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GameChange Solar

pv magazine webinars

Protecting Australian solar projects against extreme wind and hail risks

20 November 2025

10:00 am – 11:00 am | AWST, Perth

1:00 pm – 2:00 pm | AEDT, Sydney

Bella Peacock
Editor
pv magazine

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GameChange Solar

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VDE Americas

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CPP Wind Engineering Consultants

Welcome!

pv magazine webinars

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. 👀 💡

CPP WIND ENGINEERING CONSULTANTS

Protecting Australian Solar Projects:

Extreme Wind Risks

20th 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

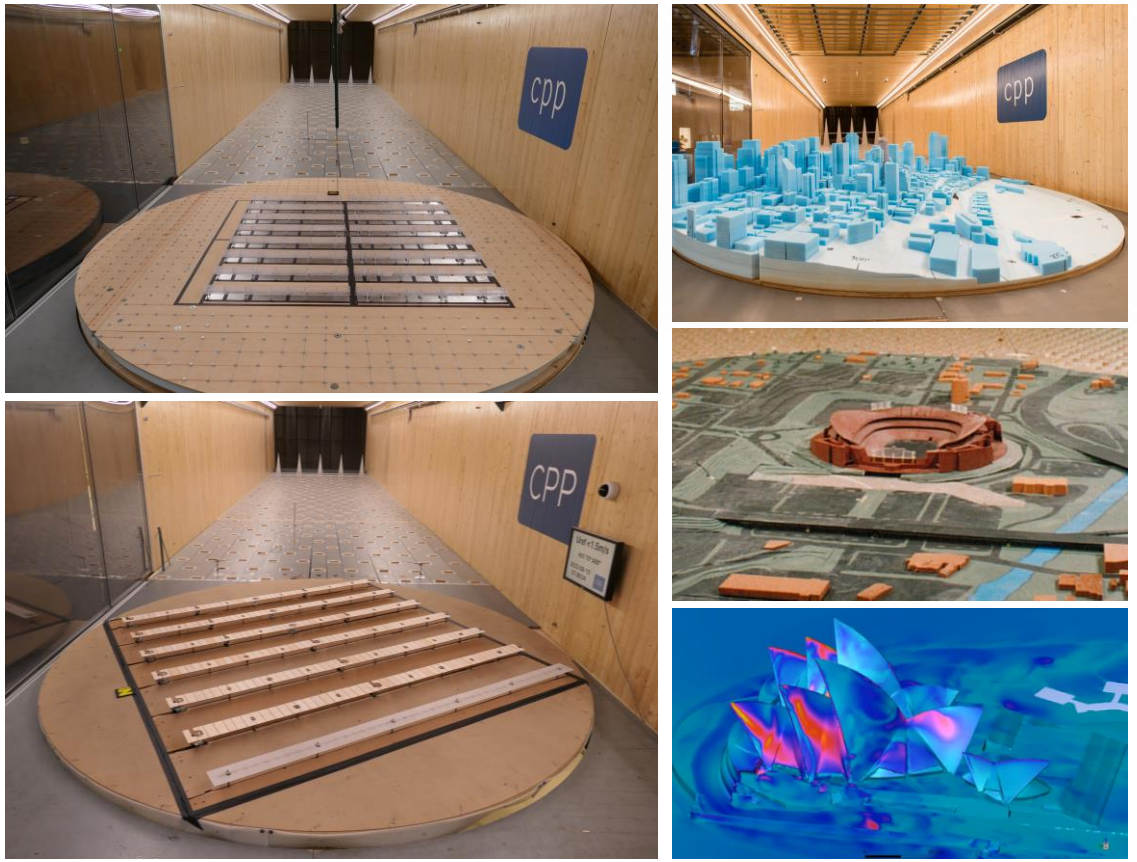
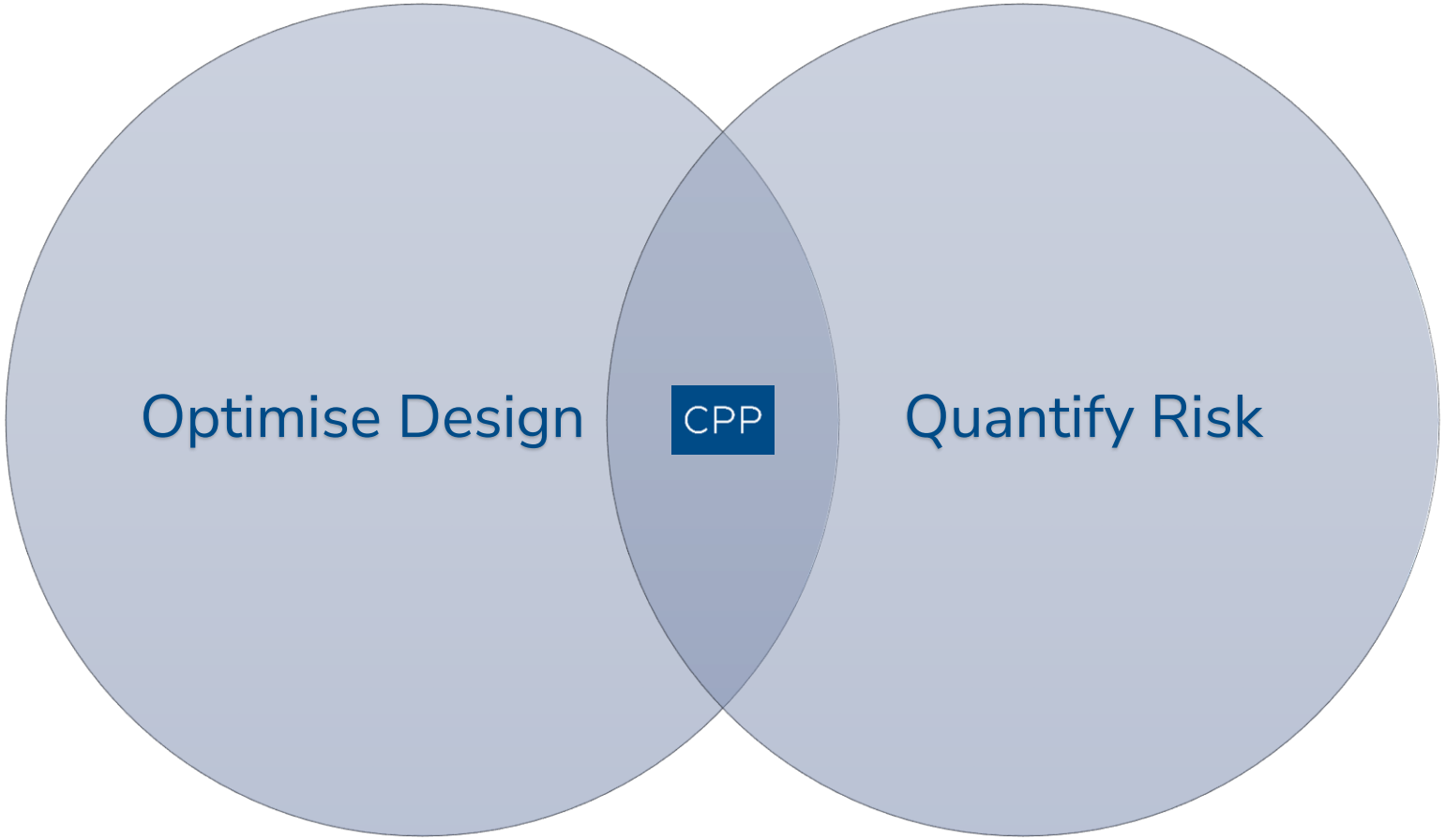


***Figure**: CPP services across different sectors*


Optimise Design
CPP
Quantify Risk

Australian Wind Map

- $\boldsymbol{Dynamic\ Pressure = q = 0.5\rho V^2}$
- *Higher recurrence interval = higher wind speeds*
- *500yr MRI:*
  - Region A = 45 m/s
  - Region D = 80 m/s * Mc
  - 87% higher wind speeds >> **3.5 times higher loads**

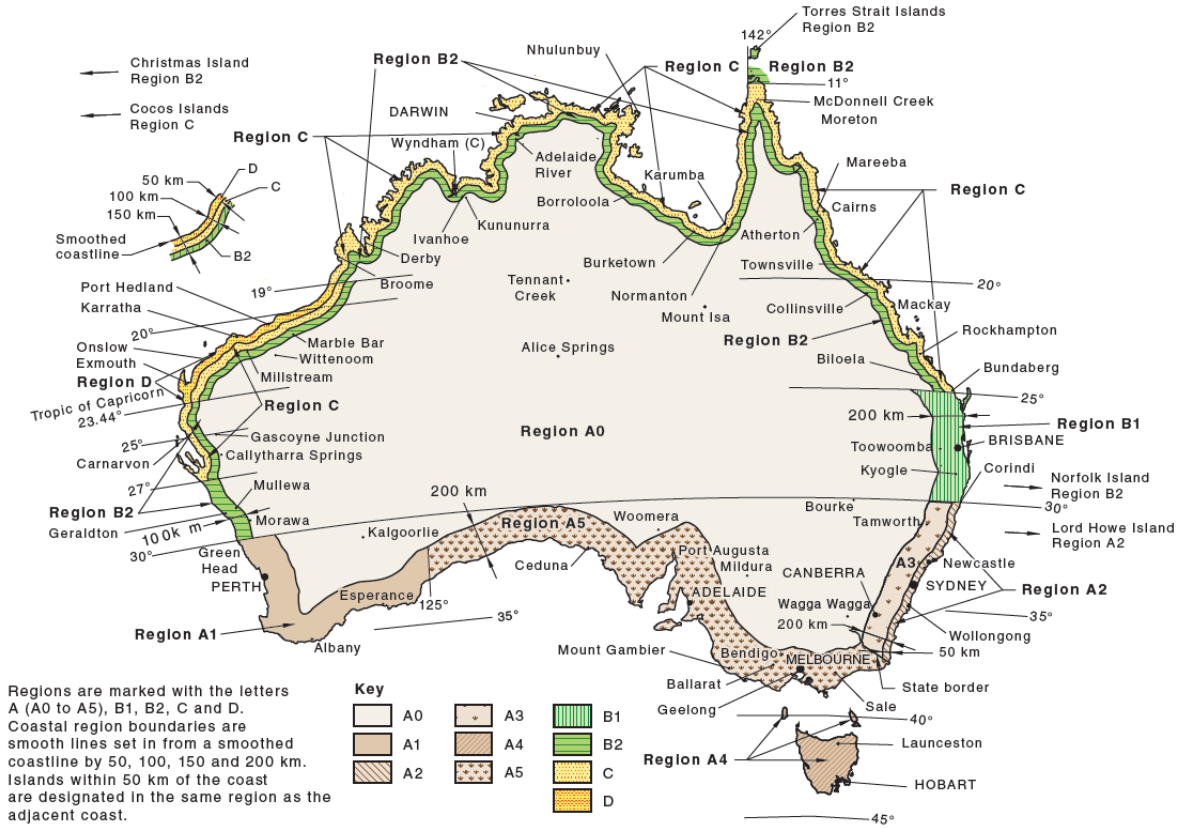


***Figure**: Wind regions – Australia (AS/NZS 1170.2-2021)*

Wind-Induced Risk

Services Throughout Site Development

Product Vendor → Reviewers → EPC → Developer → Investors → Insurer → Owner & Operator

Product-Specific Services

STEP 1
- Wind Tunnel Pressure Test
- Resonant Dynamic Analysis
- Free Vibration (Pluck) Test

STEP 2
- Aeroelastic Instability Testing

+

Site-Specific Services

STEP 3
- Wind Speed Analysis
- Site-Specific Instability Advice
- Exposure Analysis
- Hail/Snow/Wind Combination
- Ramp Rate Study

+ more

} *Safe and Economical Design*

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

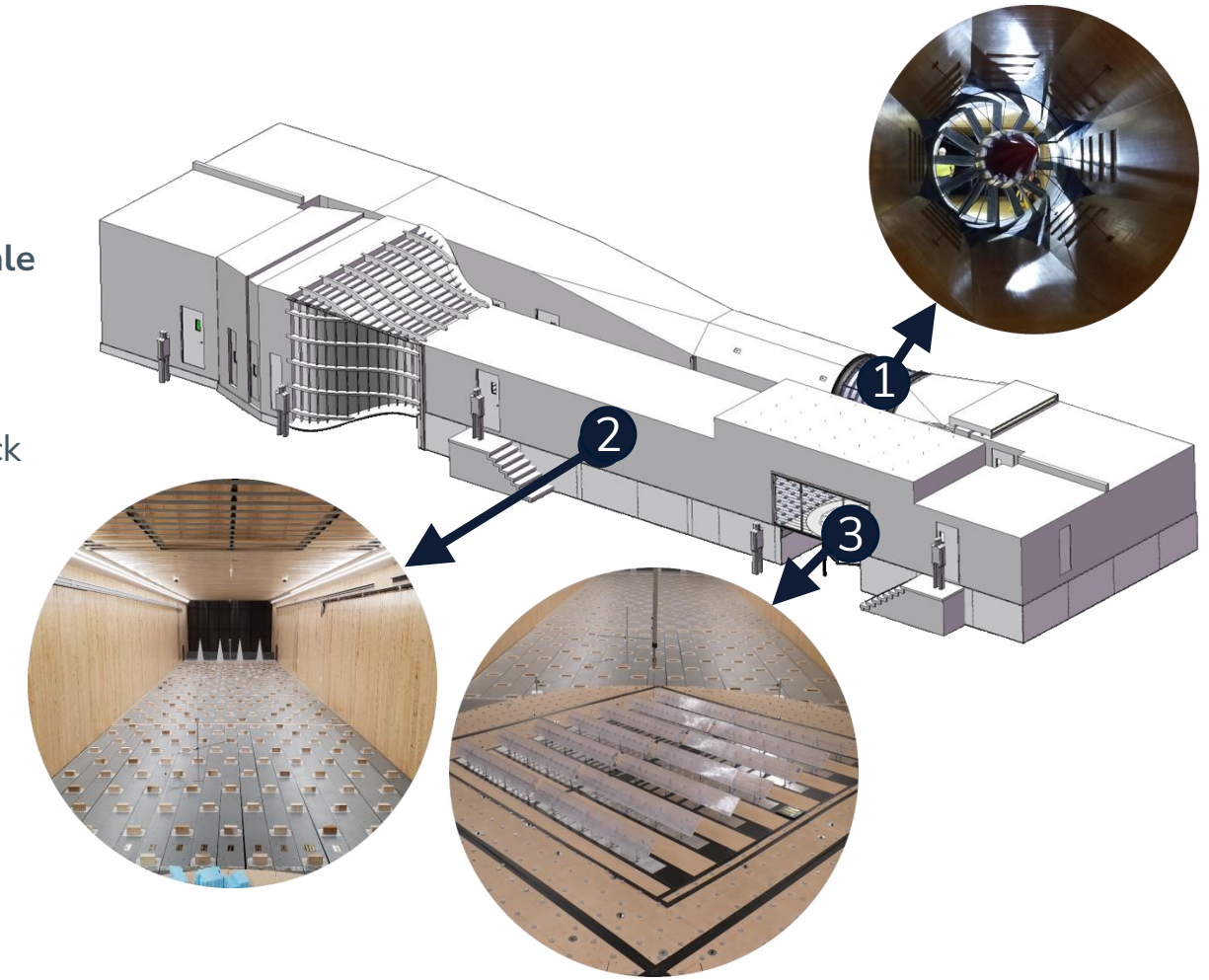
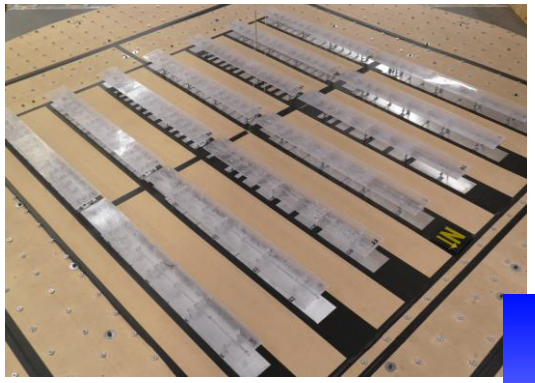
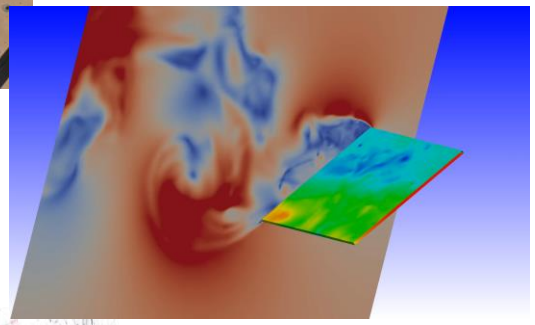


***Figure**: CPP atmospheric boundary layer wind tunnel*

Step 1: Pressure Tests

- *Rigid Pressure Models:*
- **Assumed Static Analysis**
  - Normal force and moment coefficients
  - Not covered in wind codes
- **Dynamic Amplification Factors**
  - Torsion and heaving modal excitation
  - **Advanced dynamics**
- **Pluck Test Review**
  - Natural frequencies of the system
  - Damping ratios for torsion and heaving





Figures:

Rigid Pressure Model (top)

CFD Vortex shedding off a flat plate (middle)

Pluck testing of a tracker (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)*

Step 2: Aeroelastic Testing

- *Scaled model that moves like a full-scale single-drive system in torsion*
- *Used to define the stow strategy and critical wind speed*

At low tilts: significant deflection + angular motion

At high tilts: minimal deflection + less motion

Staying Stable in High Wind Speeds

- *Stability can be improved at moderate-high tilts by increasing the torsional damping ratio*
- *Aim: to test with sufficient damping levels to reach high target design wind speeds*

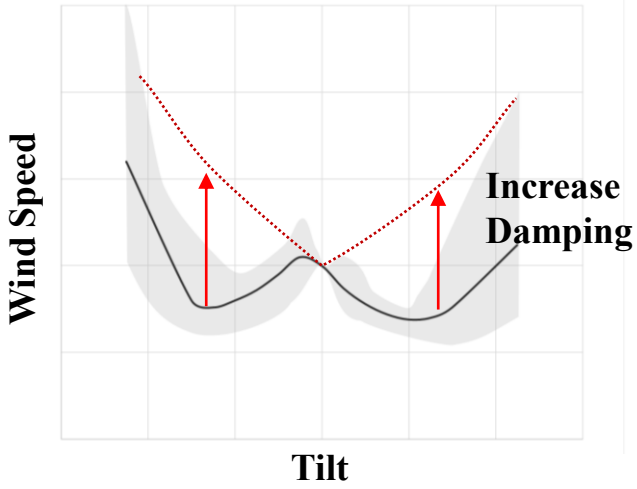


Figure: *Generic instability bounding curve*

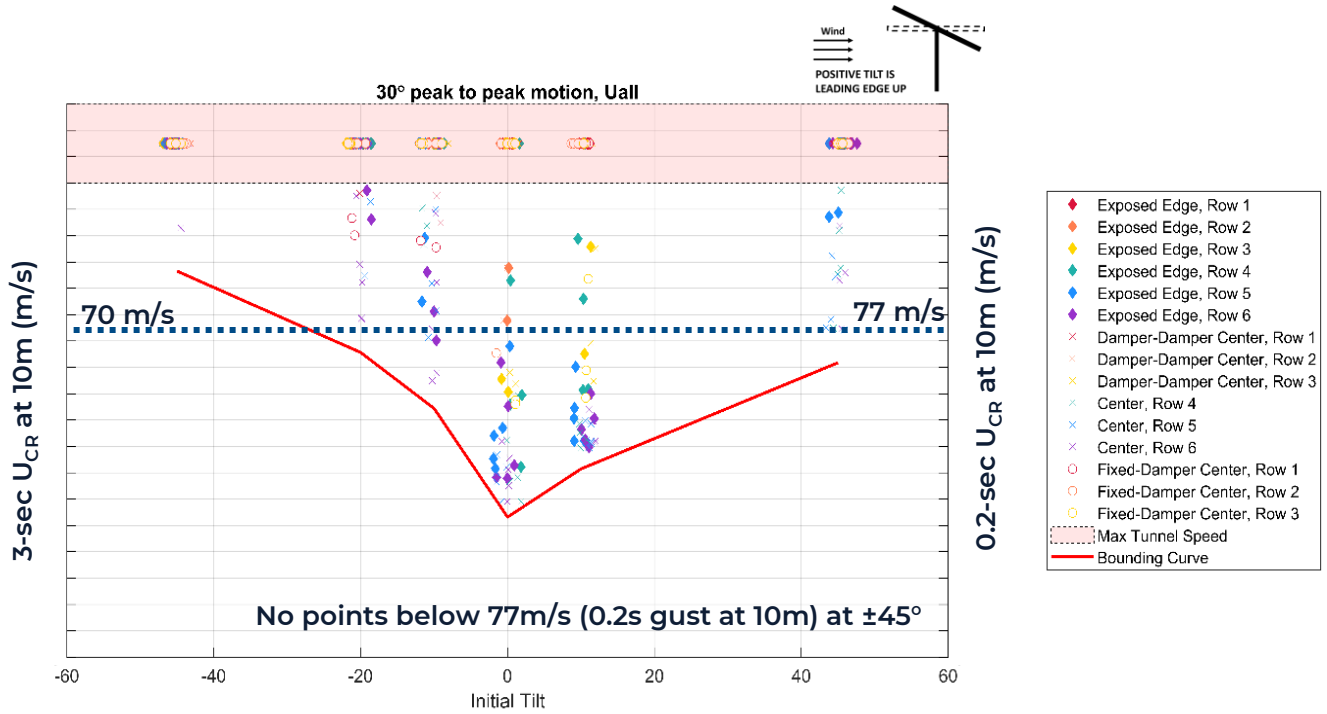


Figure: *GameChange results for high wind regions*

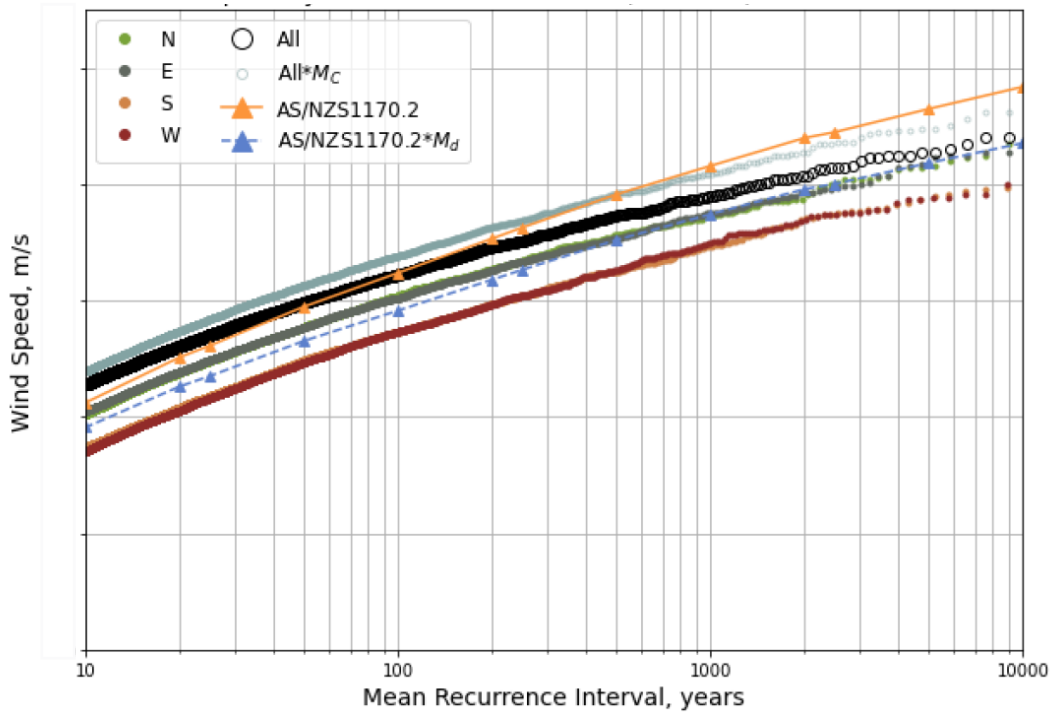
Step 3: Site-Specific Analysis

- *Risk is always > 0%, minimise it by understanding:*
  - Dominant storm types
  - Directionality

Directional design wind speeds (at 10 m, open terrain)	N	E	S	W
$\hat{U}_{500,0.2}$ (m/s at 10 meters)				

  - Return period vs failure costs
  - Changes in directionality

Figure: *Sample climate analysis including directionality*



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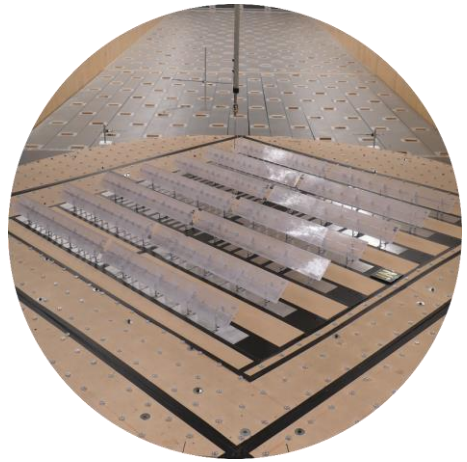
Key Takeaways

- *Quantify risk and optimise the system*
- *Wind tunnel testing to:*
  - Ensure the structure can withstand static loads
  - Dynamic amplification is accounted for
  - System is stable otherwise the rest doesn't matter
- *Site-specific analysis to assess risk for a particular **system** on a particular **site***
  - Use local wind data to accurately design your next sites

WIND CLIMATE ANALYSIS

WIND TUNNEL TESTING



SCALE WIND TUNNEL MODELING

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Thank You

Any questions?

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GAMECHANGE SOLAR
REPOWERING THE PLANET

Protecting Australian Solar Projects Against Extreme Wind and Hail Risks

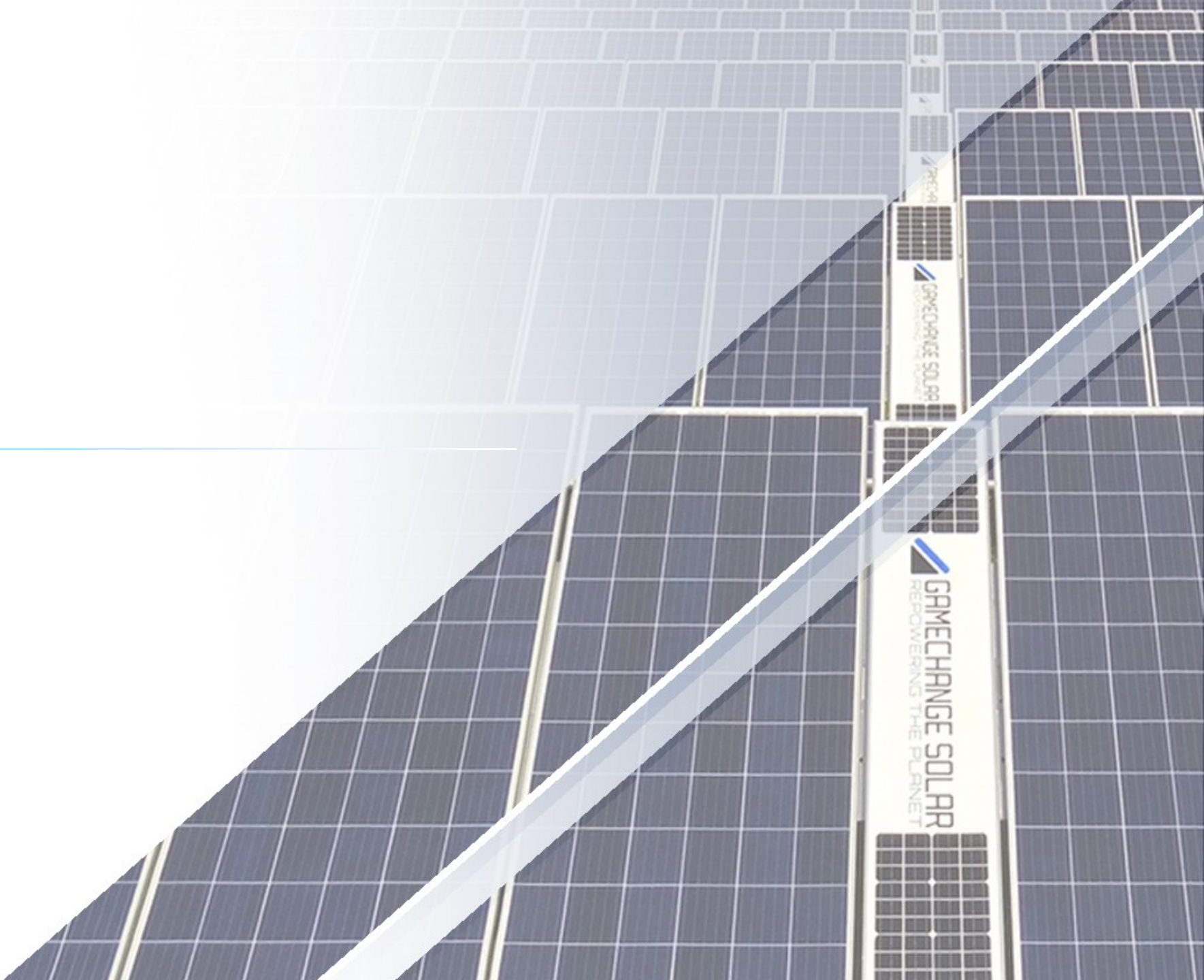
November 20, 2025

Scott Van Pelt – CTO

Agenda

1	2	3	4
Testing	**Design**	**Install**	**Operation**
CPP Wind Tunnel testing informs static and aeroelastic wind design including for sites with high design wind speeds	Incorporating wind tunnel test results allows for accurate designs to resist extreme weather events	Install costs can be dramatically reduced by using kitting, advanced delivery tracking and possibly robotic install	VDE's analysis supports insurability of operational assets and their studies validate the reliability of hail mitigation systems

Advanced Design



GAMECHANGE SOLAR
REPOWERING THE PLANET

Genius Tracker™ System Architecture

Up to 2% More Power Production vs Typical Competitor Trackers

WeatherSmart™, PowerBoost™, and SmartStow™, combine to result in higher kWh Output and higher ROE

Preassembled SpeedClamps™ or Purlins

Enable the fastest install amongst all trackers per Eclipse-M

Rows up to 440 ft [135 m] Long

Can save on installation cost

Pre-Assembled Drive System

50% Faster than typical competitor drive systems.
No machines or driveline for industry's fastest install

Wireless Communication

LwMesh with up to 250 nodes per master
Encrypted wireless data system
No trenching for power or signal wires
1 minute polling*

Bearings

50 years accelerated life tested, over 100 years design life

Rugged Design Actuator

Zero maintenance
No grease needs to be added
40-year accelerated life testing
IP66 rated
-40/+65C [-40°F /149°F] rated

Long Life 8ah Industrial Grade VRLA Battery

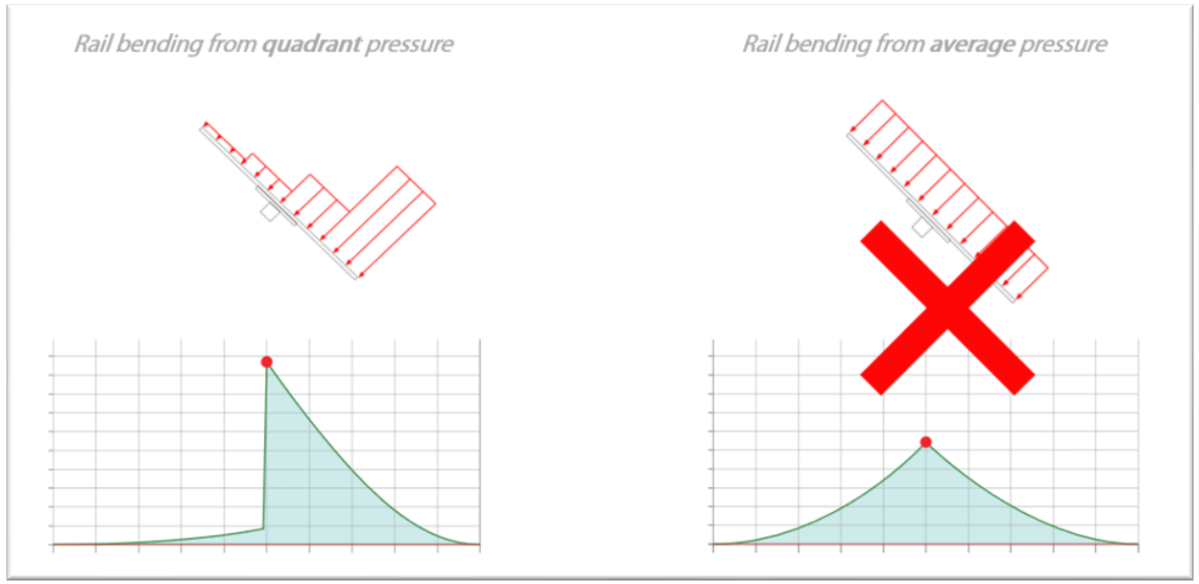
Typically, 8+ year field life
-40/+65C [-40°F /149°F] rated
No parasitic losses
Fast battery changeout
14ah SuperBattery option also available

Note*: With 100 nodes per Gen 4 Master

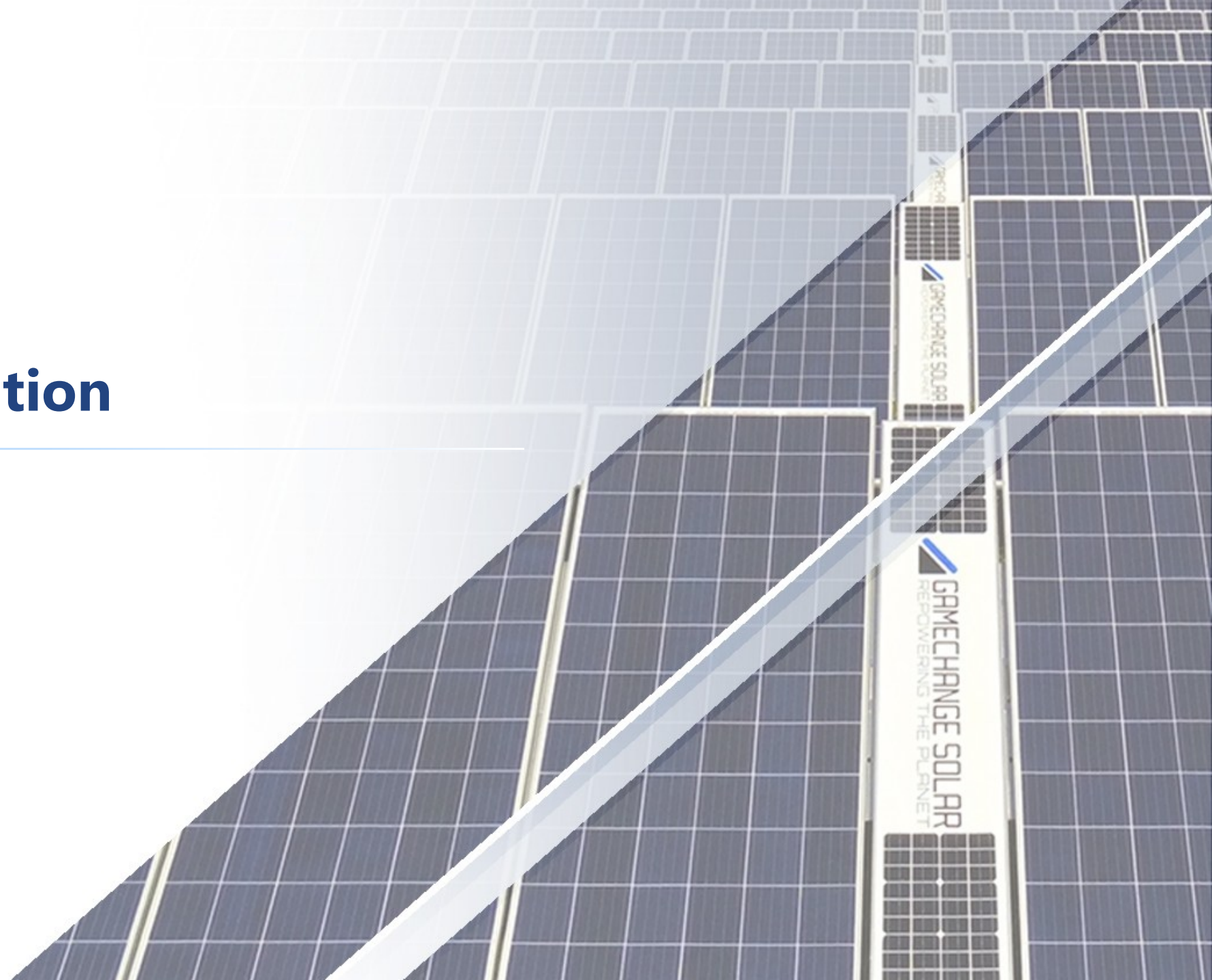
Module Testing

Unbalanced Mechanical Loading to Match Real-World Loading Conditions

- Led the market to adopt this approach with 2021 PV Magazine Webinar
- Testing per site-specific wind load
- Tracker OEMs who average load over whole module risk failure onsite
- Capacity checked with both static and cyclical tests



Advanced Installation



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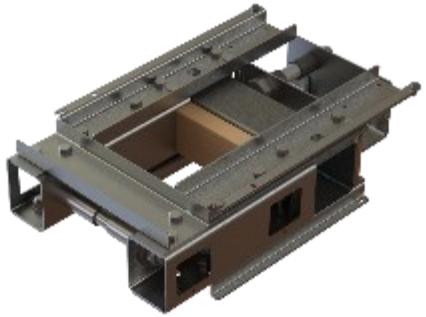
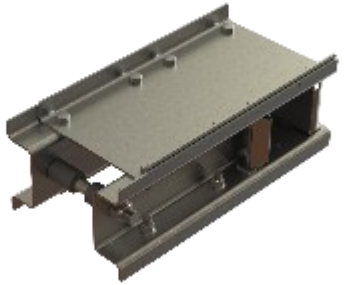
Preassembled Driving Arm, Bottom Bracket & Drive System

Simpler Staging, Minimal Skus = Faster Install + Big Labor Cost Savings

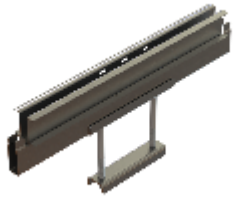


Preassembled
Drive Arm System
(includes Bottom
Bracket Assembly)



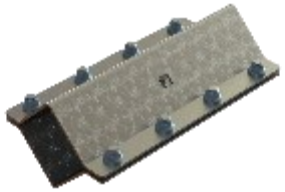
Preassembled
Damper Arm

Preassembled
Damper Bottom Bracket

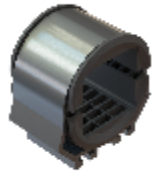


Preassembled
SpeedClamp

Preassembled
Purlin



Preassembled
Squeeze Splice



Bearing
Assembly

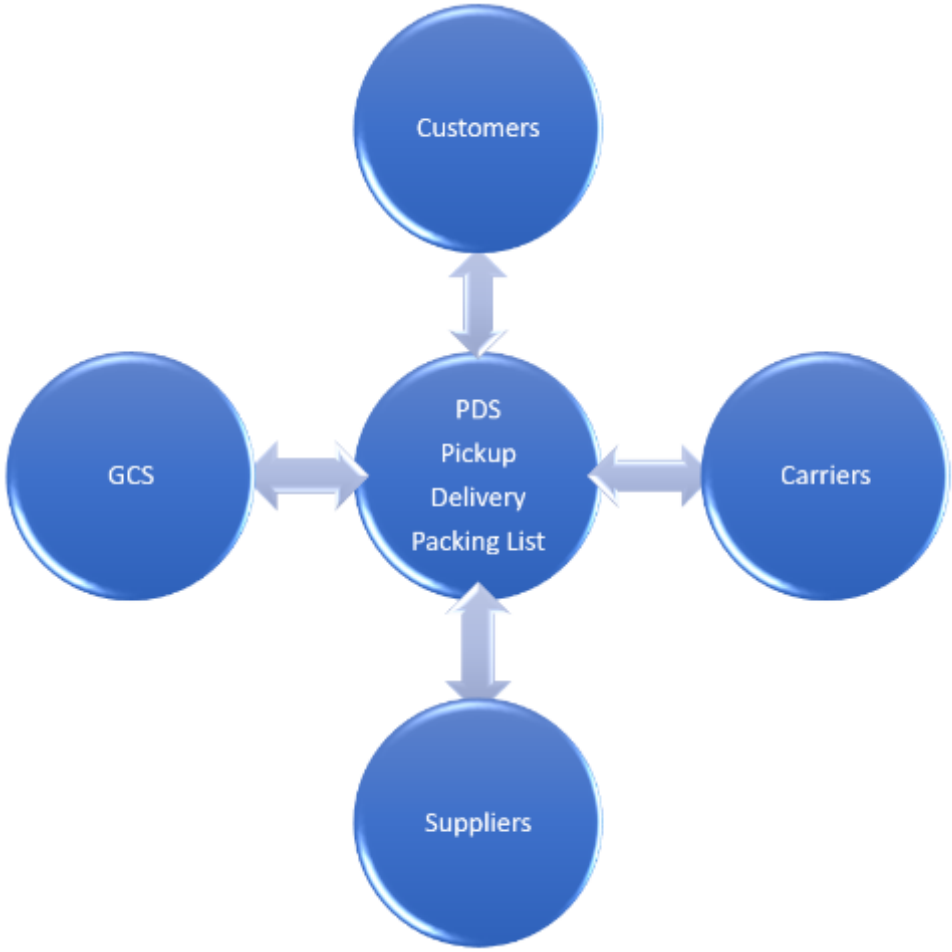
Industry's Best PDS (Production Delivery System)

Transparent Information

Single Point of Truth

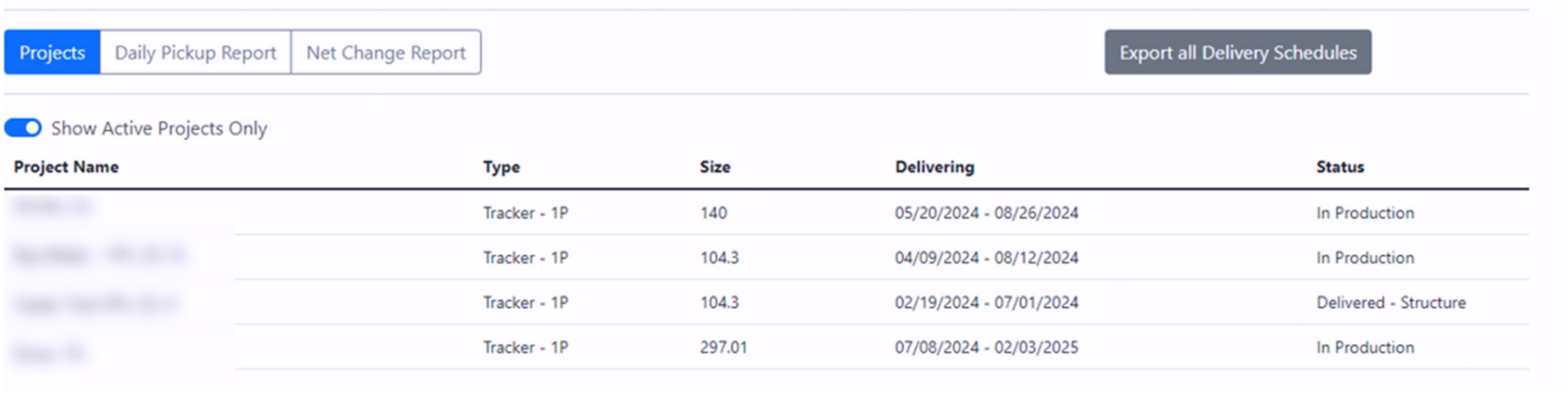
All access the same data/dates

- Customer
- GCS
- Vendor/Port
- Carrier/Driver



Customer Portal

Provides Unparalleled Visibility and Access to Information Related to Your Projects



Project Name	Type	Size	Delivering	Status
[redacted]	Tracker - 1P	140	05/20/2024 - 08/26/2024	In Production
[redacted]	Tracker - 1P	104.3	04/09/2024 - 08/12/2024	In Production
[redacted]	Tracker - 1P	104.3	02/19/2024 - 07/01/2024	Delivered - Structure
[redacted]	Tracker - 1P	297.01	07/08/2024 - 02/03/2025	In Production

- ☑ BOM, BBA quantities and sequencing
- ☑ Change Orders
- ☑ Delivery Schedules
- ☑ Delivery Confirmation and POD management
- ☑ Inventory reconciliation
- ☑ Real time views linked to our internal delivery schedules
- ☑ Mobile access

Customer Portal

BOM By Area

Customer requested installation sequence

Commodity	PCS12A5	PCS12A6	PCS11B2	PCS11A3	PCS11A2
Area Material Completion (Original Plan)	5/2/25	5/9/25	5/9/25	5/9/25	5/16/25
Area Material Completion (Live)	5/2/25	5/9/25	5/9/25	5/9/25	5/16/25
Area Material Completion (Delivery Plan)	4/30/25	5/7/25	5/7/25	5/8/25	5/13/25
Bearing -Preassemble	4/7/25	4/7/25	4/7/25	4/7/25	4/7/25
Bracket	4/14/25	4/14/25	4/14/25	4/14/25	4/14/25
Drive System	4/22/25	4/22/25	4/29/25	4/29/25	4/29/25
Hardware	3/4/25	3/4/25	3/4/25	3/4/25	3/4/25
Post	3/27/25	3/27/25	3/27/25	3/27/25	4/7/25
Purlin Component	3/25/25	3/25/25	3/25/25	3/25/25	3/25/25
Speed Clamp	4/22/25	4/23/25	4/29/25	4/29/25	4/30/25
Splice	4/21/25	4/28/25	4/28/25	5/5/25	5/5/25
Standard Component	3/4/25	3/4/25	3/19/25	3/19/25	3/19/25
Tube	4/30/25	5/7/25	5/7/25	5/8/25	5/13/25
Electronics	6/9/25	6/9/25	6/9/25	6/9/25	6/16/25

Original Plan: Original area completion dates stipulated in the contract

Live: Latest mutually agreed upon area completion date

Delivery Plan: Date each area will be completed based on real-time Delivery Schedule data

Each commodity type can be expanded to show total required Construction, Spares and already delivered quantities and material required for each project area

	Construction	Spares	Delivered	PCS12A5	PCS12A6	PCS11B2	PCS11A3	PCS11A2
Speed Clamp				4/22/25	4/23/25	4/29/25	4/29/25	4/30/25
GC318-E-35-G180 End Clamp Insert, G180	12,316	124	12,440	556	552	556	556	556
GC4318DXH-FS6-470mm-.046/.046/.068-G90-P Preassembled SpeedClamp Dual Tabs - Heavy, 470mm, G90	154,437	155	105,600	7,272	6,912	7,272 4/29/25	6,948 4/29/25	6,948 4/30/25
GC4318DXH-FS6-870mm-.046/.053/.068L-G90-P Preassembled SpeedClamp Dual Tabs - Heavy, 870mm, G90	49,697	50	36,000	2,018	2,328	2,018	2,342	2,342 4/29/25

Visual indicators will give the user detailed information on the status of material deliveries for each areas required quantity and completion date

- Complete: Highlighted green
- On-time: Lists the date that area will be complete
- Trending late: Highlighted yellow (just in time) or Highlighted red (late)

Genius Tracker 28% Faster Than Competitors

Independent Time Study by Eclipse-M

COMPARISON TO MARKET RELEVANT 1P TRACKERS

Following is a comparison of the three competitive (market relevant) 1P trackers and two cases of the Genius Tracker. Tracker to provide some visibility to the driving factors that show the Genius Tracker to be the best in class in this comparison.

At the summary level the Genius Tracker, based on the field verified update (incorporating the maximized factory pre-assembly configuration observed being installed in Dec 2023), is 28% more productive (takes 28% less labor) than the average of the three industry competitors.

	Competitor 1 1P 650W Standard Wind	Competitor 2 1P 650W Standard Wind	Competitor 3 650W Standard Wind	GameChange Standard Wind 650W	GameChange LEAN Standard Wind 650W
Main Structure	98.1	177.6	95.8	81.0	68.9
Drive System Assembly	25.5	8.7	11.7	5.6	5.6
Module Install/ Grounding	41.2	57.7	51.3	49.5	39.6
Total MH/ MW	164.8	244.0	158.7	136.1	114.1
Better than average Tracker 1, 2 and 3 (negative is better)				-28%	-40%

SpeedClamp™ Increases Install Speed

Reduces torqued connections for panelization by 67%

Drone Captures Effortless and Unparallel Install Speed for Solar Trackers Using GameChange Solar SpeedClamp™

1. Two workers carry the module to the tube.
2. Both workers align and insert the module into the SpeedClamp™ using spacers.
3. One worker drives the two nuts to attach the SpeedClamp™ onto the tube, which simultaneously attaches and grounds the module.
4. One worker then does the final torque on all modules after completion of entire row.

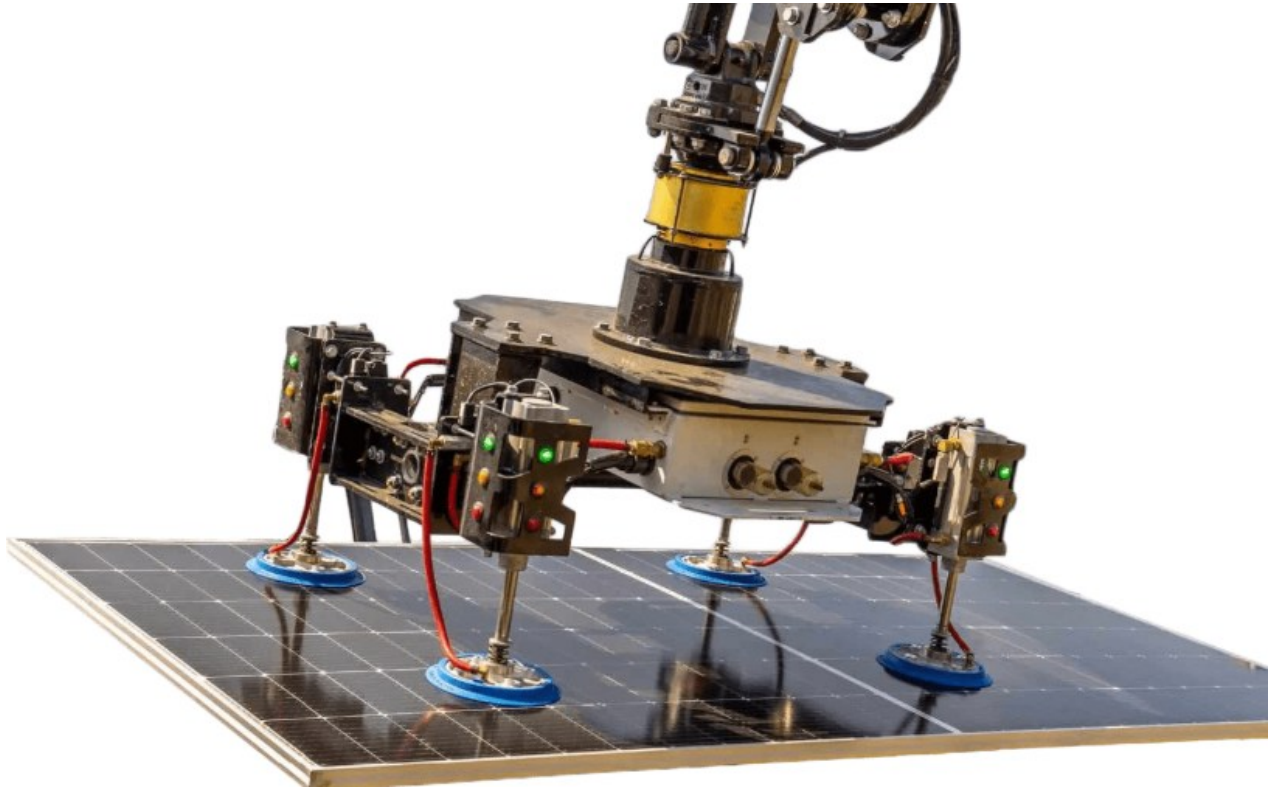
Total time per module averaged **28** seconds.

This means that two workers install 1,028 modules per day, or 514 per day per worker.

Robot Assisted Installation

Useful in areas with scarce labor or labor fatigue concerns

- Support can range from simple module placement, or post install all the way up to fully autonomous installation
- Robots to assist with Panel Install already being used on GameChange projects in Texas, USA.
- Working with over a dozen robotic vendors in various levels of design and compatibility testing.



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THANK YOU

MERCI 谢谢 GRACIAS

ありがとう DANKE धन्यवाद

OBRIGADO GRAZIE

Hail Risk to Solar in Australia & Real-world validation of GameChange's automated HailStow service

VDE Americas

pv magazine Webinar

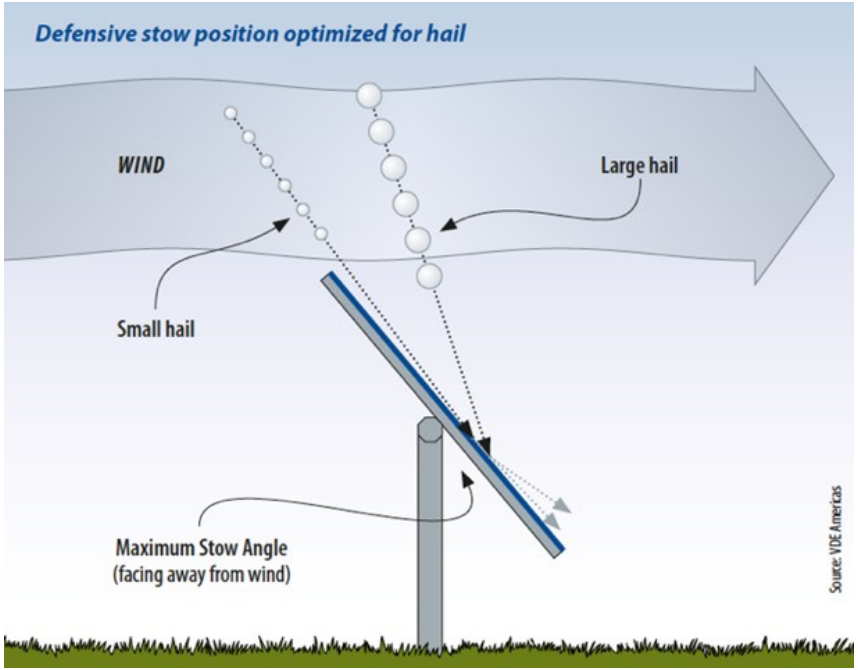
November 2025

Jon Previtali, VP, VDE Americas

VDE AMERICAS

VDE Americas, the leading provider of Hail Risk Intelligence for solar

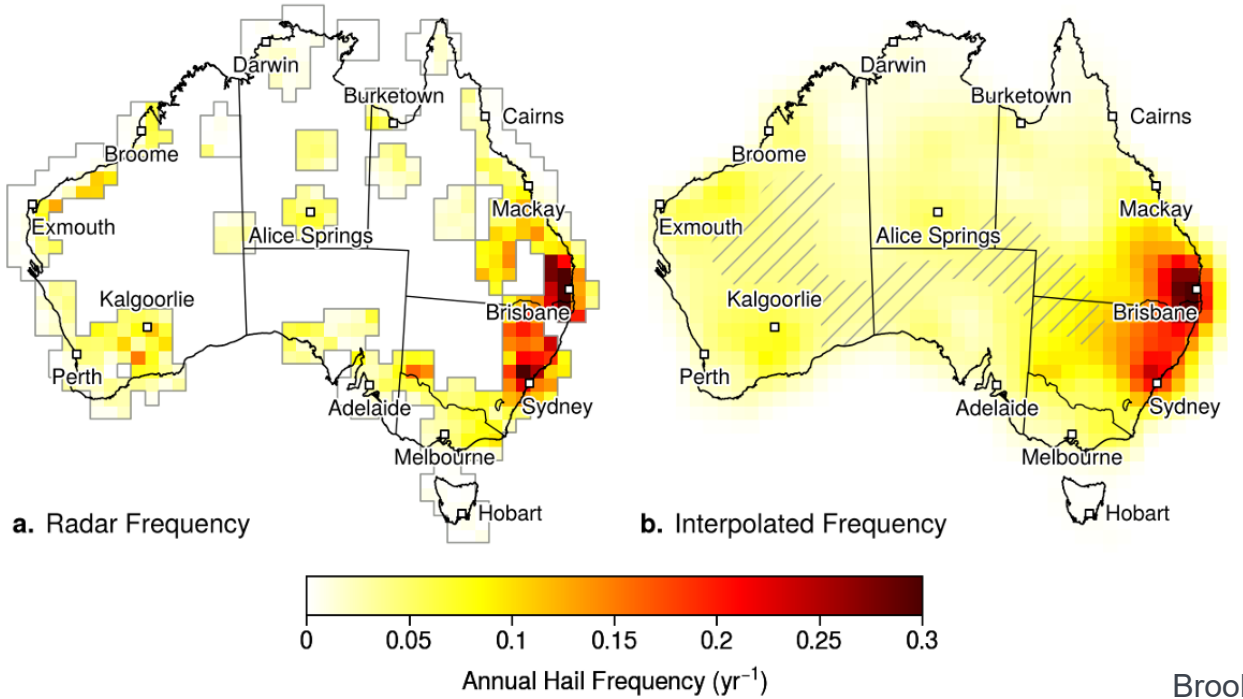
- Site- and equipment-specific hail analysis
- Probable Maximum Loss (PML) and proforma/downside reports
- Hail Risk Atlas™ ArcGIS maps (CONUS)
- Co-probability of windspeed and direction with hail
- Hail monitoring and stow protocols, tests, and 3rd party validation services
- PV module Hail Resiliency Curves with RETC test lab



VDE AMERICAS

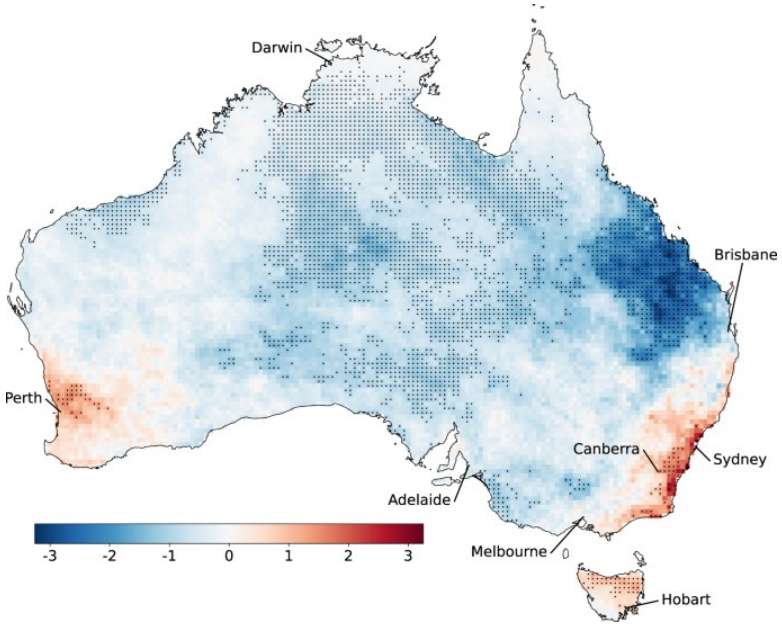
Hail risk to solar in Australia

Hail risk in Australia



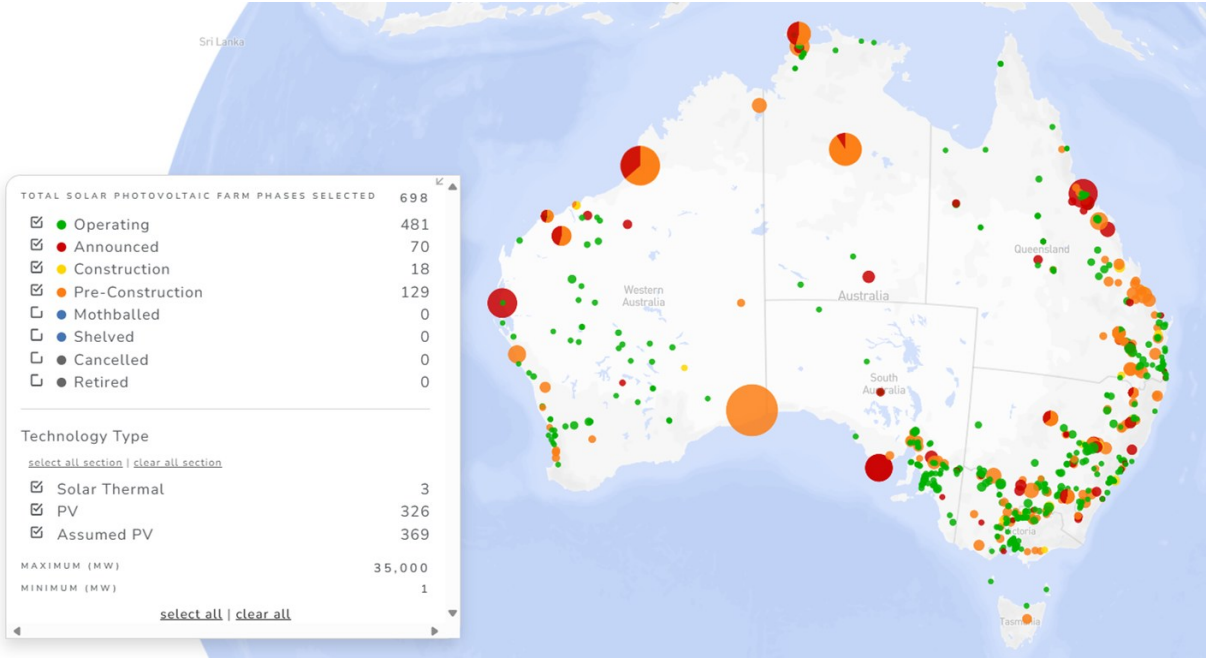
Brook et al, 2023

Hail risk in Australia – long term trend



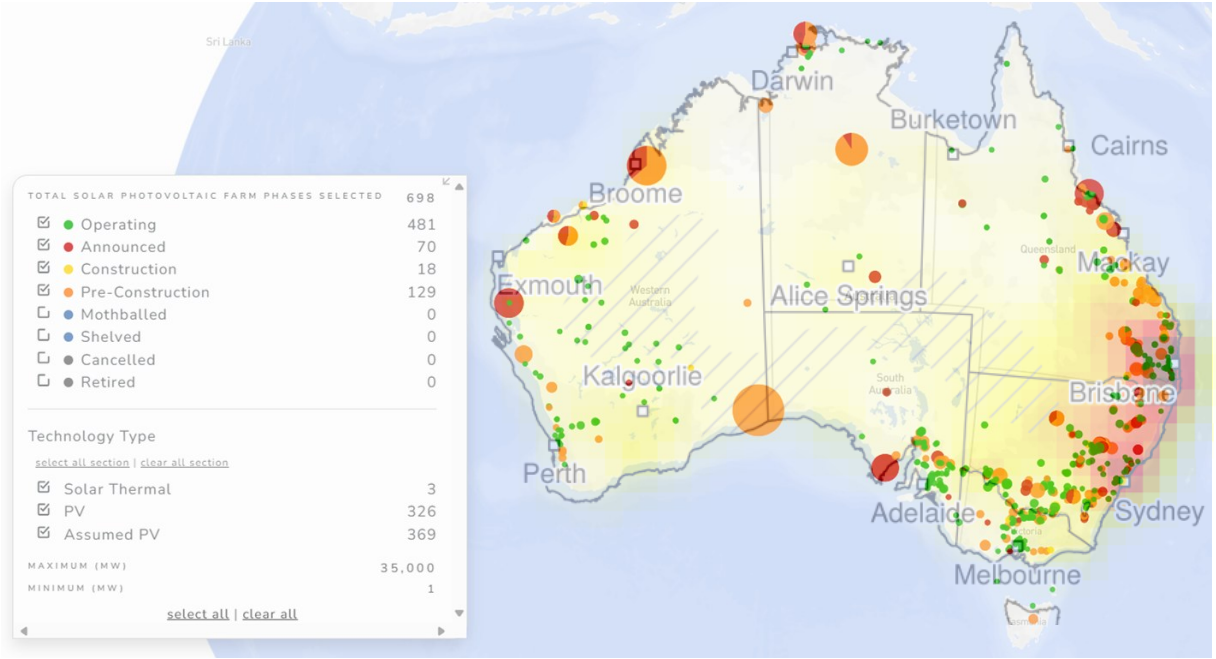
Changes in hail hazard across Australia: 1979–2021 in days per decade. (Raupach et al, 2023)

Solar projects in Australia



Current solar projects (Global Energy Monitor, 2025)

Solar projects & hail risk in Australia

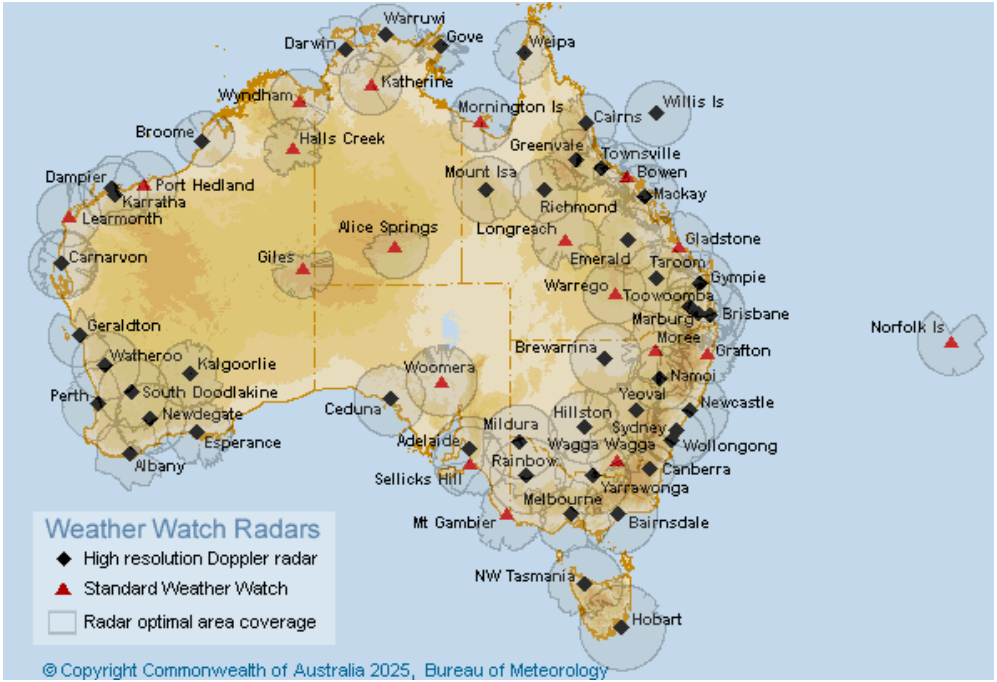


Current solar projects (Global Energy Monitor, 2025)

Hail risk: Brook et al, 2023

Hail monitoring & alerting in Australia

Hail monitoring in Australia: Bureau of Meteorology (BOM)



Under the radar: a technician works beneath the radar's circular dish (left); looking up at Melbourne's Laverton radar (right). (BOM)

Hail alerting services in Australia

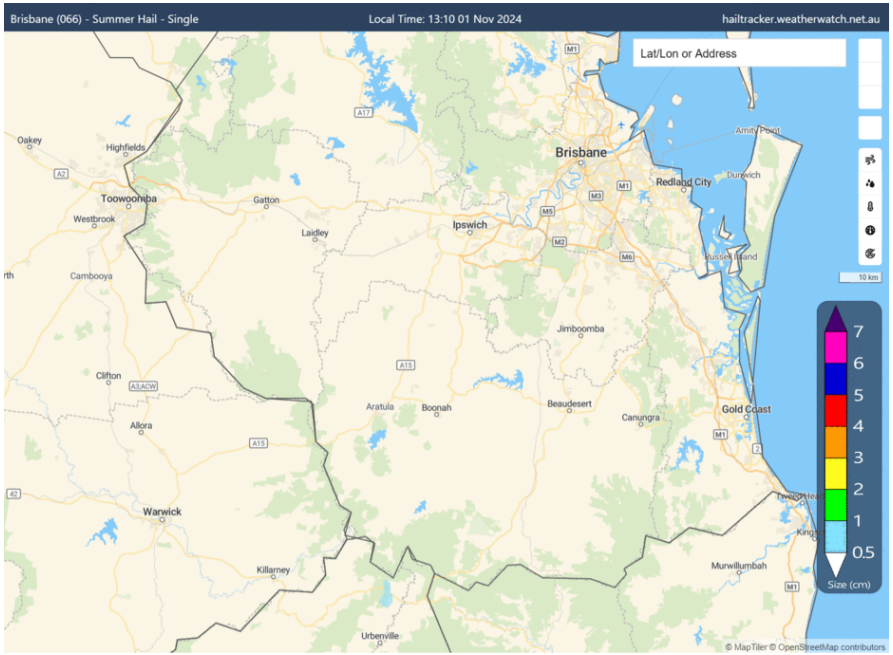
Hail alerting services in Australia

- Weatherwatch HailTracker® / SmartHail™
- Early Warning Network (EWN) SolarAWARE

(Neither service reviewed and verified by VDE)

Best practice

- Use API query, e.g., once per minute, versus email or text alerts to improve reliability.



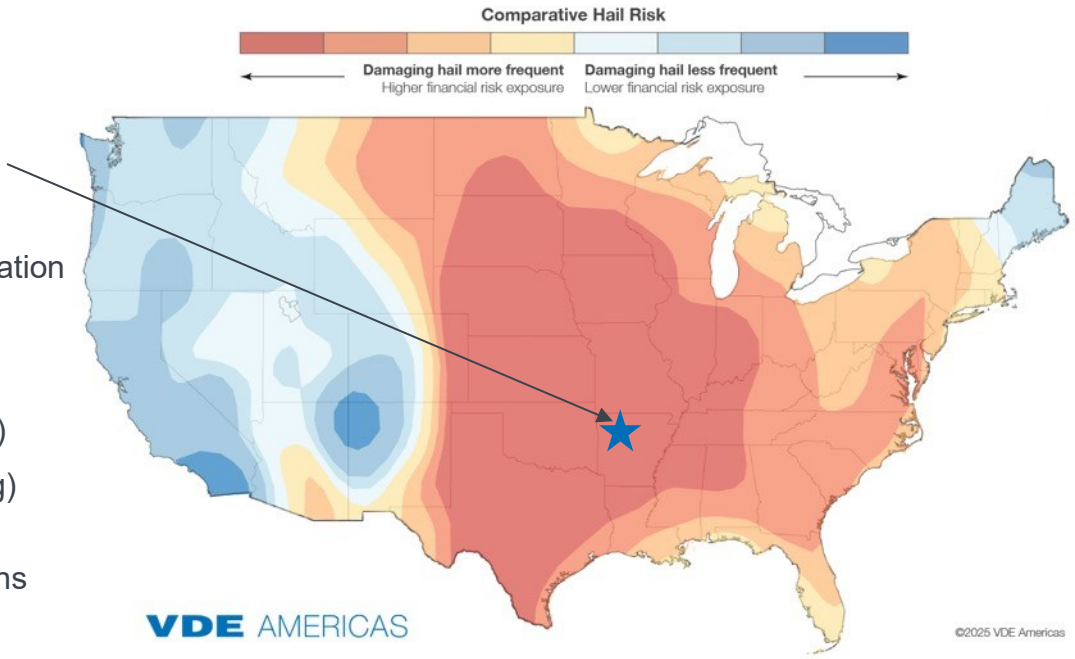
Source: Weatherwatch

GameChange HailStow Performance Validation Study

GameChange HailStow Automated Hail Protection System
Case Study: Real-World Performance Validation

Study Design

- **Parameters**
  - **Location:** Johnson County, Arkansas
  - **Period:** April 2025
  - **Method:** Independent third-party evaluation
- **Data Sources**
  - Monitoring & Alerting Services
    - **DTN:** 18,312 alerts (2,803 triggering)
    - **XWeather:** 776 alerts (296 triggering)
    - **National Weather Service (NWS):** NEXRAD radar + ground observations
  - GameChange Solar: Activation emails, tracker positions, API logs



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GameChange HailStow Automated Hail Protection System
Case Study: Real-World Performance Validation

HailStow System Configuration

- 6-minute response time
- API queries every 2 minutes
- Fully automated operation

Triggering Criteria

- 5-30 miles: Hail ≥0.75" + ≥30% probability
- <5 miles: Hail ≥0.50" + ≥30% probability

Validation Test:

A. Verify DTN and X-Weather hail alerts using NWS hail records

B. Upon triggering, confirm HailStow system automatically:

1. Sends activation notifications
2. Commands trackers to protective west-facing position
3. Maintains protective positioning for one hour after the last qualifying alert

GameChange HailStow Automated Hail Protection System
Case Study: Real-World Performance Validation

Study Results

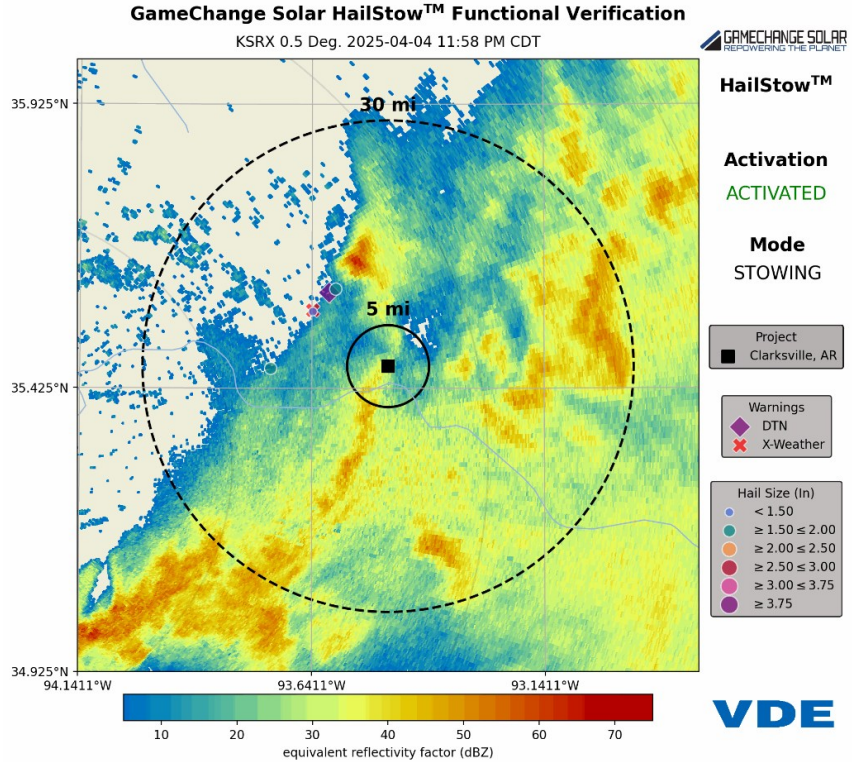
- **Response Metrics**
  - Emails sent same minute as alerts
  - All units met 6-minute spec
  - 100% activation rate
  - 19,000+ alerts processed
- **System Reliability**
  - 100% API uptime
  - Zero manual intervention
  - 24/7 monitoring capability

Event	Date Time	Duration	System Activation	Nearest Hail Observation		
				Before Activation (1)	Awaiting Confirmation (2)	Confirmed HailStow (3)
1	April 2 11:28-17:30	6 hours	Successful	None	None	14.5 mi
2	April 3 07:12-09:30	2.3 hours	Successful	None	None	21.8 mi
3	April 3 13:46-20:00	6.2 hours	Successful	None	14.8 mi	4.4 mi
4	April 4 05:22-09:00	3.6 hours	Successful	14.5 mi	10.4 mi	27.6 mi
5	April 4 15:40-19:30	3.8 hours	Successful	None	None	22.9 mi
6	April 4-5 23:30-06:00	6.5 hours	Successful	None	11.4 mi	15.5 mi

(1) Period before HailStow triggering criteria are met
(2) System activated but status not yet reported (waiting for next polling period)
(3) System status confirms trackers in protective stow position

GameChange HailStow Automated Hail Protection System

Case Study: Real-World Performance Validation



Play Animation

Thank you!

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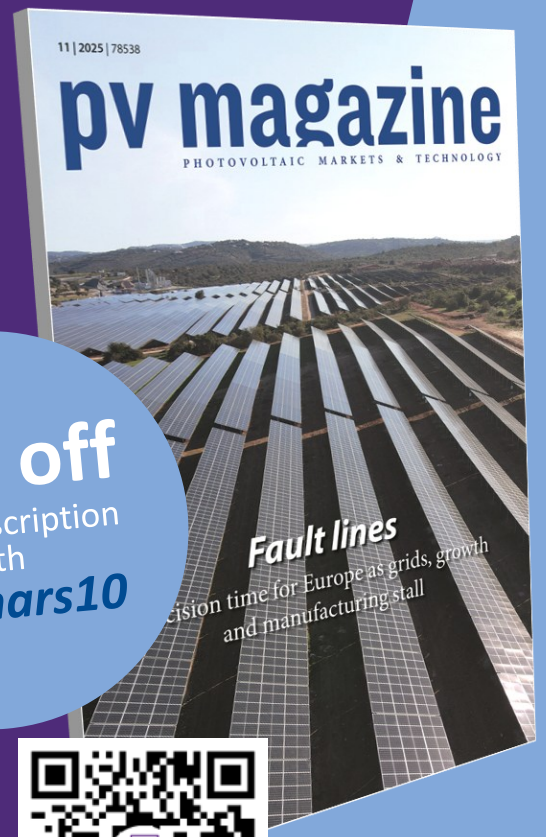

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