

Driving the Standard: Wind Testing, Solar Trackers, and Peer Review

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12/10/2019

Featured Speakers

Alex Roedel, Director of Design & Engineering, *NEXTracker*

Dr. Girma Bitsuamlak, Director (Research), *WindEEE Research Institute and Boundary Layer Wind Tunnel Laboratory, University of Western Ontario (UWO)*

Dr. David Banks, President *CPP Wind Engineering Consultants*

Moderator:

Molly Cox, Research Associate, *Wood Mackenzie Power & Renewables*

gtm: WEBINAR

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Speaker Bios



Today's Speakers



Alex Roedel
Director of Design & Engineering
NEXTracker



Dr. Girma Bitsuamlak
Director (Research)
*WindEEE Research Institute and
Boundary Layer Wind Tunnel
Laboratory, University of Western
Ontario (UWO)*



Dr. David Banks
President
CPP Wind Engineering Consultants

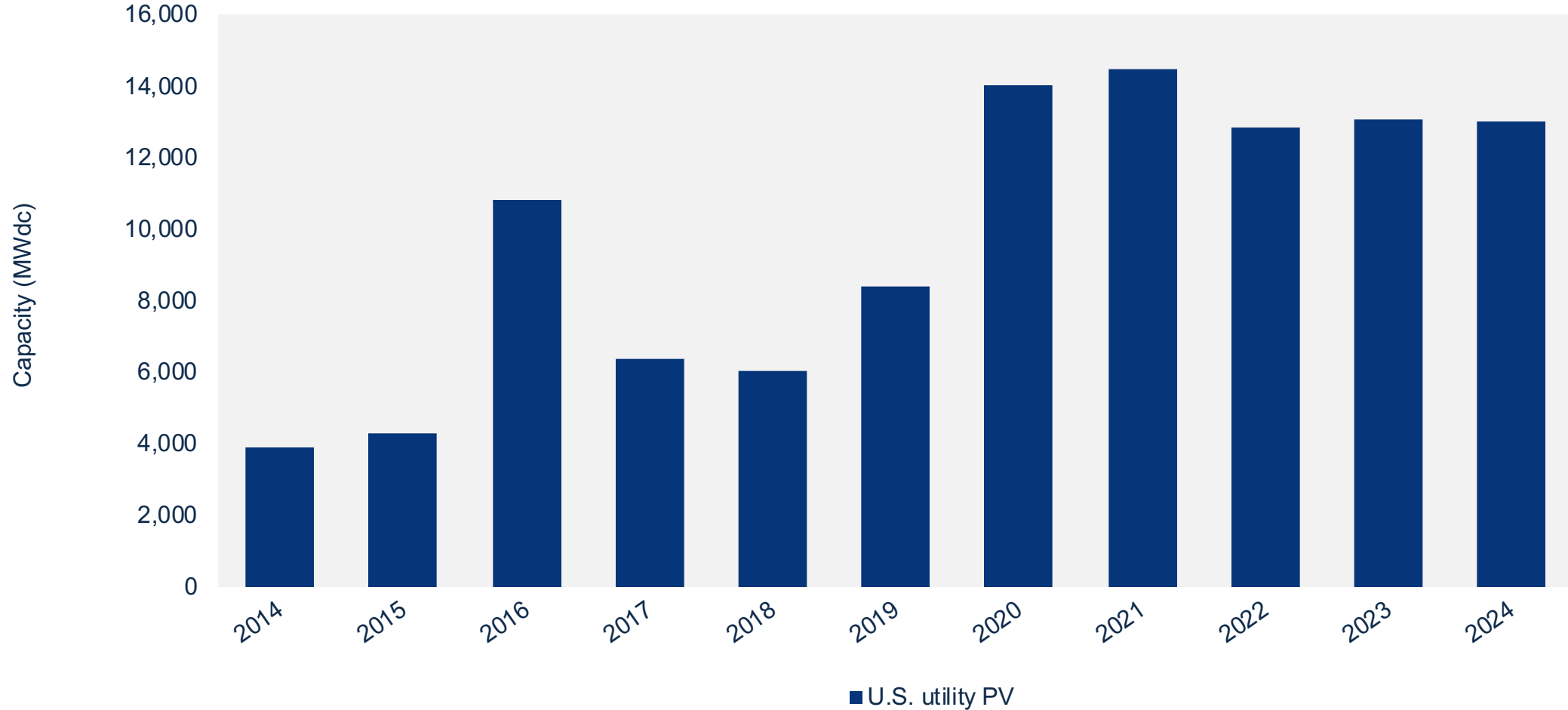


Molly Cox
Research Associate
Wood Mackenzie Power & Renewables

Utility PV market outlook, 2019-2024E

The bulk of new procurement is targeting 2021 COD

U.S. utility PV installation forecast, 2014-2024E

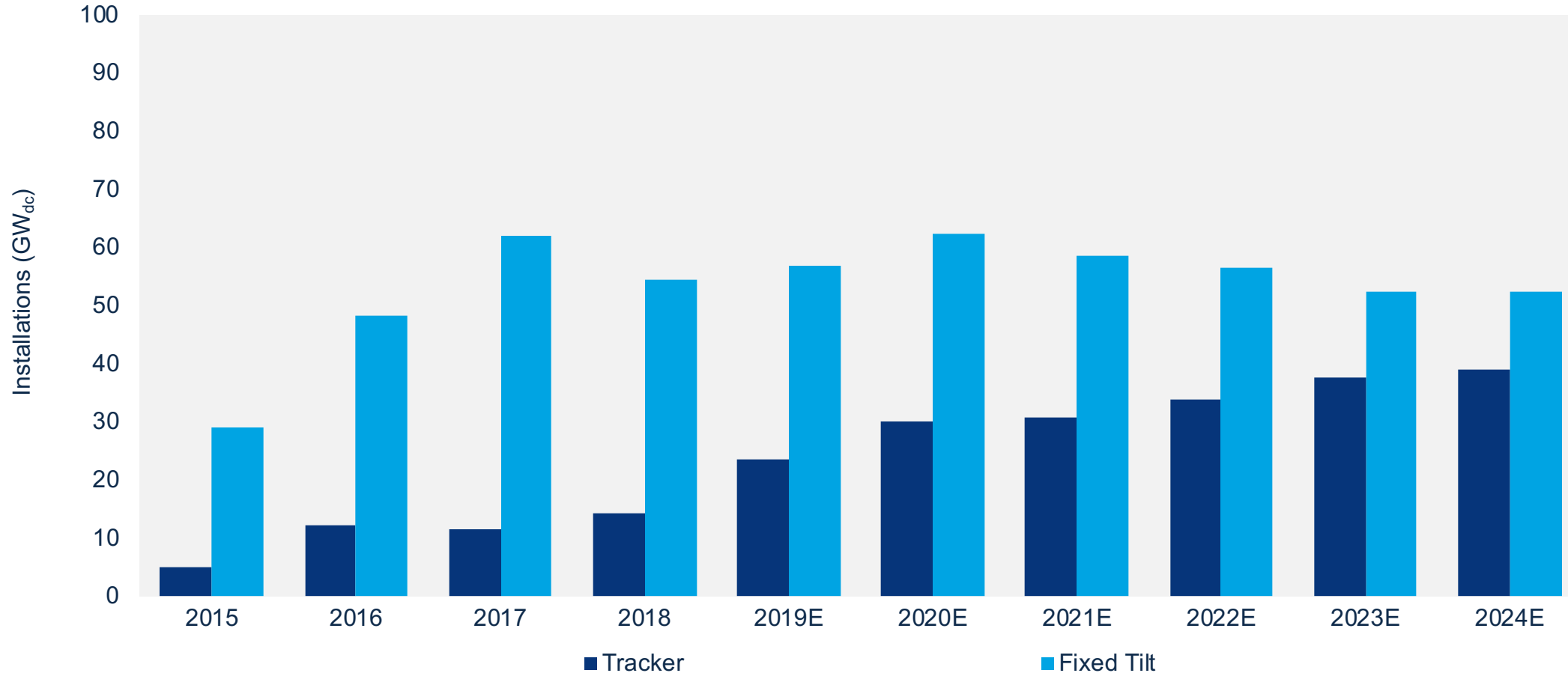


Source: Wood Mackenzie Power & Renewables

Solar tracker installations will grow on average by 11% annually from 2019 to 2024

2019 will see the largest uptick in tracker installations as the market experiences 62% YOY growth

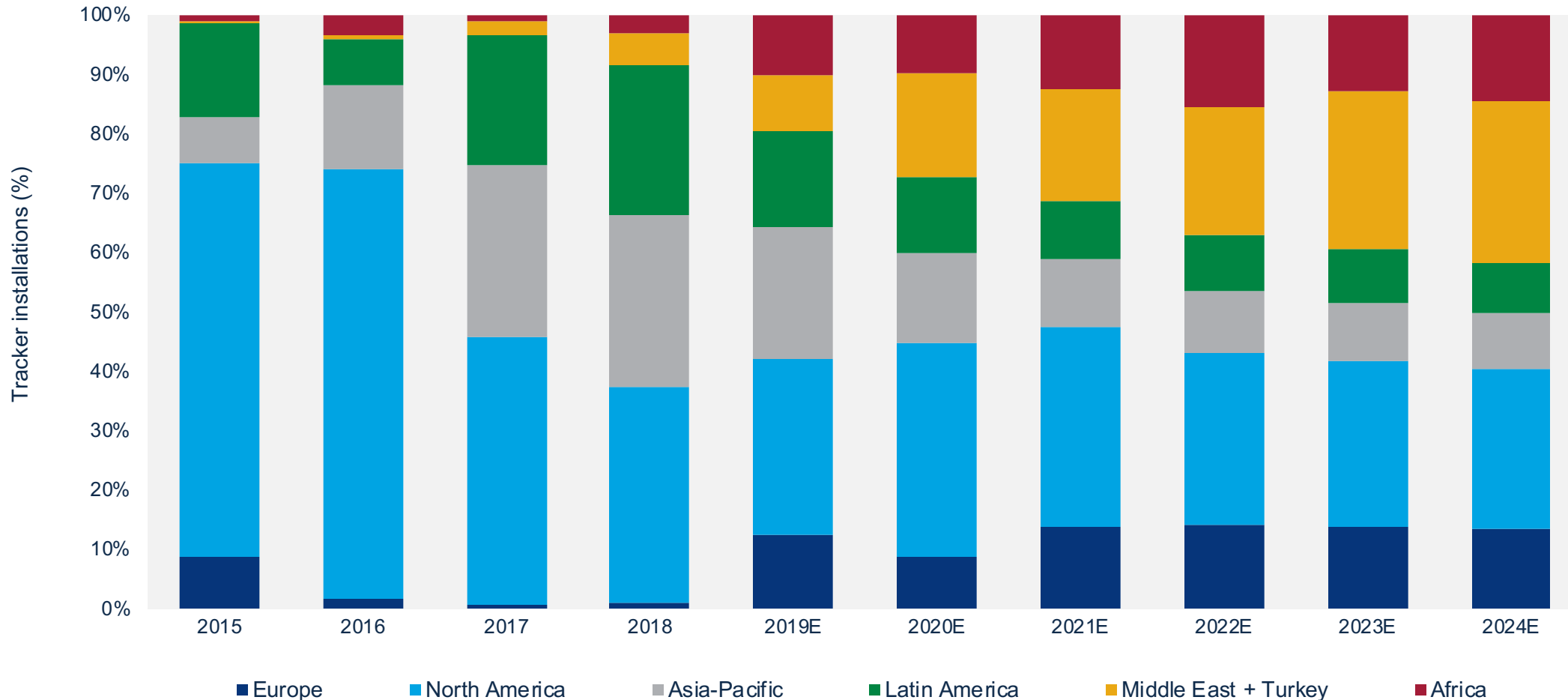
Global PV ground mount installations, 2015 – 2024E (GW_{dc})



As solar markets in the Middle East and Africa grow, their tracker markets will follow suit

Europe's tracker installations will take off in 2019 and remain at a steady 13%-14% share of the global market

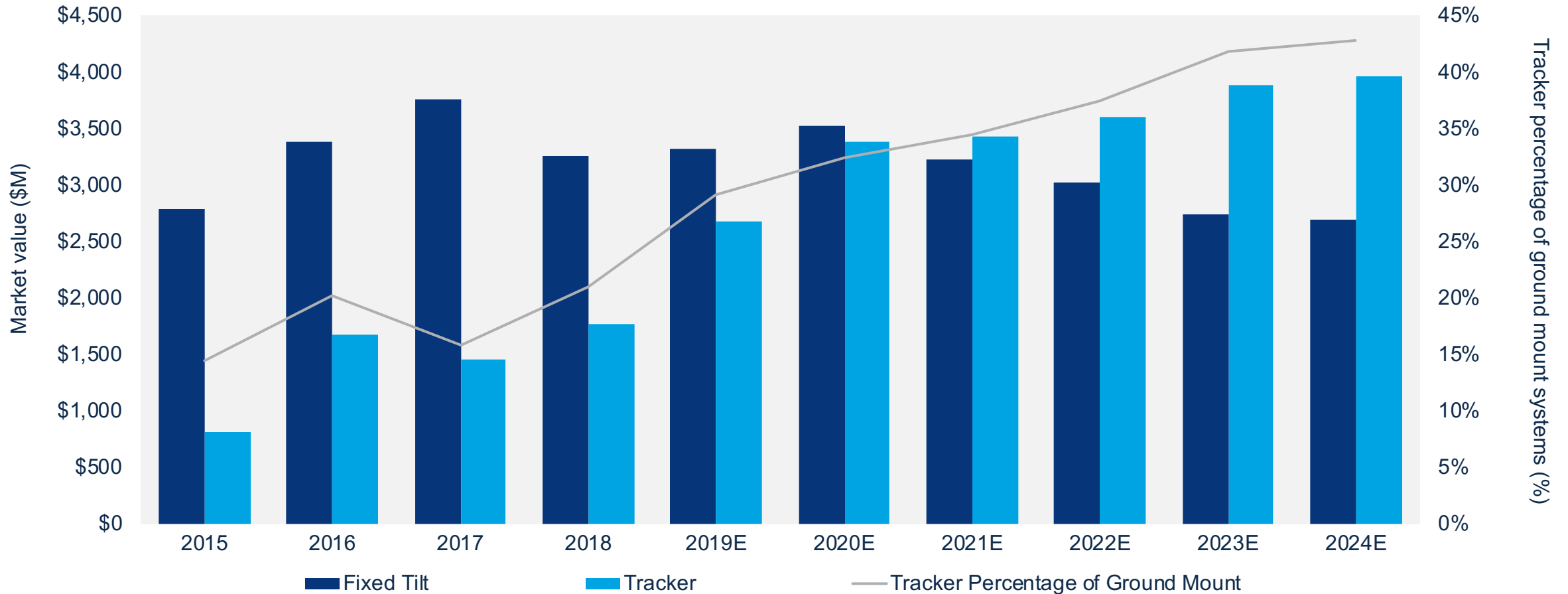
Tracker installations by region, 2015-2024E (%)



By 2021, trackers will overtake fixed-tilt systems in terms of total global market value

Still, trackers will only account for 34% of the global ground-mount market

Global market value and percent of ground mount systems that are tracker, 2015 - 2024E (\$M) (%)



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December 10, 2019



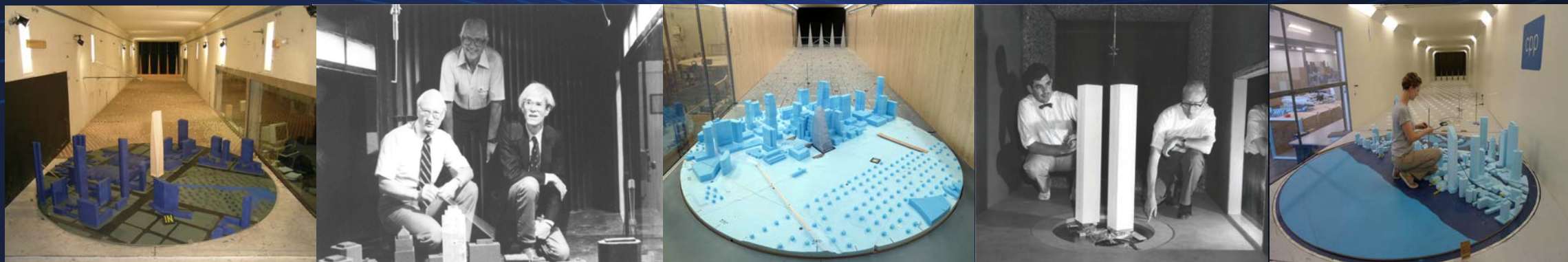
Dr. David Banks
President



Dr. David Banks has directed hundreds of solar wind loading studies in his tenure

- Static, dynamic, aeroelastic
- Roof mount (residential & commercial)
- Site studies

- Internationally renowned wind engineering firm founded in 1981
- Wind tunnels in Colorado, USA and Sydney, Australia
- Wind loads for tall buildings, launch vehicles, solar
- Air flow for ventilation, dispersion, comfort



Source: CPP Wind



Dr. Girma Bitsuamlak

*Canada Research Chair in Wind Engineering,
Director (Research), WindEEE Research Institute
and Boundary Layer Wind Tunnel Laboratory,
University of Western Ontario (UWO)
gbitsuam@uwo.ca*

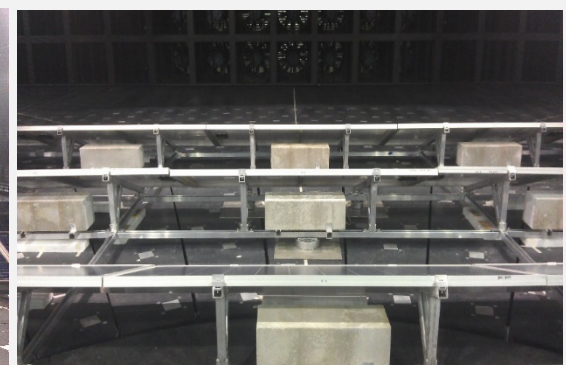
Dr. Bitsuamlak and his team model:

- microclimate effects on structures in extreme wind (e.g. hurricane and tornado safety), and
- normal climate (thermal and energy performance).

He has also executed aeroelastic analysis of various skyscrapers like the Freedom Tower in New York.



The Wind Engineering, Energy and Environment Research Institute (WindEEE RI) was established in recognition of novel opportunities in wind research, including modeling wind load mitigation of solar panel arrays.



Maturing Industry

Global Attention on Dynamic Wind Analysis

- NEXTracker released a ground breaking white paper on dynamic wind analysis in September 2018
- First webinar of its kind in the industry
- Growing industry attention on understanding and enforcing dynamic issues
- “Torsional galloping” and “aeroelastic instability” now commonly known by engineers and non-engineers alike
- Dynamic analysis now done by all leading racking manufacturers



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DESIGNING FOR THE WIND

USING DYNAMIC WIND ANALYSIS AND PROTECTIVE STOW STRATEGIES TO LOWER SOLAR TRACKER LIFETIME COSTS

By Alex Roedel

WEBINAR:

Designing for Wind in the Age of Mass Solar Tracker Deployment

18 2:00 PM

SYSTEM INTEGRATION Technical Briefing

A tested and proven wind mitigation

Contents lists available at ScienceDirect

Journal of Wind Engineering and Industrial Aerodynamics

journal homepage: www.elsevier.com/locate/jweia



Aerodynamics of ground-mounted solar panels: Test model scale effects

PV in need of a new

PV Trackers: We need to talk about wind resilience

Published on October 22, 2019



Simon Hugh
Partner at Ever



We Need to Talk about Wind Resilience

By GREEN BUILDING AFRICA - NET CARBON ZERO BUILDINGS AND CITIES — November 9, 2019

Comments

As published in *PV Magazine* 21st October 2019

Industry Trends

Rigorous design standards protect the tracker industry

In my role as CEO for a tracker company, I'm witnessing more and more companies are adding steel mass back into their tracker designs and dampers to address their failure issues."



Mark Kingsley

President and CEO

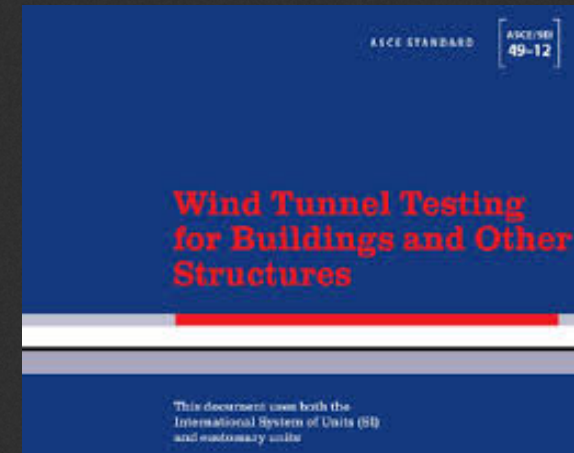
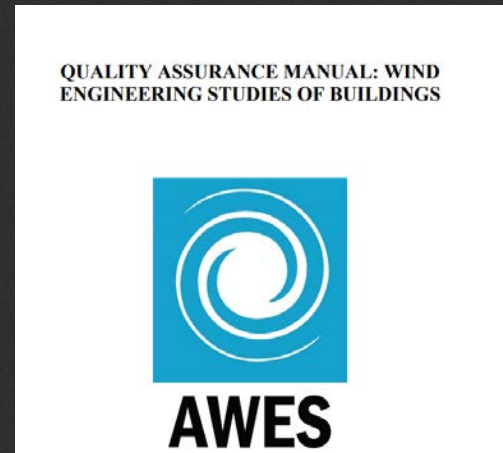
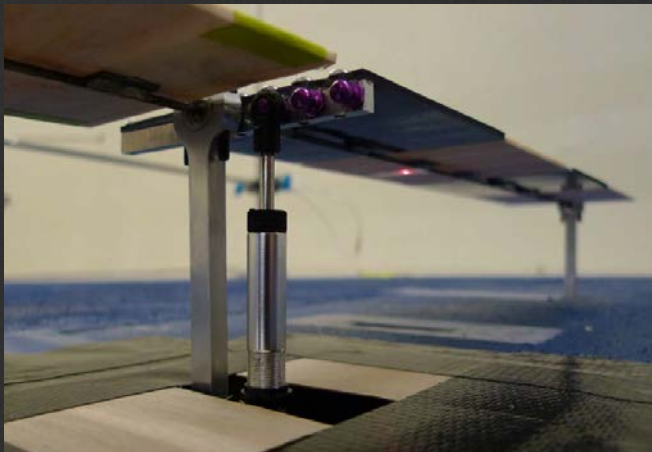
Alion Energy

Understanding Accuracy

There may be several ways to approach this, but they should give the same answer.”

-David Banks, CPP

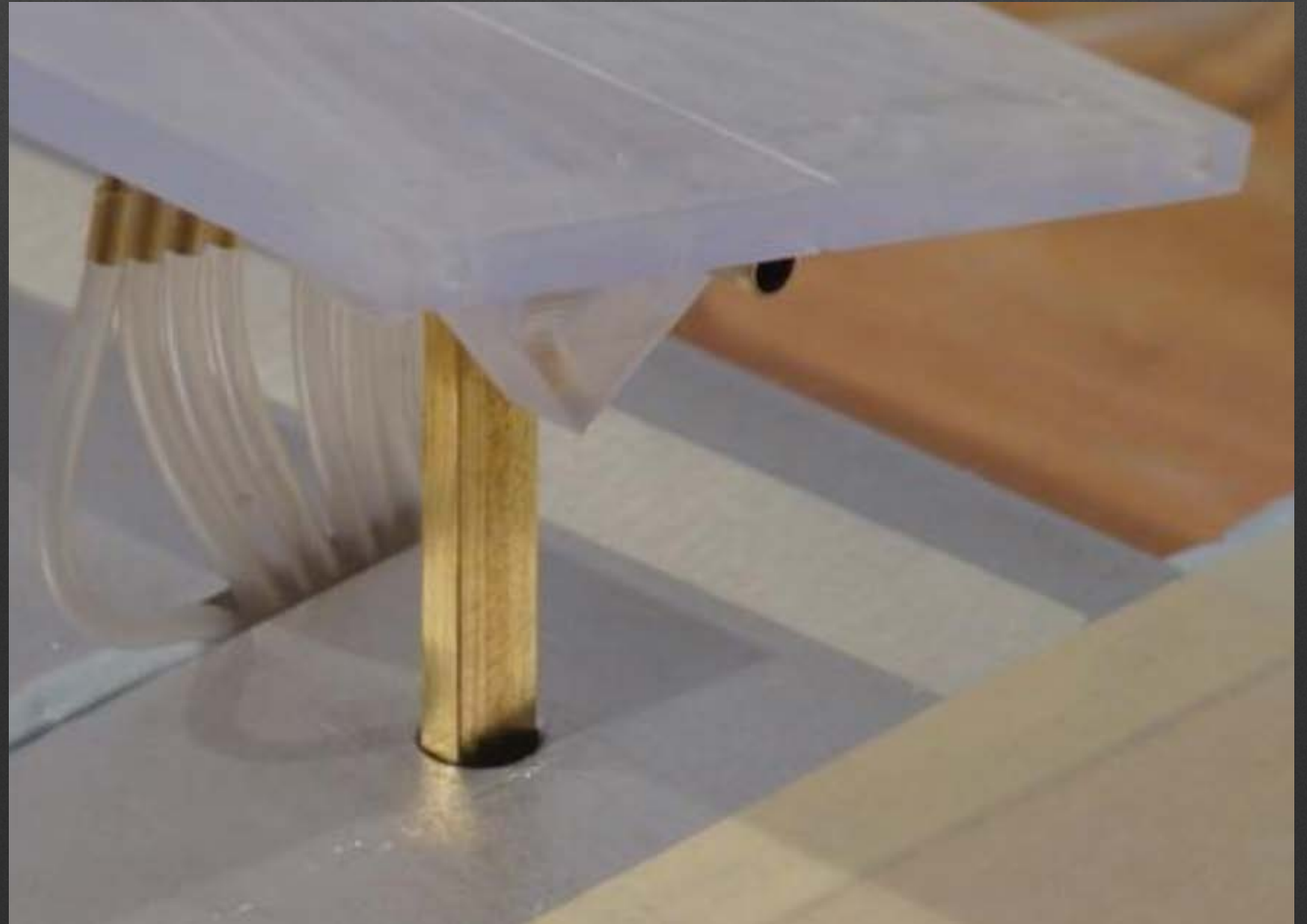
- ASCE 49-12, AWES QAM (and others) list the wind tunnel testing standards that need to be followed
 - *Not intended to limit innovation*
- Confusion amongst professionals as to which method provides the correct results
- If wind loads are lower, there should be a good reason why.
 - *Low-load lab shopping*



Reporting Module Pressure Values

Reported Pressures Can Vary up to 20%

- IEC 61215 defines methods for approving modules on structures
- Design only includes static analysis for approval
- Rewards trackers that stow at the vulnerable position of 0 degrees due to static torsional divergence
- Only stable trackers allow modules to perform for their intended design life



Dynamic Modes & Types

Education Needed to Understand Beyond Dynamic Effects

- Multiple dynamic effects are causing catastrophic damages
- Most trackers failures are happening due to torsional divergence, not torsional galloping

Parameter Sensitivity	Torsional Divergence	Torsional Flutter or Galloping	Vortex Lock-in
Sensitive to Damping	No	Yes	Yes
Sensitive to Mass	No	Yes	Yes
Sensitive to Stiffness	Yes	Yes	Yes
Operational Angles at Risk	Low Tilts	High Tilts	High Tilts

Note : *Dynamic divergence* means oscillatory growth of response amplitude, *Static divergence* means non-oscillatory growth of response amplitude; Both *static and dynamic responses* are of torsional mode.



Failures Happen at Low Wind Speeds

Industry Only Understands Basic Dynamic Effects

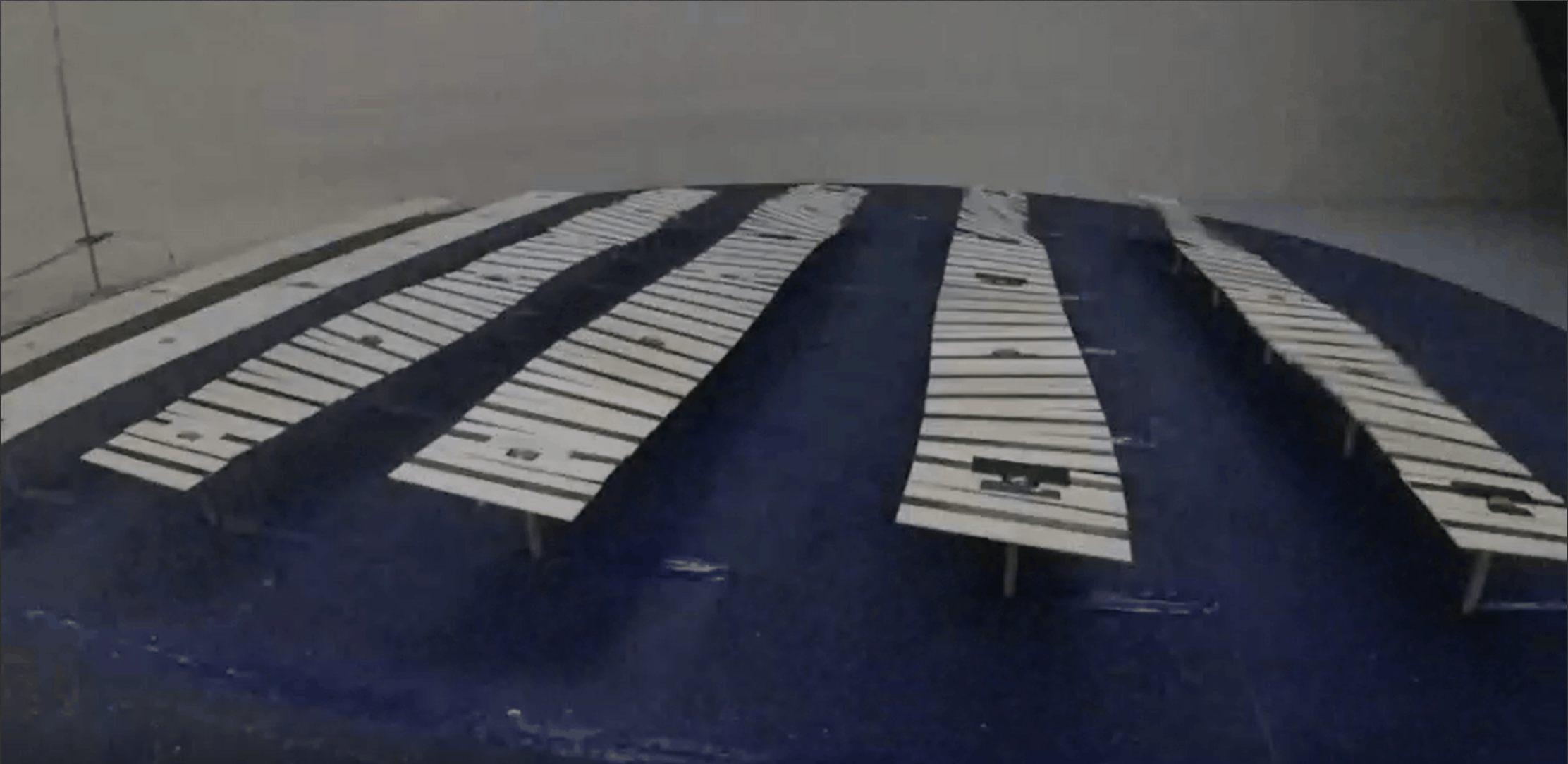
- Misunderstanding of dynamic loads and effects results in failures at operational wind speeds
- Greater focus needed on proven stability for multiple major aeroelastic effects
- Areas with *frequent*, not high winds, need the greatest analysis and focus across the industry

Photo Courtesy: Everoze

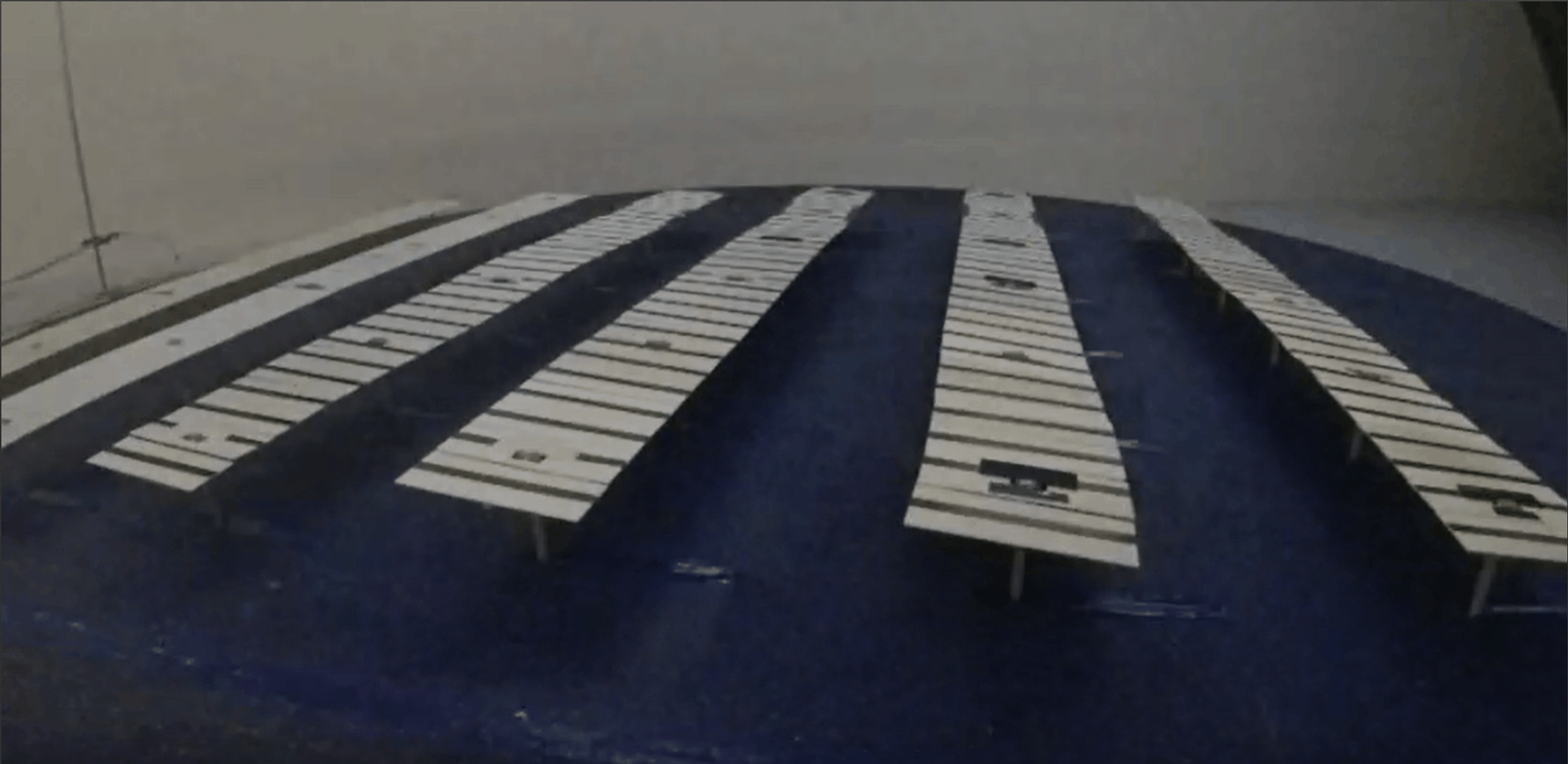


NX Gemini™ Two-in-Portrait Smart Solar Tracker

NX Gemini Wind Tunnel Testing – Upper Limits

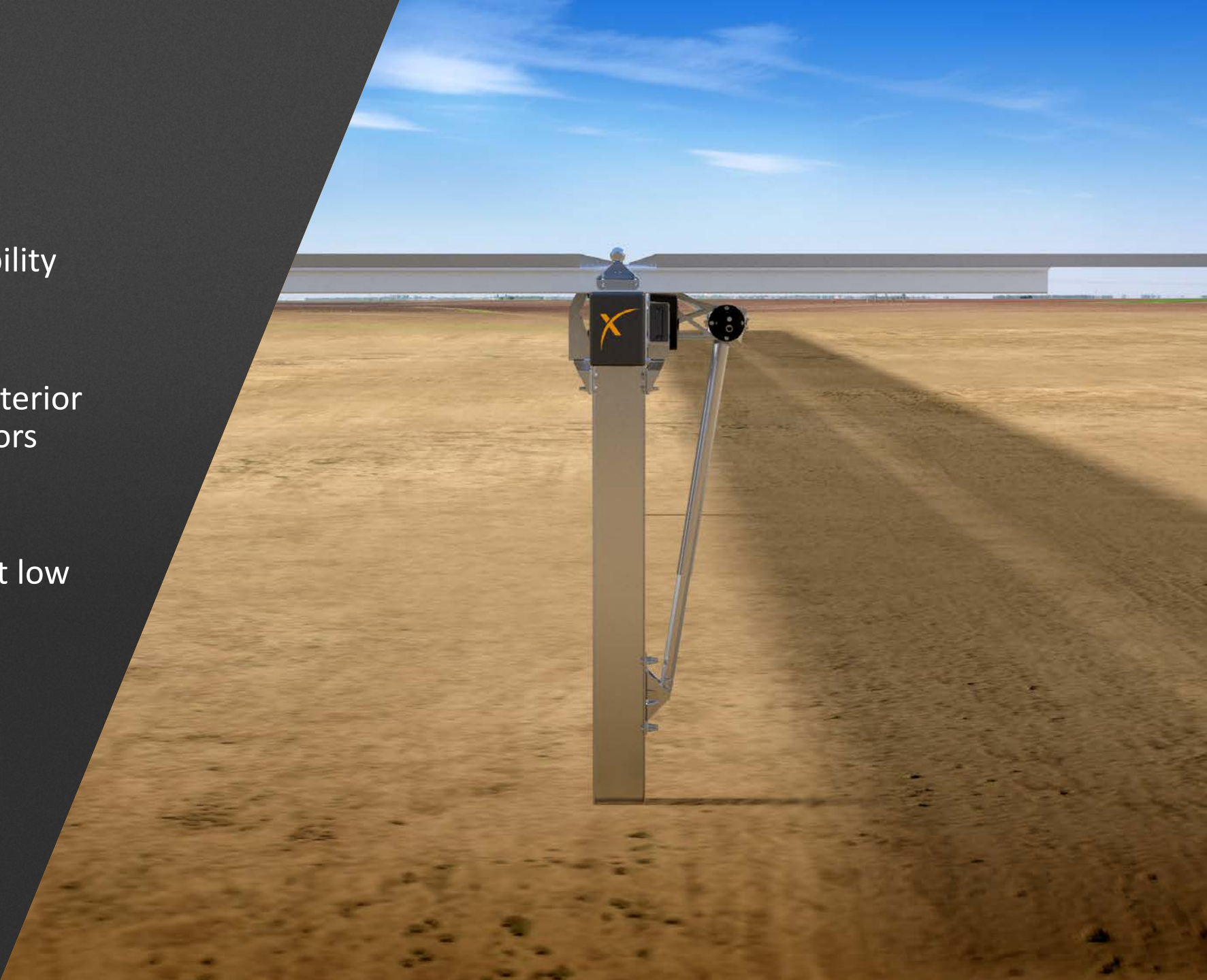


NX Gemini Wind Tunnel Testing – Stability



Locking Tracker

- Prevents aeroelastic instability
- Locking at every pier on exterior trackers with linear actuators
- Allows stability and stow at low tilt angles



Advocacy for Peer Review




Dr. Girma Bitsuamlak


Director (Research), WindEEE Research Institute and Boundary Layer Wind Tunnel Laboratory, University of Western Ontario (UWO)

- Many industry professionals often don't fully understand wind tunnel testing methodology and results
- Only third-party peer reviewed studies should be allowed
- Reviewer must have outstanding credentials in the wind tunnel testing field

Contents lists available at ScienceDirect

 **Journal of Wind Engineering and Industrial Aerodynamics**

journal homepage: www.elsevier.com/locate/jweia



Aerodynamics of ground-mounted solar panels: Test model scale effects

Aly Mousaad Aly^{a,b,*}, Girma Bitsuamlak^b

^a Department of Civil and Environmental Engineering, Louisiana State University, Baton Rouge, LA 70803, USA
^b WindEEE Research Institute, Department of Civil and Environmental Engineering, Western University, The Boundary Layer Wind Tunnel Laboratory, London, ON, Canada N6A 5B9

ARTICLE INFO	ABSTRACT
<p>Keywords: Wind loading Wind tunnel testing Geometric scale Low-frequency turbulence High-frequency turbulence Wind spectra Solar panel Computational fluid dynamics</p>	<p>Most boundary-layer wind tunnels (BLWTs) were built for testing models of large civil engineering structures that have geometric scales ranging from 1:500 to 1:100. However, producing aerodynamic models of the solar panels at such scales makes the modules too small, resulting in at least two technical problems. First, the resolution of pressure data on such small models becomes low. Second, the test model may be placed in the lower portion of the boundary-layer that is not a true representative of a real world scenario, due to high uncertainty in wind velocity. To alleviate these problems, development of a standardized testing protocol is very important. Such protocol should account for different time and geometric scales to design appropriate wind tunnel experiments that can allow accurate assessment of wind loads on the solar panels. The current paper systematically investigates the sensitivity of wind loads to testing ground-mounted solar panels, both experimentally (in a BLWT) and numerically (by computational fluid dynamics (CFD)), at different geometric scales. While mean loads are not significantly affected by the model size, peak loads are sensitive to both the geometric scale and the spectral content of the test flow. However, when the objective is to predict 3-s (three seconds) peak loads, large models can be tested in a flow that has reduced high-frequency turbulence.</p> <p>© 2013 Elsevier Ltd. All rights reserved.</p>

Peer Review Process

Only Experts have the Credentials to Verify Results

- Examine the wind profile characteristics simulated in the tunnel
- Validate the calibration and suitability of wind tunnel instrumentation
- Thoroughly check the efficacy of the data and if possible, conduct an independent analysis of the data set
- Offer theoretical consistency of observed results and conclusions



Figure 1: Wind tunnel model of the NEXTracker array section.

Separating Fact from Fiction

Reaching Accurate Results and Achieving a Reliable Energy Platform

- Peer reviews verify the completeness of the wind tunnel test as per state of the art
- Best way to verify “right” from “wrong”
- Only way for the industry to move forward to be a reliable energy source

Thank You

Alex Roedel

Director, Design & Engineering

aroedel@nextracker.com

m +1 510 270 2521

