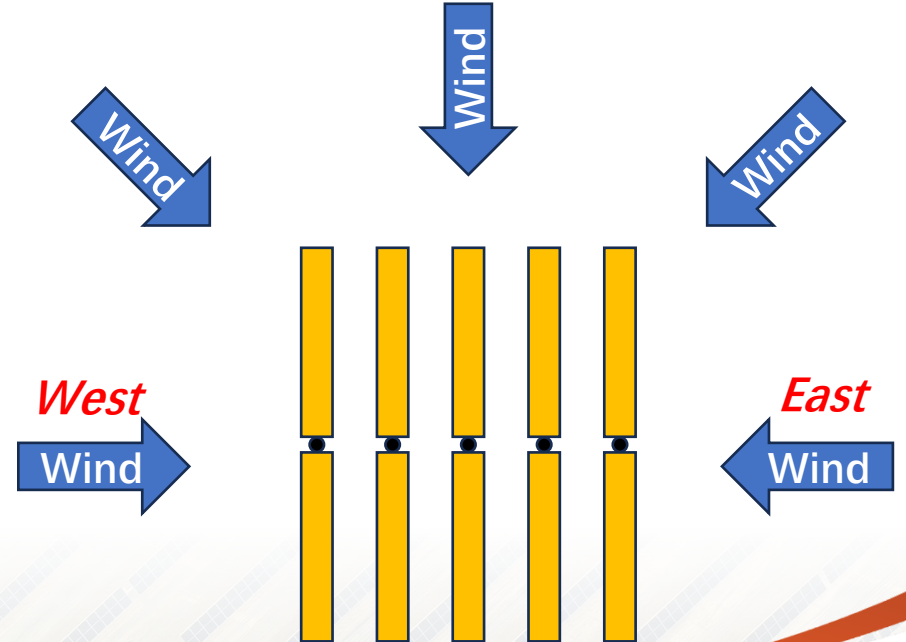
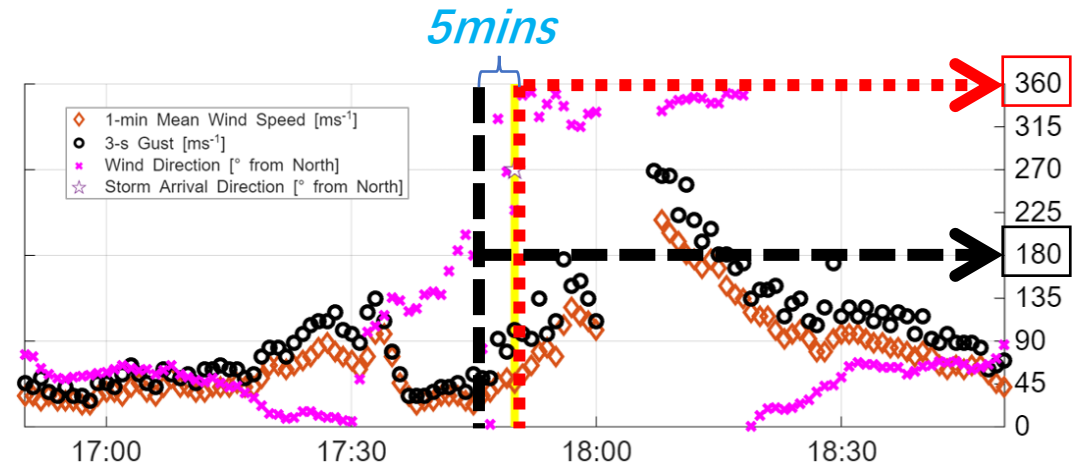
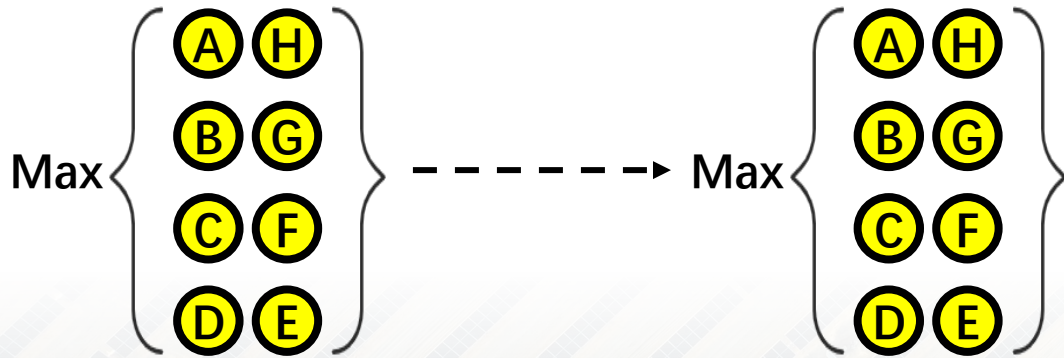
Wind Design Load – Wind Direction Changing



K_d for Wind Load



Coefficient & Ucr

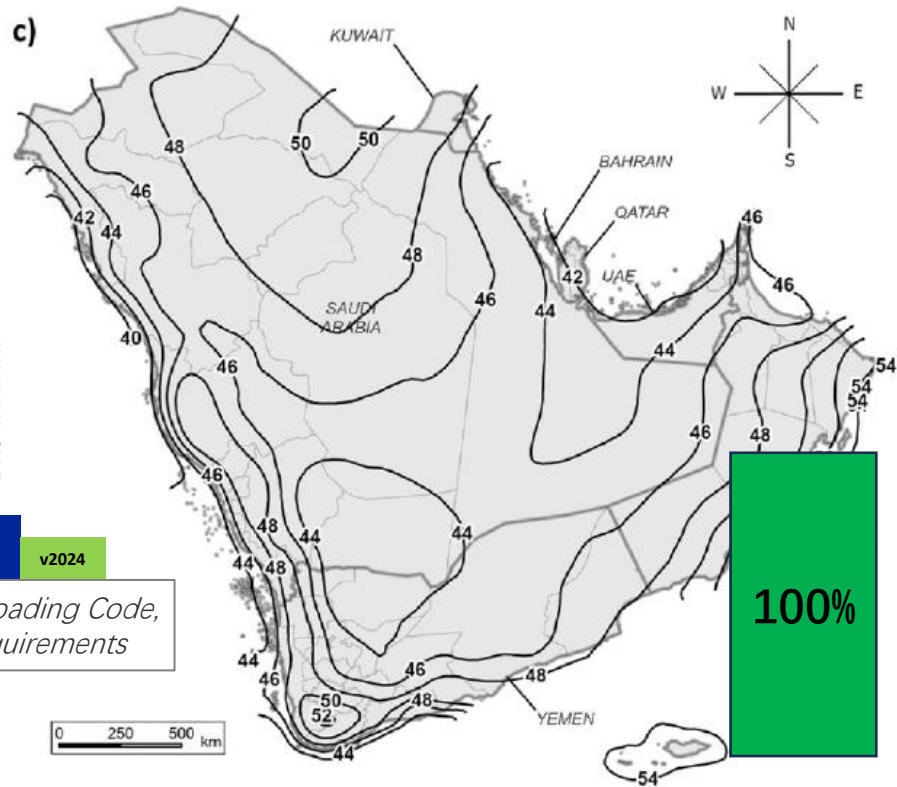




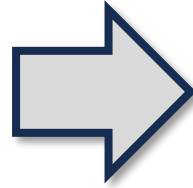
Wind Design Load – MRI



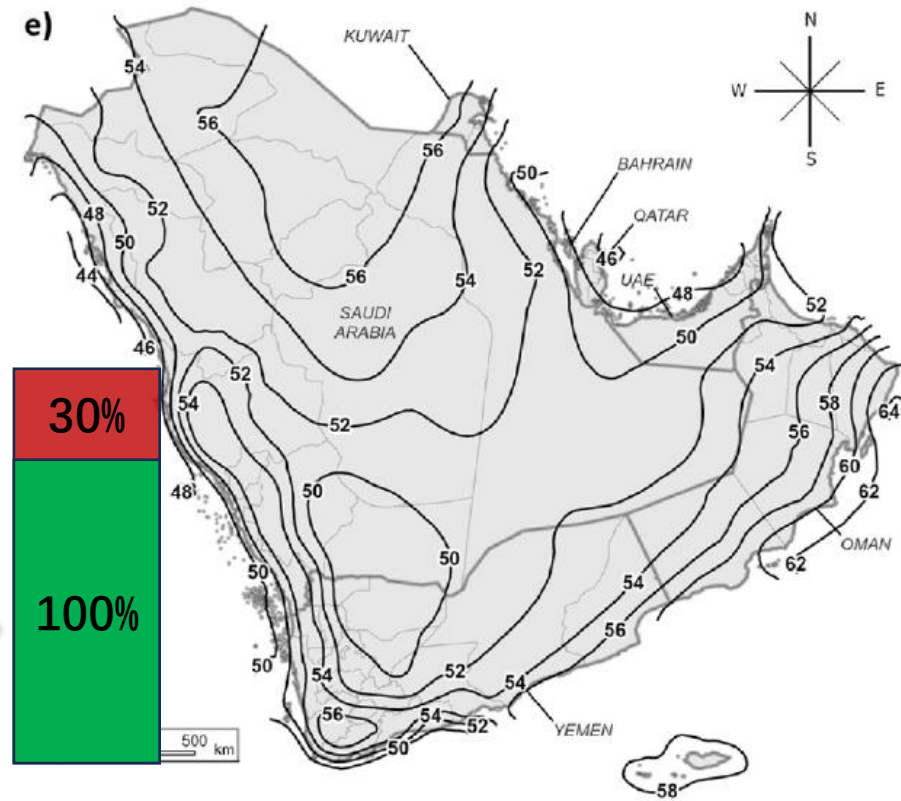
SBC301 v2024
Saudia Loading Code,
Code requirements



Return Period: 300years
Risk Probability in 30years: 9.5%
(Project Req in 2022year)



Wind Pressure Increase 30%



Return Period: 1700years
Risk Probability in 30years: 1.8%
(Project Req in 2026year)



Wind Design Load



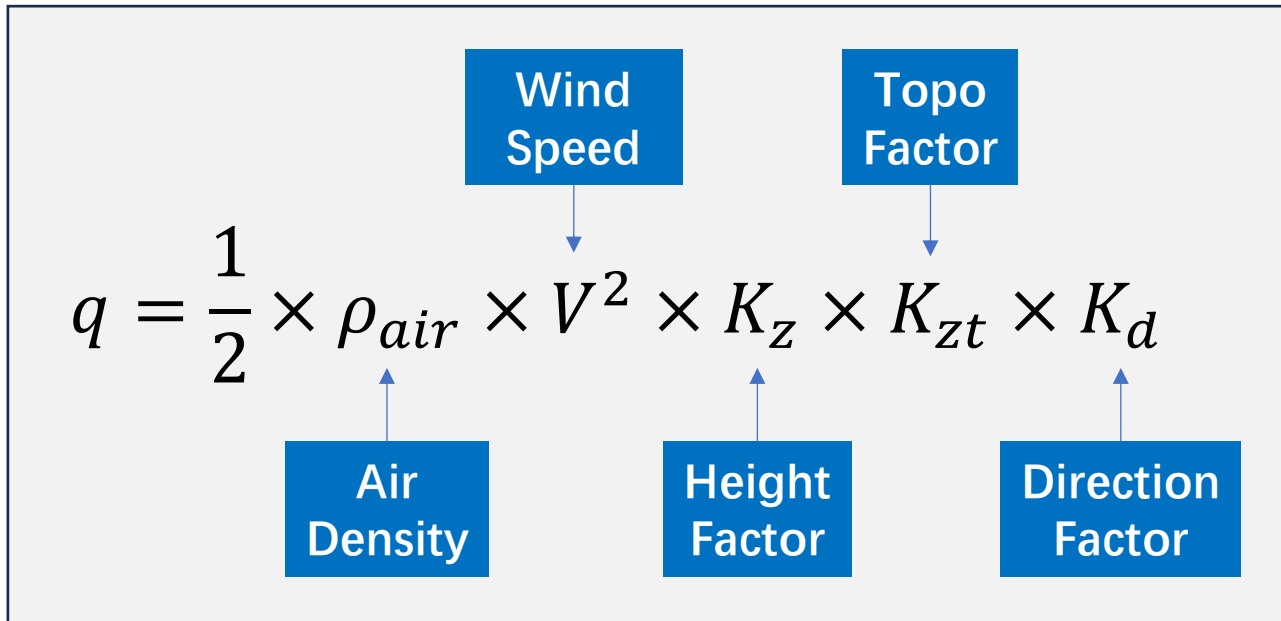
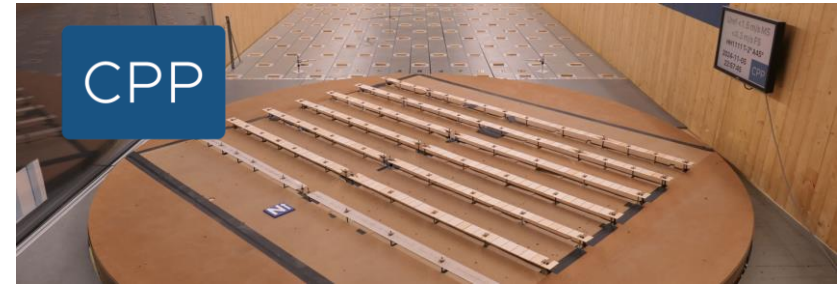
ASCE 7 v2022

Minimum Design Loads and Associated Criteria for Buildings and Other Structures

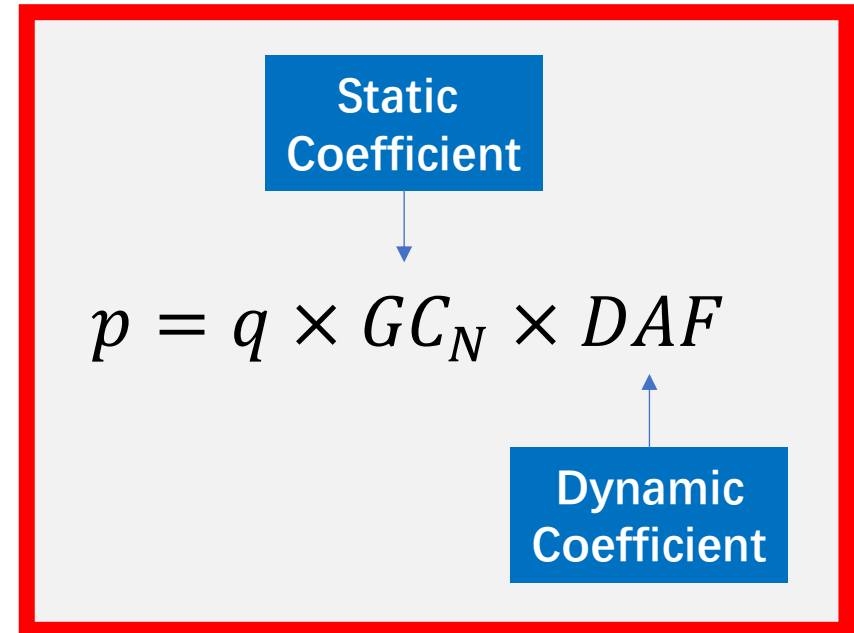


SBC301 v2024

Saudia Loading Code, Code requirements



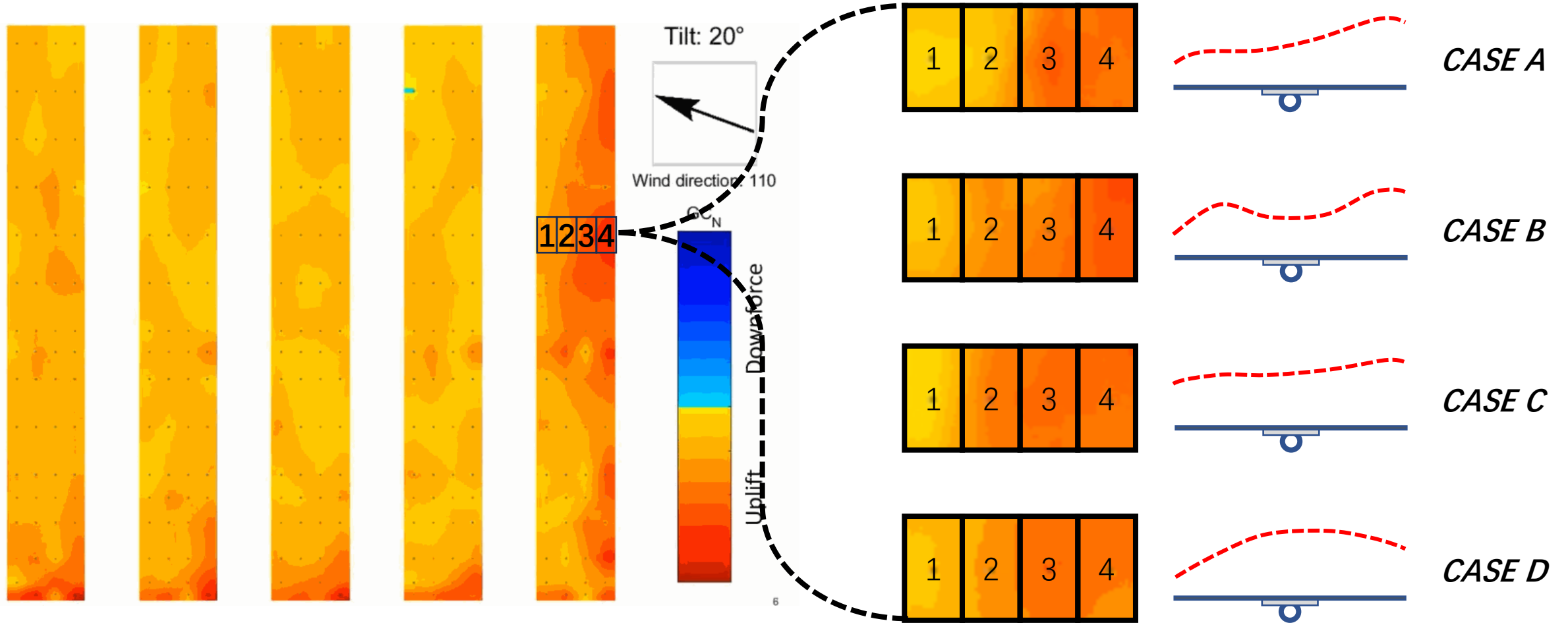
Velocity Pressure



Panel Wind Design Load



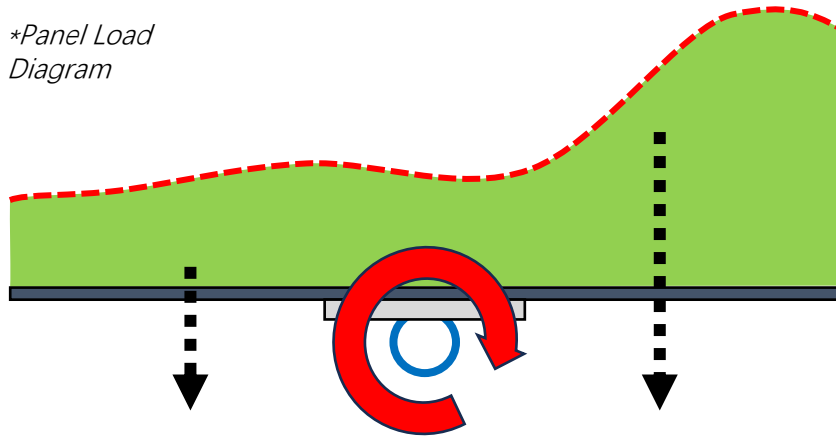
Wind Design Load – Dynamic Wind Profile



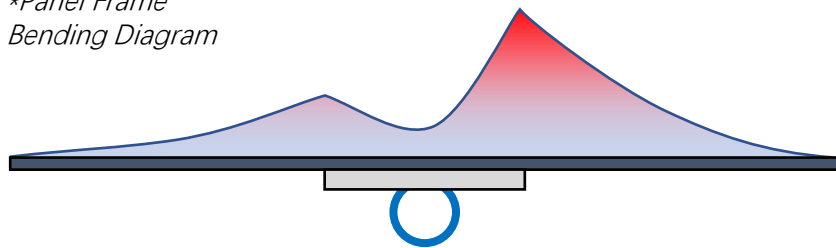


Wind Design Load – GCM vs GCN

*Panel Load Diagram



*Panel Frame Bending Diagram



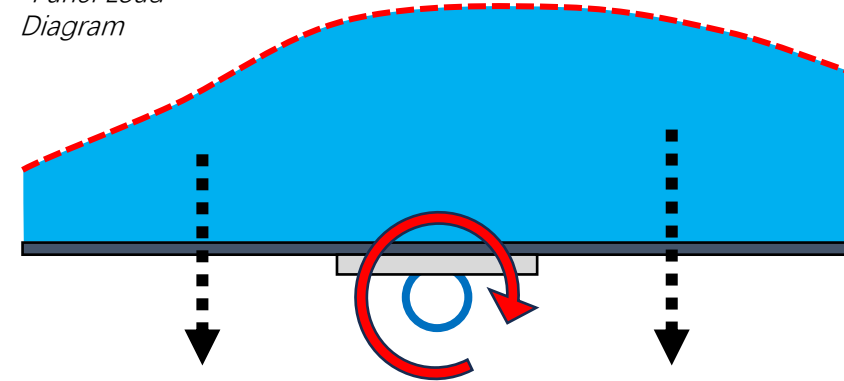
Peak Torsional Moment

GCM Module

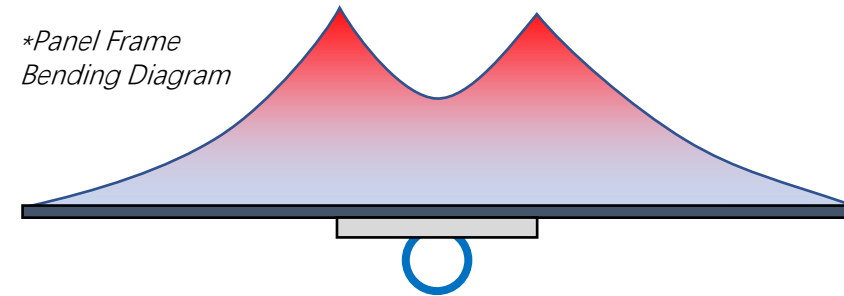
(GCM_{Purlin})

(GCM_{Clamp})

*Panel Load Diagram



*Panel Frame Bending Diagram

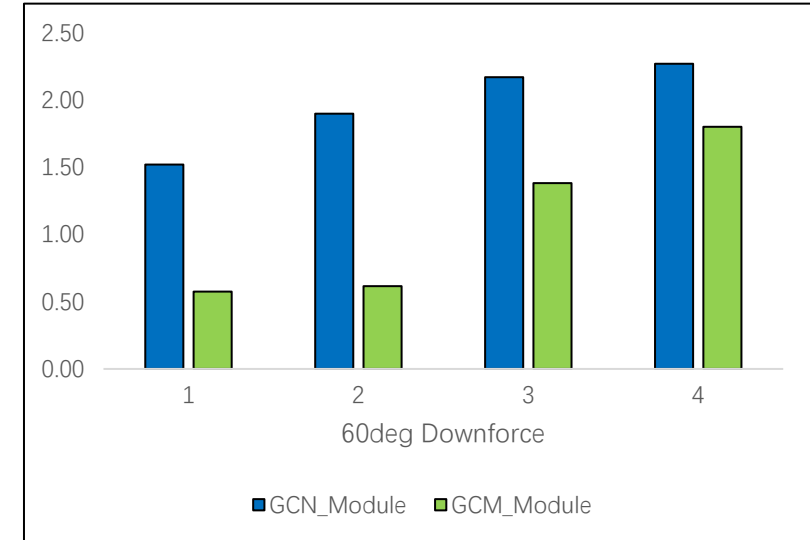
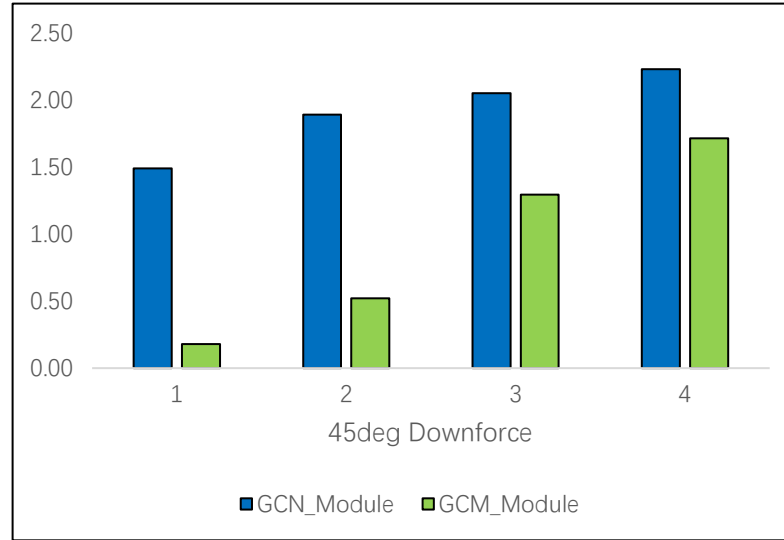
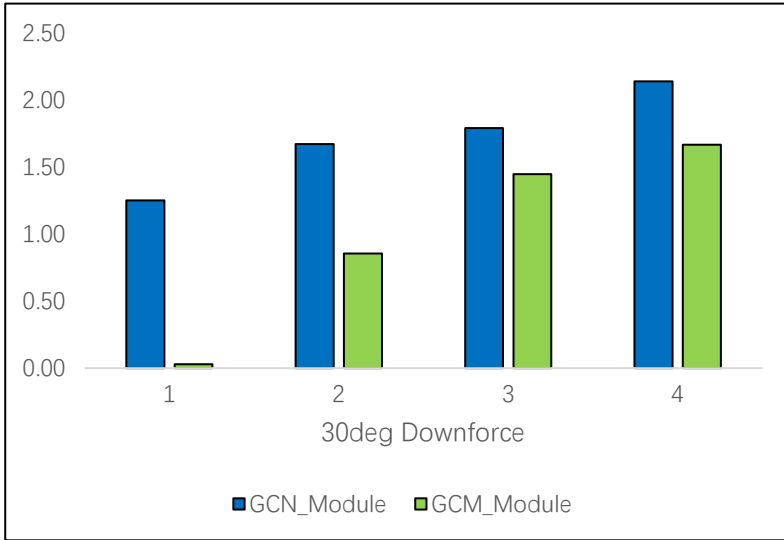


Peak Average Pressure

GCN Module



Wind Design Load – GCM vs GCN



GCN Module

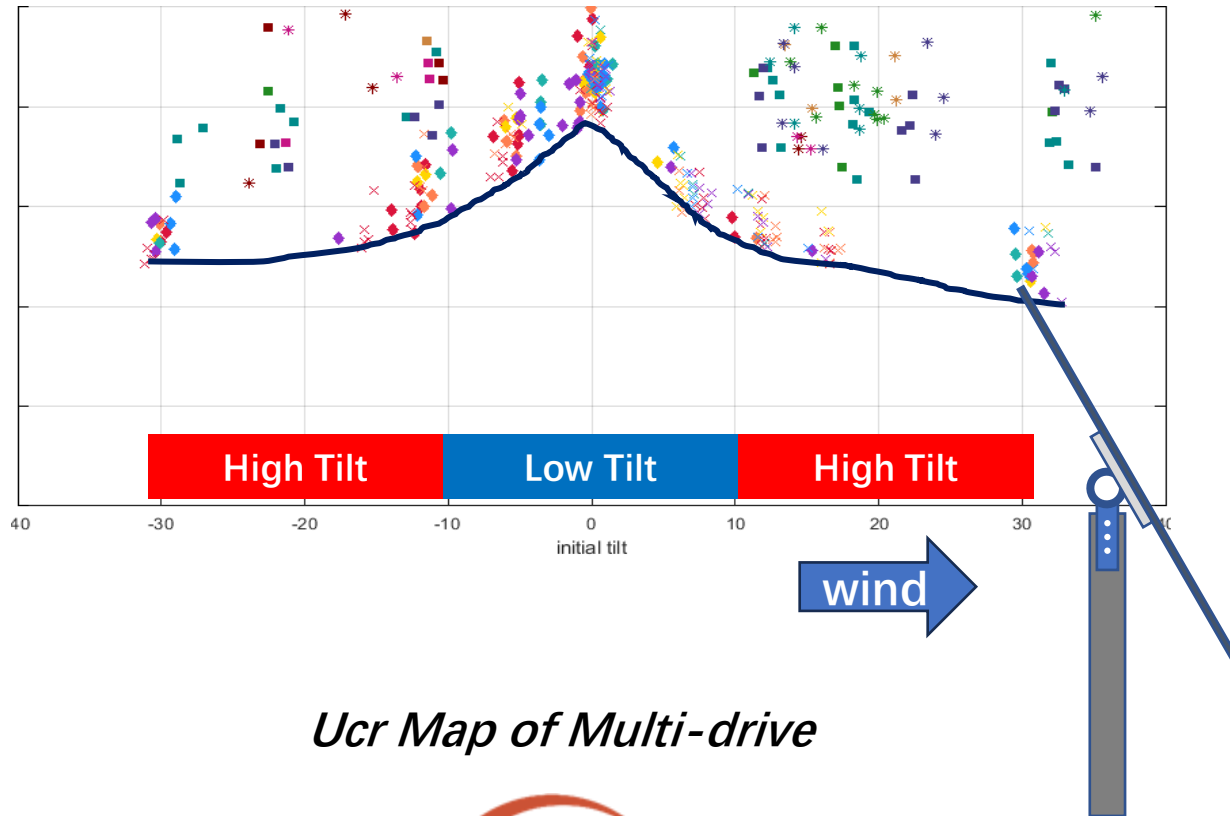
The average of these pressure is reasonable for comparison with IEC uniform pressure test for modules.

CPP

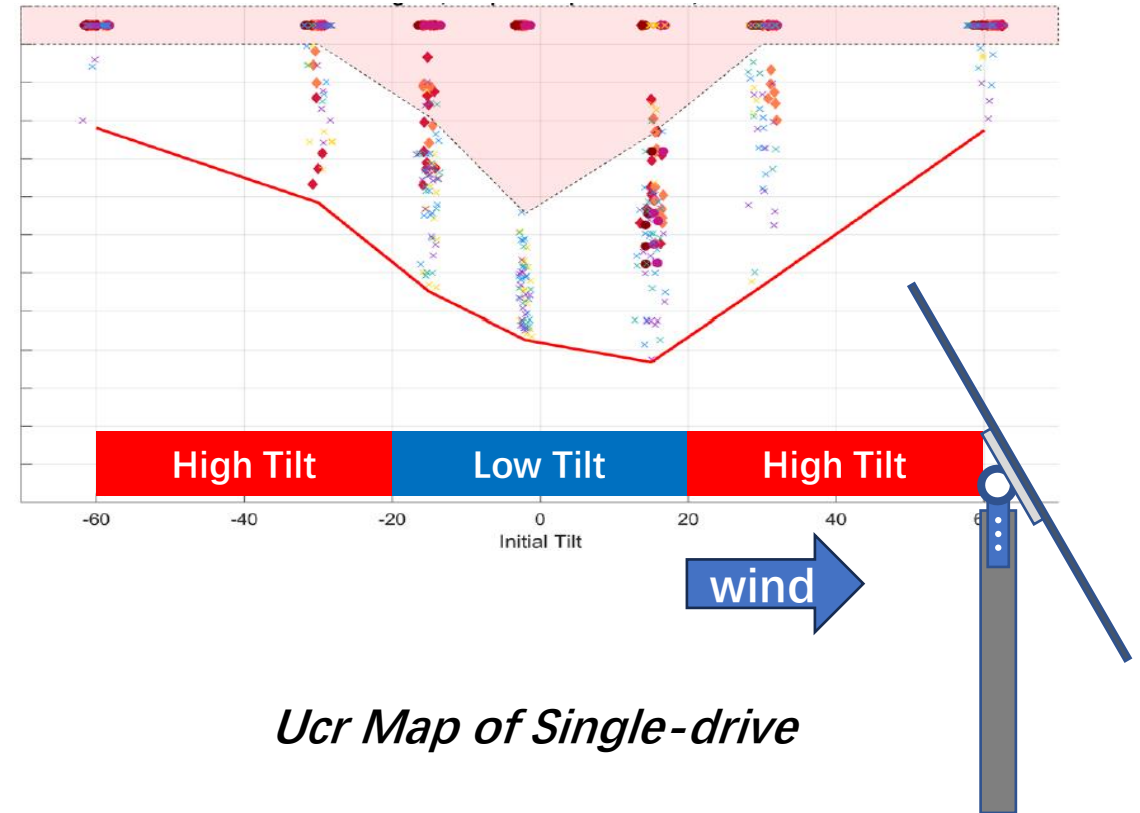




Wind Design Load – Multi-drive vs Single-drive



Ucr Map of Multi-drive



Ucr Map of Single-drive

Competitors



Wind Load Calcs + Panel Structure + Tracker Purlin Design

Wind Pressure
Stow Strategy

Double Glass
Aluminum Frame
(Steel Frame)

Purlin Length
Purlin Thickness
Purlin Material

Wind Design Load

Panel Design Load

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- Local Wind Velocity
- Local Wind Direction
- WTT Pressure Coefficient
- Stow Tilt

- Multiple Test to Failure is required
- Material Safety Factor is needed
- Longer Tracker Design Trend



ARCTECH

VERIFICATION BASE

“*Full-scale Test*”

Product showcase and functional testing base





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Head of R&D Innovation at Arctech Solar

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LinkedIn: John Smart

Thanks

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WIND ENGINEERING
CONSULTANTS

Will your solar plant survive the next storm?

How to correctly identify wind load risk for solar installations – Panels

7th May 2026

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.
 - **Utility-Scale Solar Sites**
- *Offices around the world:*
 - US, Australia, Canada, Malaysia, India, UAE
- *Four wind tunnels:*
 - 2 in Colorado, 1 in Sydney, 1 in Kuala Lumpur

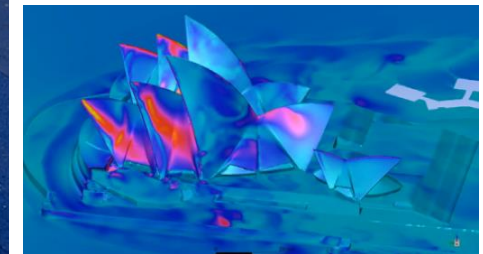
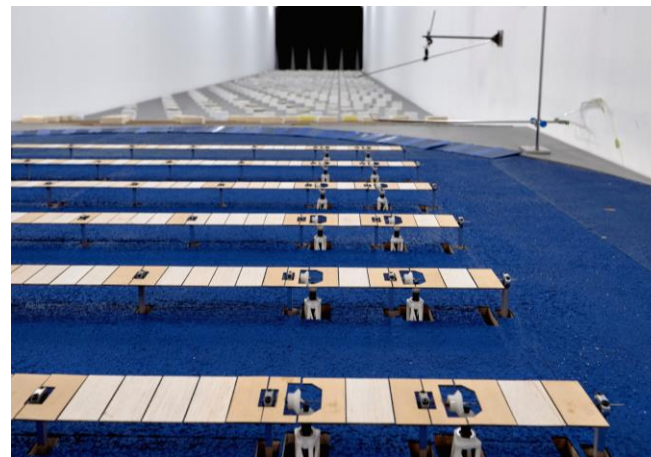
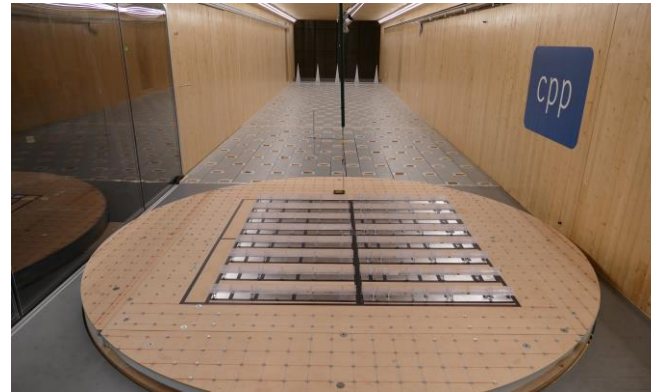


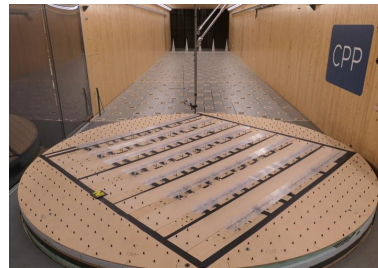
Figure: CPP services across different sectors

What's checked on the tracker system?



Product and *Site-Specific Services*

- Wind Tunnel Pressure Test
- Resonant Dynamic Analysis
- Aeroelastic Instability Testing
- Aeroelastic Loads
- Free Vibration (Pluck) Test
- *Wind Speed Analysis*
- *Site-Specific Instability Advice*
- *Ramp Rate Study*



Trackers are verified and designed for a selected risk level using relevant and realistic testing methodology

What's checked on the panel?



Module Testing

- IEC 61215:
 - Evenly loaded static test (MQT16)
 - Evenly loaded cyclical test (MQT20)

Steady + Even Distribution



Figure: Steady, evenly distributed load on a module

How to quantify loads on panels?

- *In a wind tunnel:*
 - Correctly modelled atmospheric boundary layer
 - High quality, calibrated model
 - Well characterised pressure and wind data acquisition

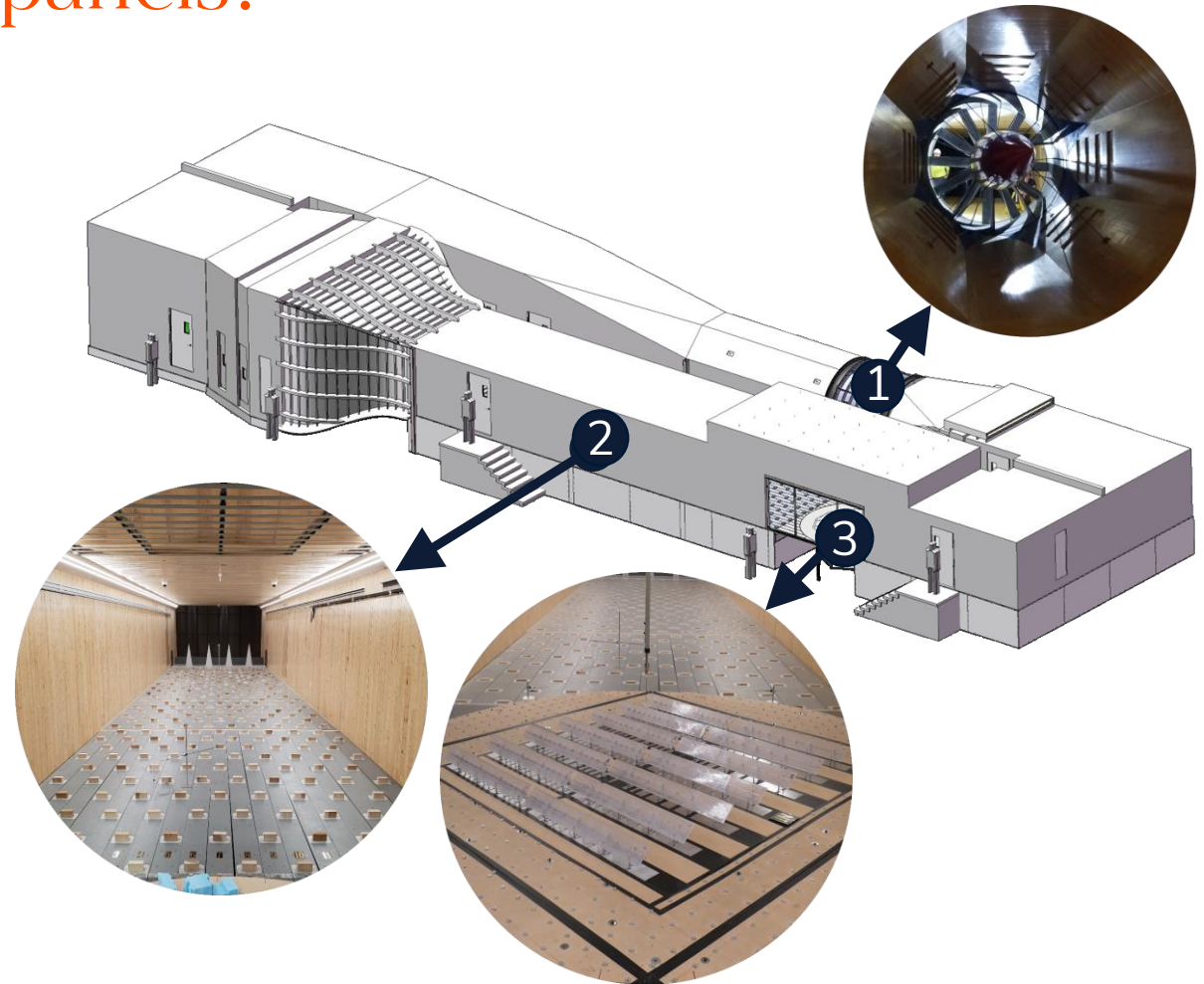


Figure: CPP's atmospheric boundary layer wind tunnel

How to quantify loads on panels?

- *In a wind tunnel:*
 - Sufficient pressure taps to capture the gradient
 - Tested for various tilts and wind directions
 - Normalised by a correctly defined wind speed height, and duration

1 Wind is not steady, it fluctuates

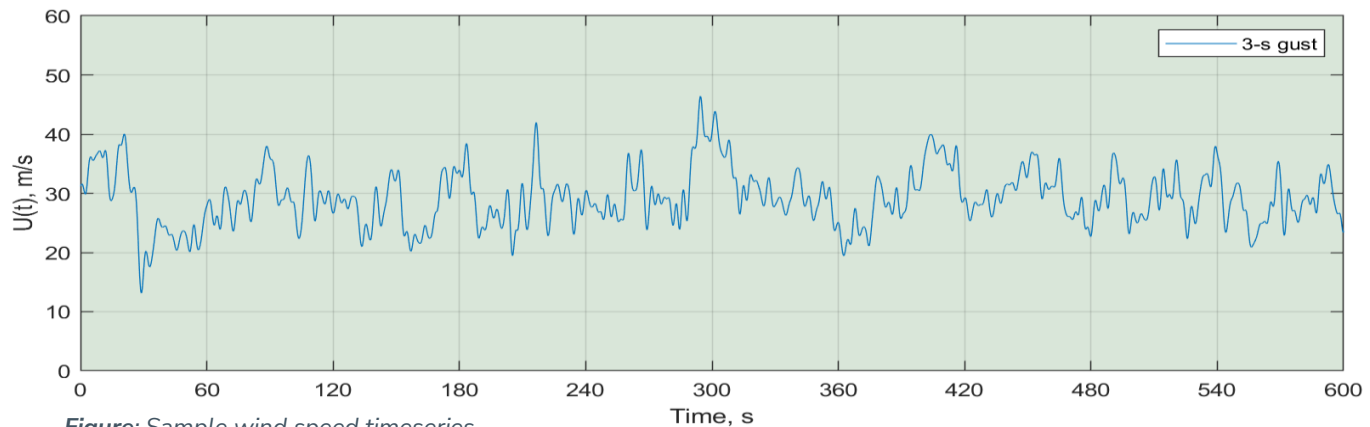


Figure: Sample wind speed timeseries

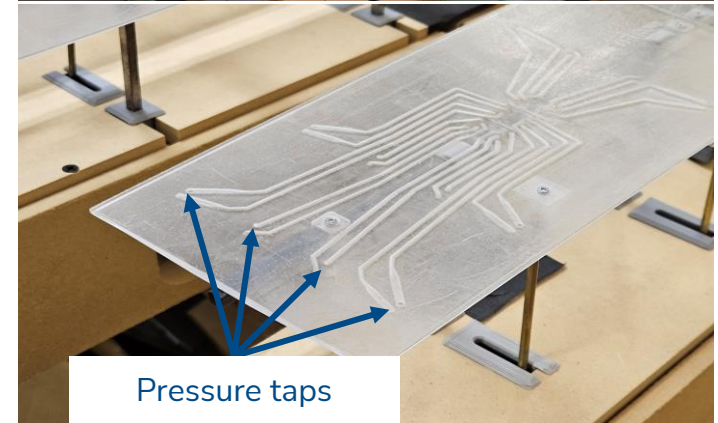
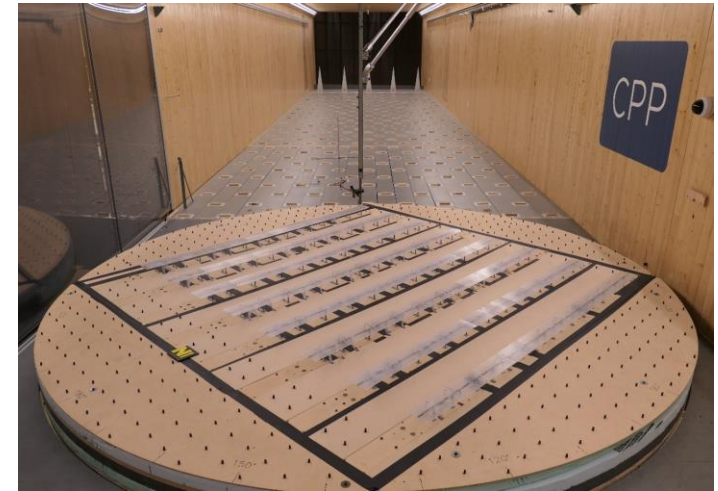
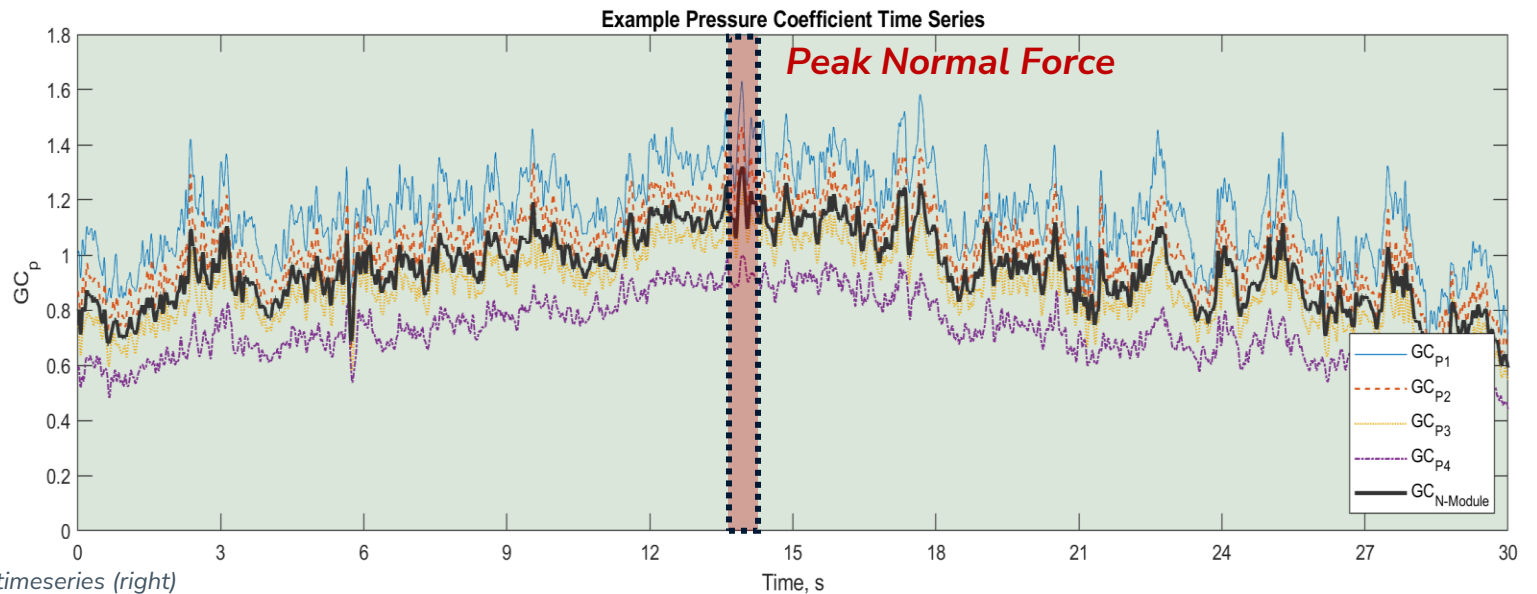
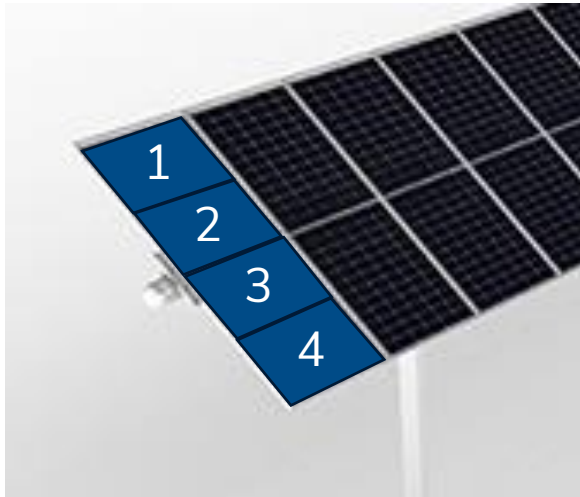


Figure: Pressure model testing

What do you find?

- Pressure at 4 segments across the panels – typically presented as a gust pressure coefficient
- Timeseries of each quarter panel is combined, based on the load case of interest. For example:
 - Averaged for peak normal force
 - Weighted with moment arms for peak moment

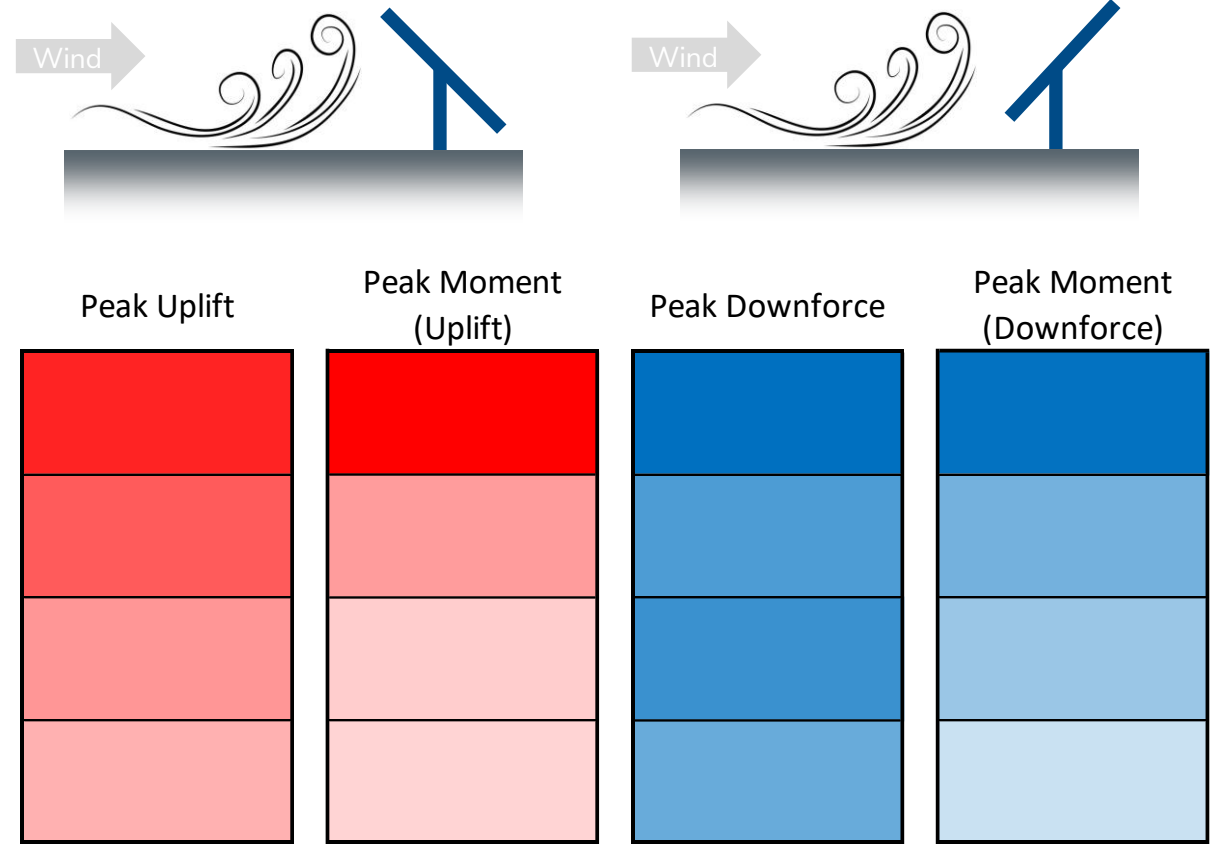


Figures: Panel pressure segments (left) and corresponding timeseries (right)

What do you find?

- *Wind load pattern varies by:*
 - Tilt
 - Wind direction
 - Load case of interest

2 Wind loads are not evenly distributed



TYPICAL MODULE LOAD CASES
(RED = UPLIFT NET PRESSURE; BLUE = DOWNFORCE NET PRESSURE)

Tracker and Panel Dynamics

- Trackers and panels move:
 - Torsion
 - Maximum motion for panels at the end or between two drives
 - Heaving
 - Maximum motion for panels between two posts
 - Panel vibration
 - Improved by longer rails and additional attachment points

3 Panels experience inertial loading



Videos: Torsional vibration (top) and heaving (bottom) of trackers

How to verify the load on the panel?

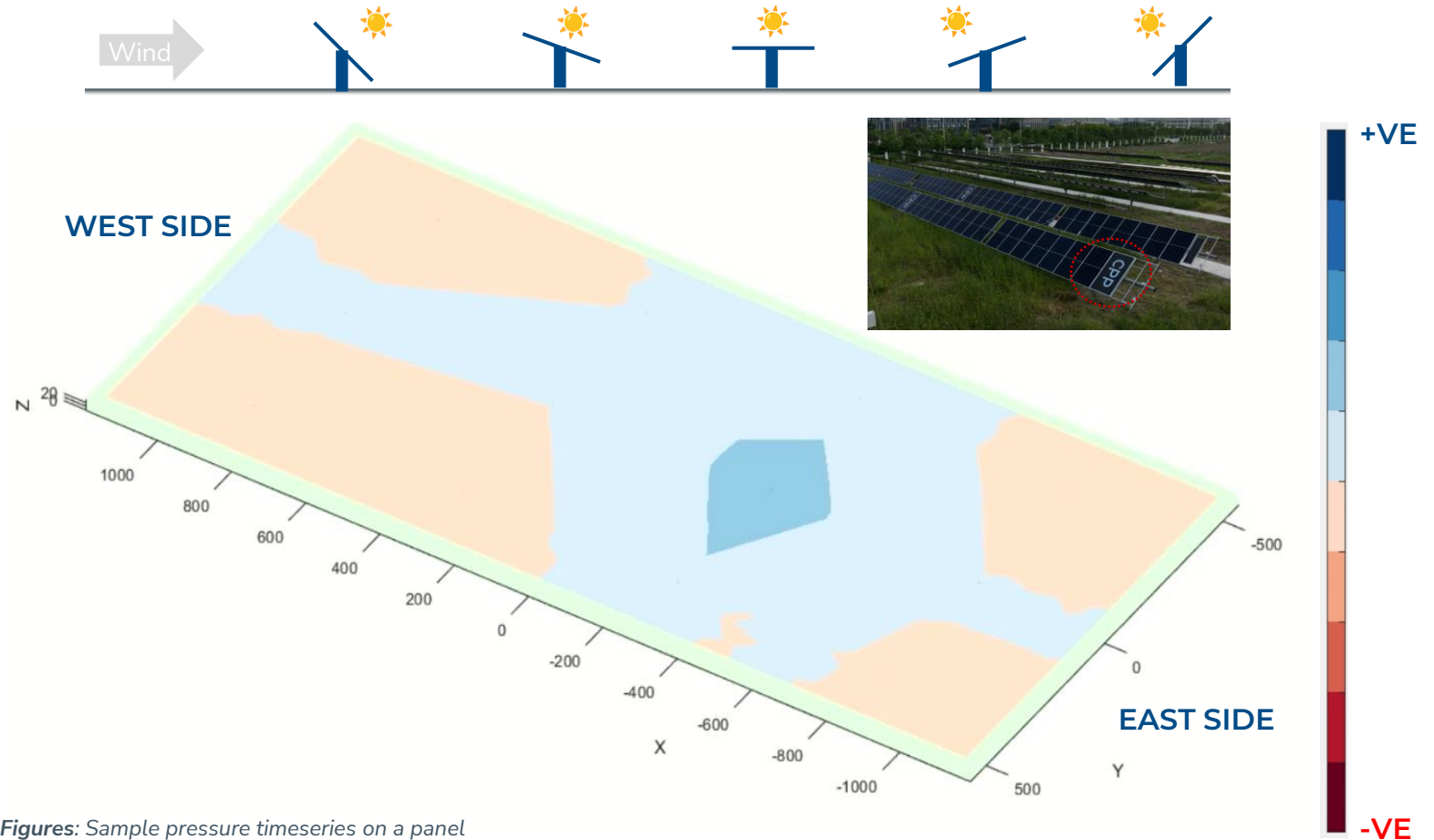
- *Field monitoring:*
 - Arctech verification bases (AVBs)
 - Equipment at various locations across the sample array:
 - Smart pressure panels
 - Dynamic motion sensors
 - Anemometer



Figures: CPP equipment at China and Spain AVBs

How to verify the load on the panel?

- *Example timeseries:*
 - April 6th – 8AM to 2PM
 - Mean pressure
 - Wind from the west



Figures: Sample pressure timeseries on a panel

Summary

- *To prevent panels being the weakest component, they should be tested to similar rigour as the mounting system.*
- *A realistic, relevant test should consider that:*
 - 1** Wind is not steady, it fluctuates.
 - 2** Wind loads are not evenly distributed.
 - 3** Panels experience inertial loading.
- *And verify it! What are your panels actually rated to?*



Thank You

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Q&A



Matthew Lynas

Editor
pv magazine



John Wang

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