

Quality Roundtable at All-Energy Australia 2018



Keys to delivering quality arrays in a booming market

Gold sponsors



October 3, 2018 – Quality Roundtable at All-Energy Australia

pV magazine group

Agenda

Announcement – Solar Panel Validation Initiative

Quality Panel Discussion I – case studies I & II

DG co-MC, Geoff Bragg

Presentation I – Global Field Survey 2018

Break

Presentation II – Australian large scale market update

Presentation III – Battery technology and supplier risk

Quality Panel Discussion II – case study III

Utility scale co-MC, Aaron Zadeh

Final takeaways and networking

Announcement



Michelle Crosbie
Managing Director
Clean Energy Regulator



Australian Government
Clean Energy Regulator

RENEWABLE
ENERGY
TARGET

Clean Energy Regulator

pv magazine Quality Roundtable

Solar Panel Validation

Michelle Crosbie – General Manager

Overview – Solar Panel Validation

- > Introduction/background
- > How it works
- > Industry partners/manufacturers
- > Find out more

Industry Partners

- > FormBay
- > Kickstart Agile
- > Solar Scope

Participating Solar Panel Brands

Canadian Solar

Hanwha Q Cells

Jinko Solar

LG Electronics

Opal Solar

ReneSola

Risen Energy

Trina Solar

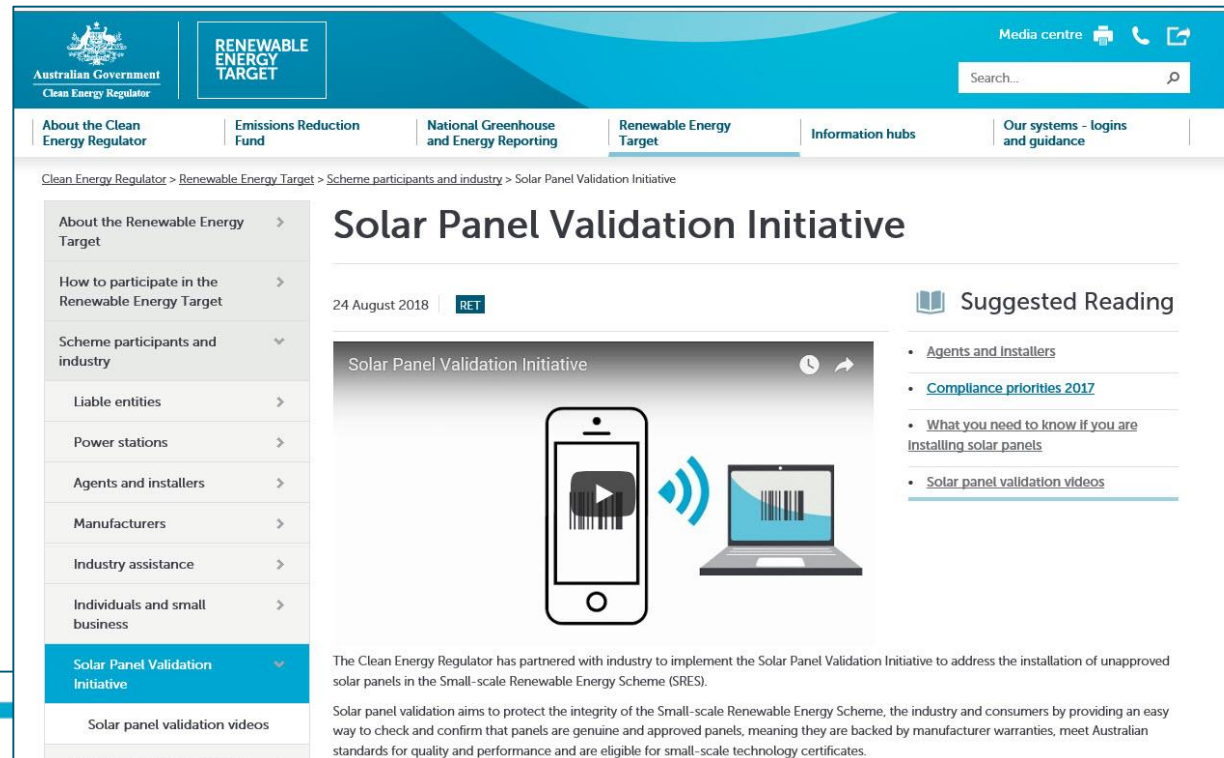
Winaico

Yingli Solar

Website information

> Available at the Clean Energy Regulator website:

<http://www.cleanenergyregulator.gov.au/RET/Scheme-participants-and-industry/Solar-Panel-Validation-initiative>



Contact us



General enquiries or assistance

1300 553 542 – Clean Energy Regulator Contact Centre

General enquiries

enquiries@cleanenergyregulator.gov.au



Referrals of non-compliance

CER-SRES-compliance@cleanenergyregulator.gov.au

Solar Panel Validation Initiative

CER-solarpanelvalidation@cleanenergyregulator.gov.au



Publications

www.cleanenergyregulator.gov.au

Quality Panel Discussion I



Panel I



Durmus Yildiz
Managing Director



Thomas Bywater
Regional Sales Manager



Sebastien Ng
Application Engineer
Fronius



BayWa r.e. Solar Systems Company Overview

PV Magazine Quality Roundtable Discussion, October 3rd, 2018

BayWa r.e. Solar Systems Pty Ltd – Australia



Year Established

September 2016

Head Quarters

Perth, WA
Acquisition of
Solarmatrix WA

Employees

19 and growing

Warehouses

1. Cockburn Central, WA
2. Loganholme, QLD
3. Wingfield, SA (3PL)
4. Chester Hill, NSW (3PL)
5. Campbellfield, VIC (3PL)

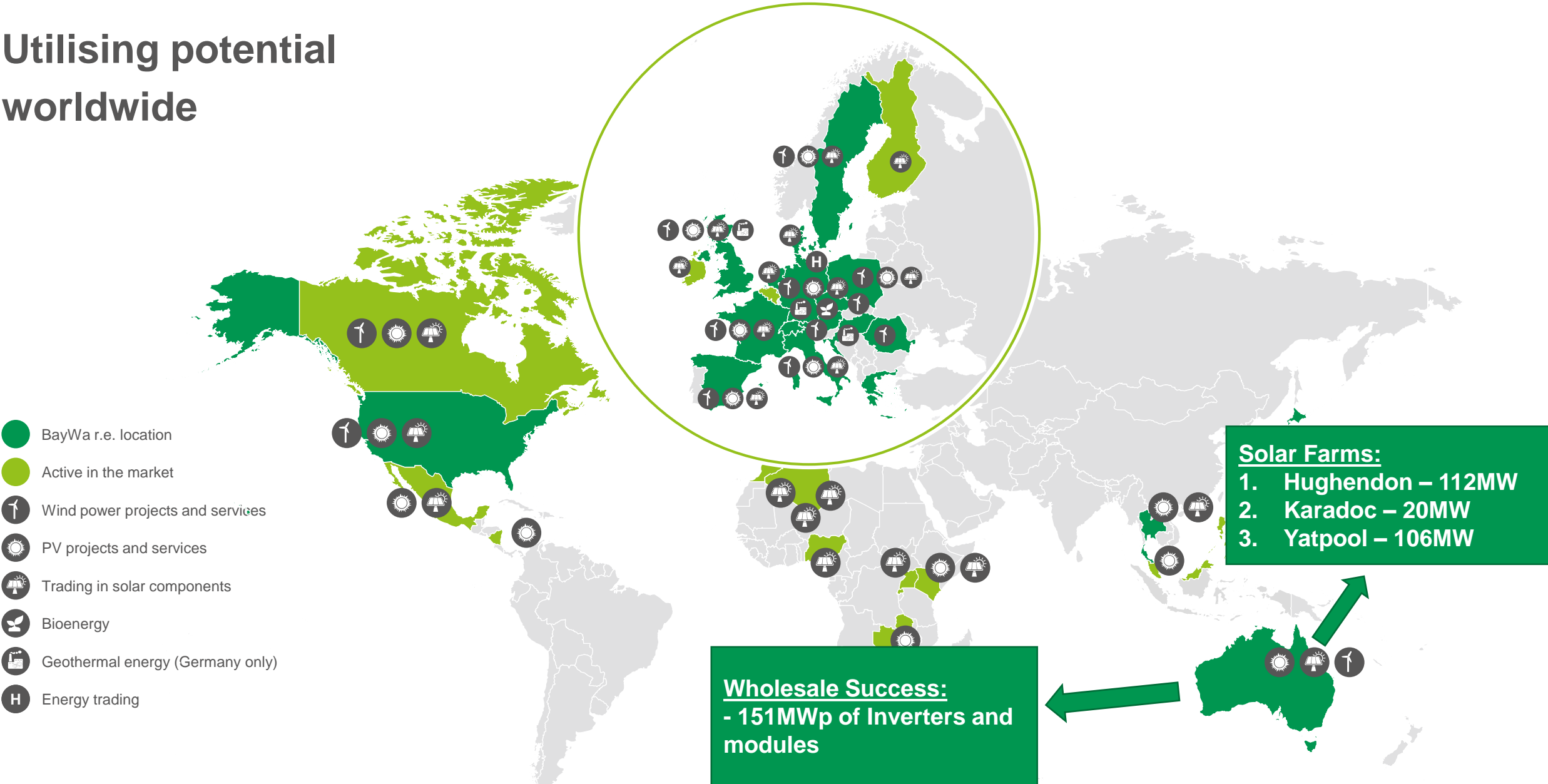
Experience

98 years
Total years of
combined experience

Mission

To support you in
converting Australia's sun
into energy

Utilising potential worldwide



Modules

Inverters

ML.
Electronics

Storage



RACKING

BOS

ENGINEERING

What Quality Means To Us

Product Quality



r.e.think energy

Our high-quality supplier portfolio



SUNGROW



JA SOLAR



Installation Quality



Thank You

BayWa r.e. Solar Systems Pty Ltd

Durmus Yildiz: Managing Director of BayWa r.e. Solar Systems

Head Office: 17A Blackly Row, Cockburn Central, Western Australia 6164

Phone: (08) 9417 1900

Email: Durmus.Yildiz@baywa-re.com

Website: <http://solar-distribution.baywa-re.com.au/en/>

Stand: #3228



/ Perfect Welding / Solar Energy / Perfect Charging



- Sebastien Ng - Application Engineer
- Fronius Australia Pty Ltd

All Energy Australia 2018

COMPANY HISTORY & PRESENT

The beginning

- / Gunter Fronius founded Fronius in Austria in 1945

Still privately owned

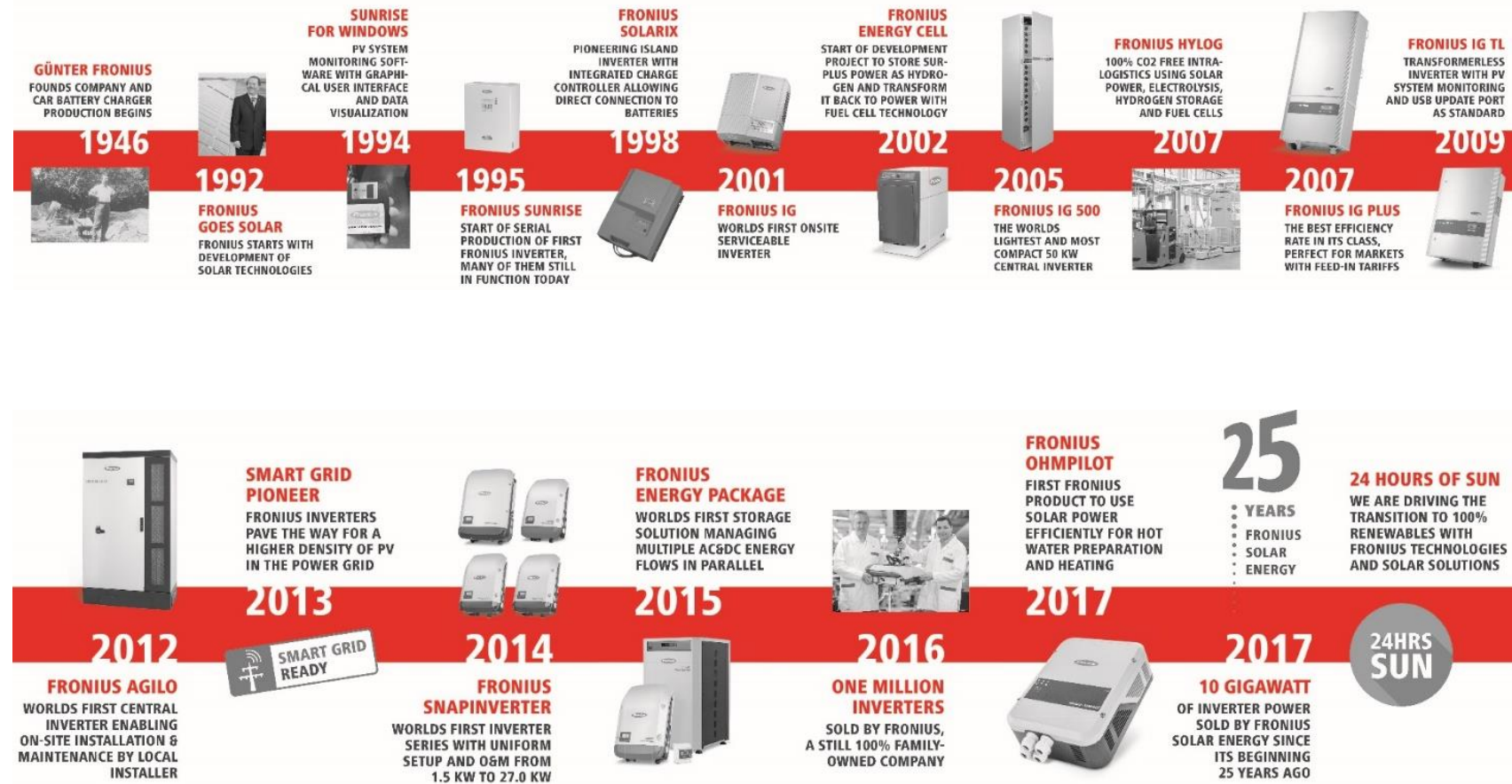
- / Family owned
 - / CEO: Elisabeth Strauss
- / Independent company
- / Experience and passion
 - / 76 years in power conversion technology



HIGHEST QUALITY STILL MADE IN AUSTRIA



26 YEARS IN SOLAR!



LOCAL SUPPORT

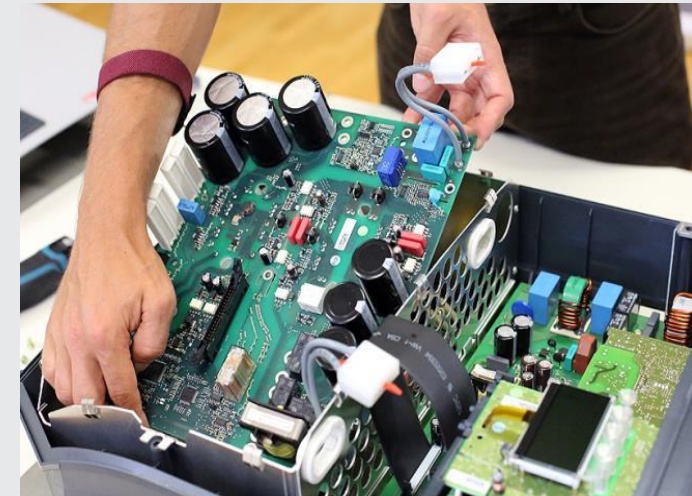
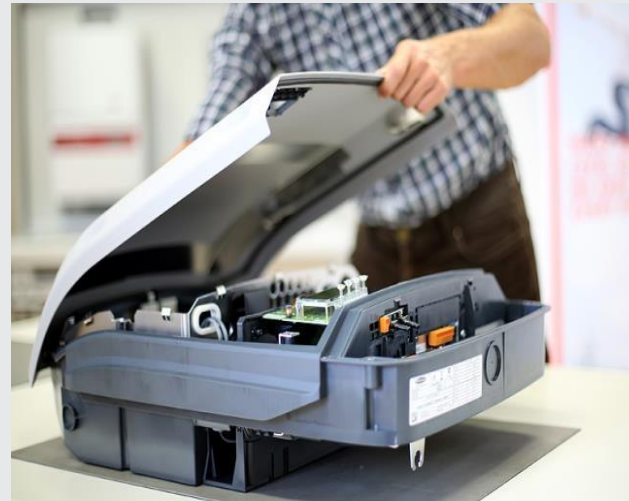
Fronius Australia

- / Head office based in Melbourne
- / Local technical support, service and training
- / Local warehouse
- / Local repair centre
- / Expanded resources and team!



INVERTER AND BOARDS EXCHANGE

- / Inverter can be swapped faster
- / Since 2000 all inverter are designed to be serviceable on site
- / ECO has 3 boards (Filter board, Display board and AC board)
- / Symo has 4 boards(Filter board, Display board, DC and AC board)



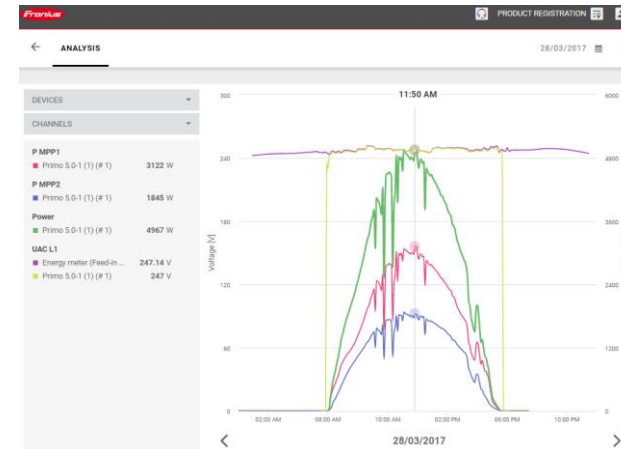
FRONIUS PROACTIVE SERVICE

/ Energy suppliers of the future

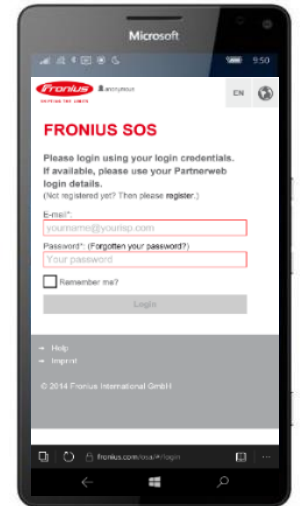


FRONIUS SNAPINVERTER QUICK INSTALLATION GUIDE

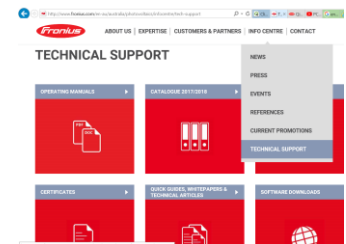
Online Installation & Commissioning Guide



Fronius Solar.web

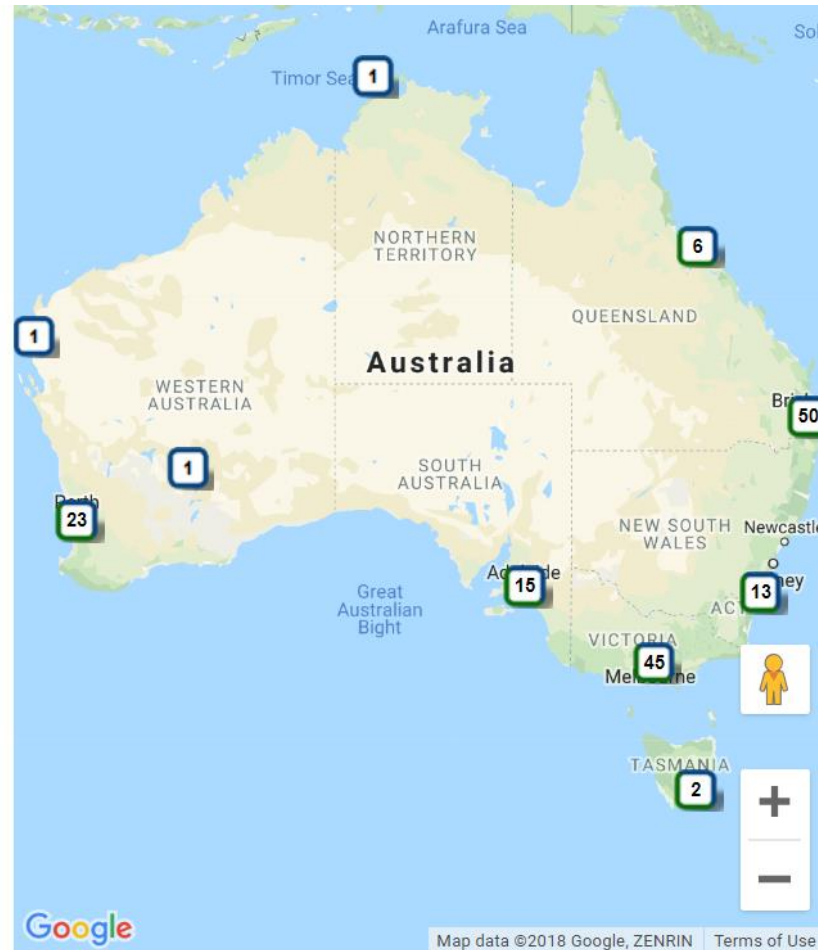


SOS: Solar Online Support



Fronius Australia Technical Support website

FRONIUS SERVICE PARTNERS SEARCH TOOL



Move the map with the mouse or zoom in and out. Click on the contact icon in the selected area and then click on a company name in the speech bubble that appears.

You can search your **location** or enter your **ZIP code** in the search fields above the map to display selected Fronius service partners in your area.

 Fronius Service Partner  Fronius Service Partner Plus

LIFECYCLE SUPPORT INTERNATIONAL (LSI)

What is Lifecycle Support International?

/ is the technical product responsible during the whole Lifecycle of a product from the R&D

/Goals in Lifecycle Support

/ decrease the failure rate by analyzing and addressing the top 3 field failures

/ Installation of Quality tests

/ Reliability calculations of new products

/ best 1st level Support on products

/ Main tasks

/ Analysis and Improvements of Inverters & Components

/ Operational experience feedback to developers

/ 1st Contact in R&D for interface partner

/ arrangement, documentation of test series

/ Coordination in R&D if the issue can not be resolved by Lifecycle Support

24H SUN – A SHARED VISION FOR A 100% RENEWABLE ENERGY SUPPLY



/ Perfect Welding / Solar Energy / Perfect Charging



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Case study I

Residential installation



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Residential installation



- Array 1
September 2009
West-facing roof
Array: 7 x 165 W modules with a 1,500W outdoor Inverter (1.5 kW)
Cost: \$15,400 minus \$8,000 rebate
- Array 2
June 2014
North-facing roof
Array: 8 x 305 W modules with microInverters (2.44 W)
Cost: \$5,000 including rebate

Residential installation

“On a really good day the panels generated up to 8 kWh and based on average readings over a year would have paid for themselves in about 20 years.”



“It yields up to 16 kWh on a good day. This system we are very happy with, and no complaints.”



Residential installation

Outcome

“Since installing the second system, we have been putting power back into the grid most days, so if the original system was still working most of the power would be going back into the grid at \$7.135 cents/kWh, which would have resulted in an additional feed-in rebate on a good day of \$57 cents, making it totally uneconomic to replace the inverter.”



Twist in the tail

Subject: VERY IMPORTANT MESSAGE REGARDING - LG ENERGY SOLUTIONS

Dear Customers

It is with great regret that I have to inform you that the company that I work for LG Energy Solutions Pty Ltd - is nothing but a fraud.

If you all knew how sick to my stomach I feel right now while I'm typing this, as I feel like I have mislead all of you and that was never my intention.

I too have been taken for a ride by these people, as I in good faith excepted a job with them after applying through seek.com.au

As they are not answering any of my emails or phone calls anymore and since late Friday night our website is also apparently offline,

I have now reported them to the following people.

Crime Stoppers

ACCC

Clean Energy Council

Office of Fair Trading QLD

A Current Affair

Australian Solar Quotes

Seek.com.au

LG Solar - (the proper one) - and I am expecting a call from their lawyers.

I am also intending in contacting both my local Criminal Investigation Unit and also the one in Brisbane today.

I would urge all of you that have handed over money, to please contact your banks urgently and get them to trace the money.

Also if any of you have received any other invoices from LG Energy Solutions - besides your original one please send them to me as I'm collating evidence.



Outcome

- 6 years of operation = 12,381 kWh
- Retail electricity price = 26.474/kWh
- Lifetime savings = \$3.278 (100% self consumption)

“Not a very good return on an investment of \$7,400 which now has no value.”

“I would like to expand my system and include battery storage, but with so many offers being advertised at such a wide variance in prices and probably quality, after my experience with Modern Solar, I can’t trust anyone.”

Residential installation

Power Consumption									Net Power									
	Meter	Credit	Total Mod Inverter	XXXX Inverter	XXXX Inverter	Net Meter	Daily into Grid	Net Consumption	Per Tracker	Total Consumption		5PM Reading	Net Power Purchaed 8am-5pm	Net Power Purchaed 5PM-8AM	Cost Power Used	Export	Net Cost	Savings
26.09.10	7555	92	2046															
27.09.10	7567	93	2053	6			1	12		17								
28.09.10	7580	94	2059	7			1	13		19								
29.09.10	7594	95	2066	5			1	14		18								
30.09.10	7609	95	2071	2			0	15		17								
01.10.10	7623	95	2073	7			0	14		21								
02.10.10	7636	96	2080	5			1	13		17								
03.10.10	7646	96	2085	7			0	10		17								
04.10.10	7656	97	2092	6			1	10		15								
05.10.10	7669	97	2098	7			0	13		20								
06.10.10	7683	98	2105	7			1	14		20								
07.10.10	7694	99	2112	7			1	11		17								
08.10.10	7708	100	2119	6			1	14		19								
09.10.10	7723	101	2125	6			1	15		20								
10.10.10	7732	102	2131	5			1	9		13								
11.10.10	7742	102	2136	7			0	10		17								
12.10.10	7753	103	2143	7			1	11		17								
13.10.10	7764	104	2150	8			1	11		18								
14.10.10	7775	104	2158	7			0	11		18								
15.10.10	7786	106	2165	7			2	11		16								
16.10.10	7795	107	2172	6			1	9		14								
17.10.10	7808	108	2178	7			1	13		19								
08.08.18	36367	14201			5,1	5	4,0	9	6,5	10	36368	1	8	\$ 2,38	\$0,29	\$2,10	\$ 0,89	
09.08.18	36376	14203			7,2	7	2,0	9	7,5	14	36379	3	7	\$ 2,38	\$0,14	\$2,24	\$ 0,45	
10.08.18	36386	14206			10,9	7	3,0	10	3,8	18	36388	2	7	\$ 2,65	\$0,21	\$2,43	\$ 0,67	
11.08.18	36395	14211			11,2	4	5,0	9	5,5	15	36399	4	7	\$ 2,38	\$0,36	\$2,03	\$ 1,12	
12.08.18	36406	14216			11,4	6	5,0	11	2,0	17	36407	1	7	\$ 2,91	\$0,36	\$2,56	\$ 1,12	
13.08.18	36414	14222			11,3	2	6,0	8	2,8	13	36415	1	7	\$ 2,12	\$0,43	\$1,69	\$ 1,34	
14.08.18	36422	14227			8,1	3	5,0	8	5,3	11	36425	3	7	\$ 2,12	\$0,36	\$1,76	\$ 1,12	
15.08.18	36432	14231			9,7	6	4,0	10	3,8	16	36432	0	8	\$ 2,65	\$0,29	\$2,36	\$ 0,89	
16.08.18	36440	14235			7,4	4	4,0	8	6,1	11	36442	2	7	\$ 2,12	\$0,29	\$1,83	\$ 0,89	
17.08.18	36449	14238			10	6	3,0	9	5,6	16	36451	2	9	\$ 2,38	\$0,21	\$2,17	\$ 0,67	
18.08.18	36460	14243			12,6	6	5,0	11	4,0	19	36461	1	8	\$ 2,91	\$0,36	\$2,56	\$ 1,12	
19.08.18	36469	14249			11,9	3	6,0	9	2,2	15	36471	2	7	\$ 2,38	\$0,43	\$1,95	\$ 1,34	
20.08.18	36478	14254			7,7	4	5,0	9	7,0	12	36480	2	8	\$ 2,38	\$0,36	\$2,03	\$ 1,12	
21.08.18	36488	14257			5,5	7	3,0	10	9,1	13	36491	3	8	\$ 2,65	\$0,21	\$2,43	\$ 0,67	
22.08.18	36499	14259			10,4	9	2,0	11	4,2	19	36500	1	8	\$ 2,91	\$0,14	\$2,77	\$ 0,45	
23.08.18	36508	14264			13,2	4	5,0	9	0,7	17	36510	2	6	\$ 2,38	\$0,36	\$2,03	\$ 1,12	
24.08.18	36516	14272			13,6	0	8,0	8	-0,3	14	36520	4	5	\$ 2,12	\$0,57	\$1,55	\$ 1,79	
25.08.18	36525	14280			13,4	1	8,0	9	0,9	14	36526	1	6	\$ 2,38	\$0,57	\$1,81	\$ 1,79	
26.08.18	36532	14287			13,2	0	7,0	7	4,0	13	36536	4	7	\$ 1,85	\$0,50	\$1,35	\$ 1,57	
27.08.18	36543	14293				5	6,0	11			36544	1						



Panel I



Durmus Yildiz
Managing Director



Thomas Bywater
Regional Sales Manager



Sebastien Ng
Application Engineer
Fronius



Distributed Generation co-MC



Geoff Bragg
NSW Chairman, Solar Energy Industries Association (SEIA)
Director, Smart Energy Council

Case Study: Commercial PV

- 540 x 300Wp roof mounted modules (162kWp)
- 5 x 30kW Inverters
- LGC creation meter
- Central Protection Relay

Geoff Bragg

Director – Smart Energy Council

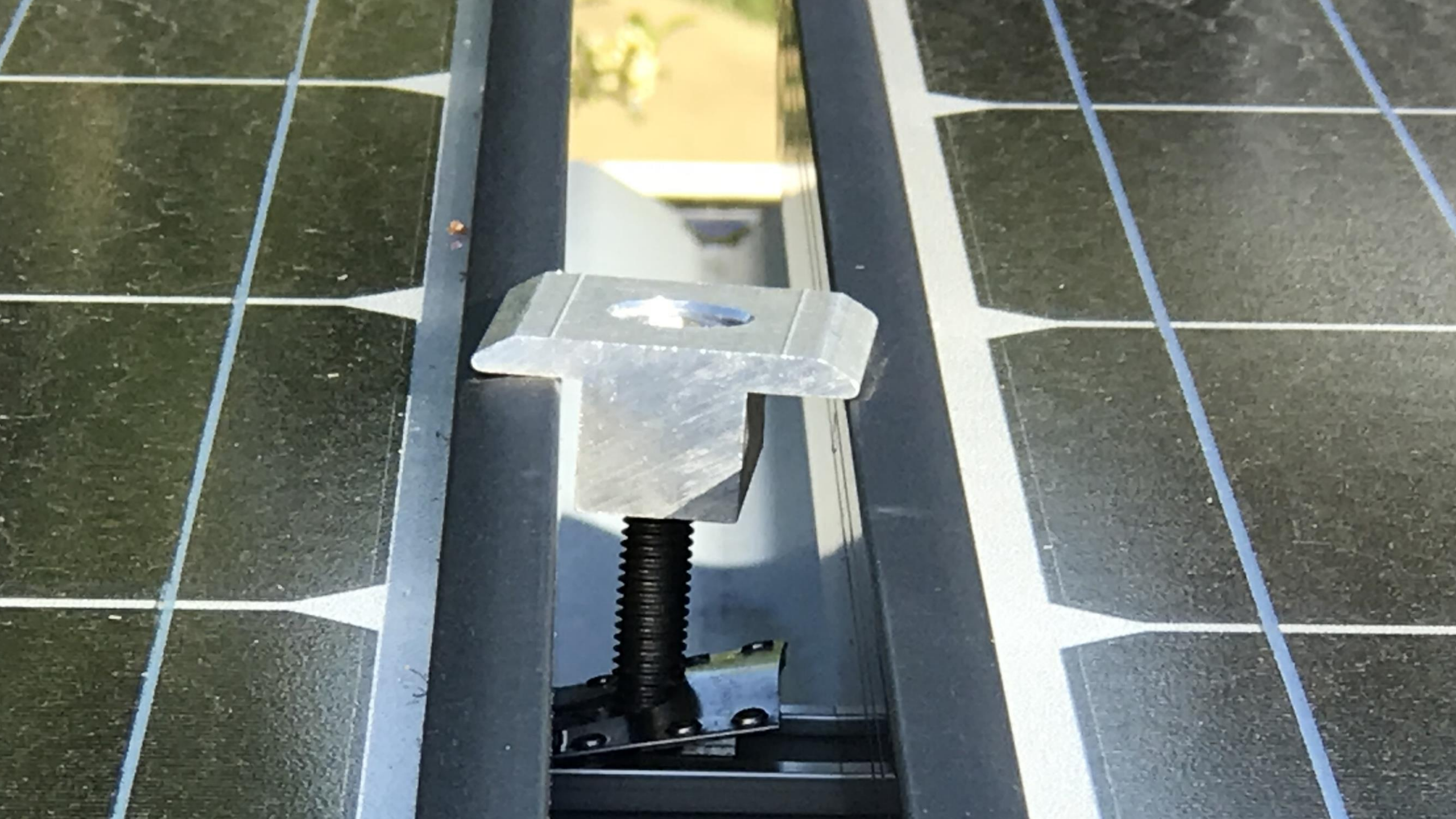
Chairman – NSW SEIA



It's hot up here...







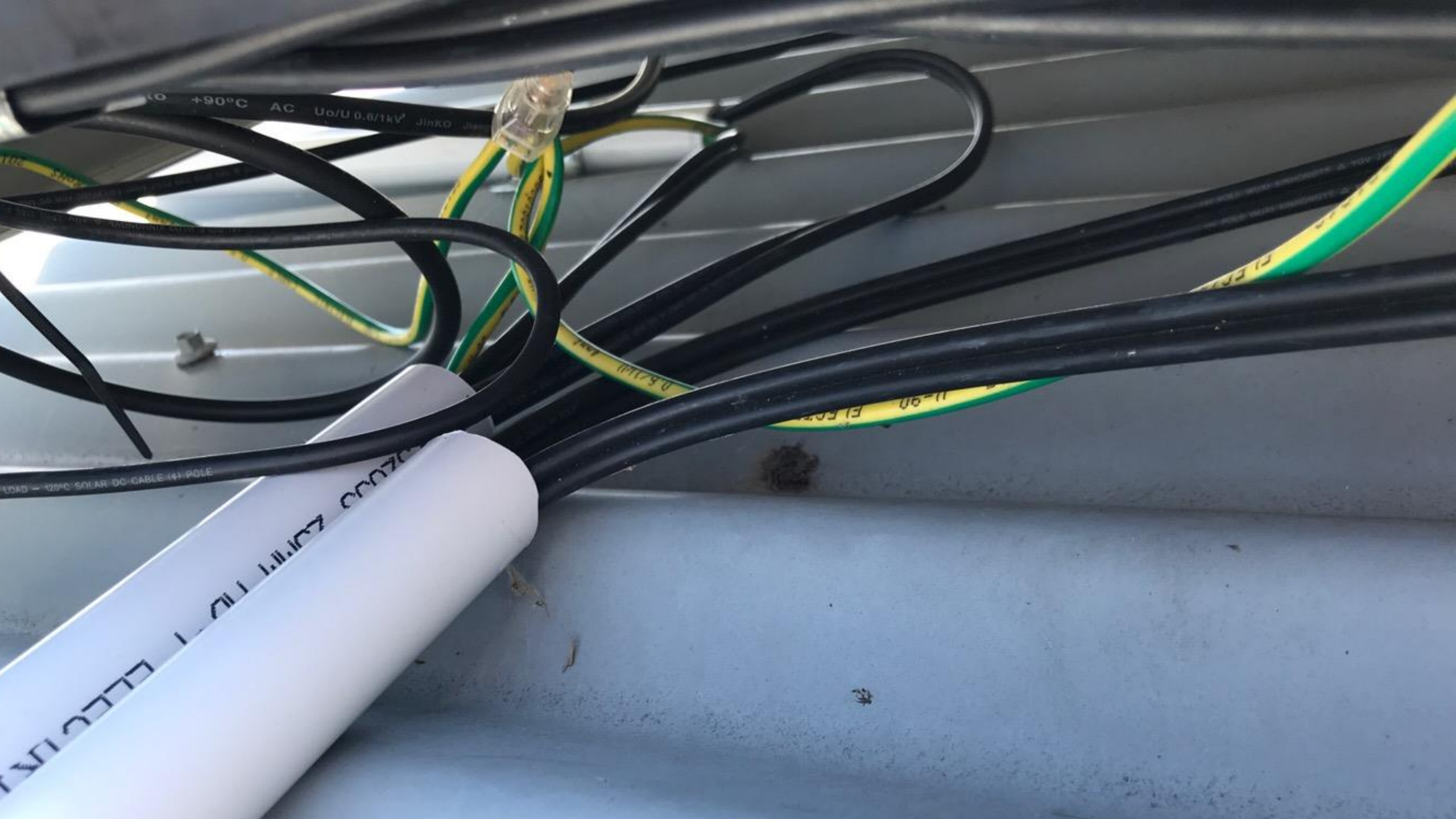


Module Installation Manual:
Mount between 280mm &
400mm from the end









UDK5 - 125°C SOLAR DC CABLE (4) POLE

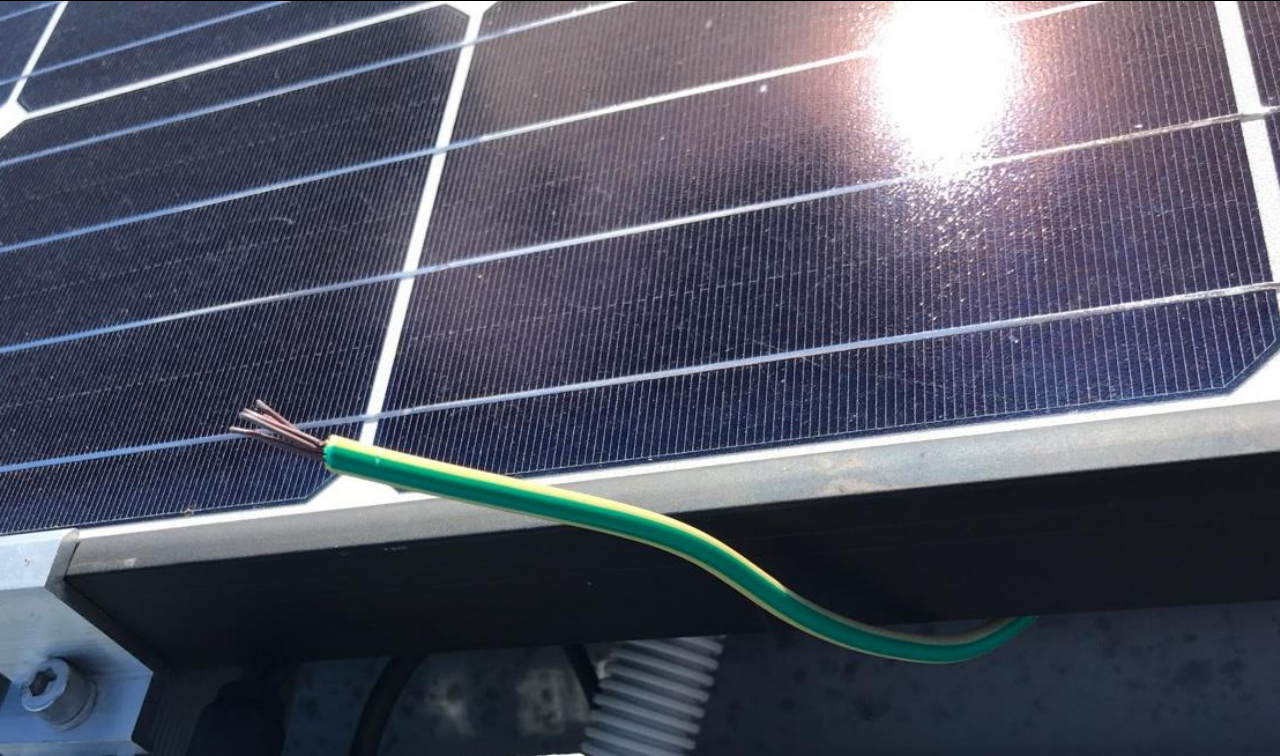
UDK5 - 125°C SOLAR DC CABLE (4) POLE

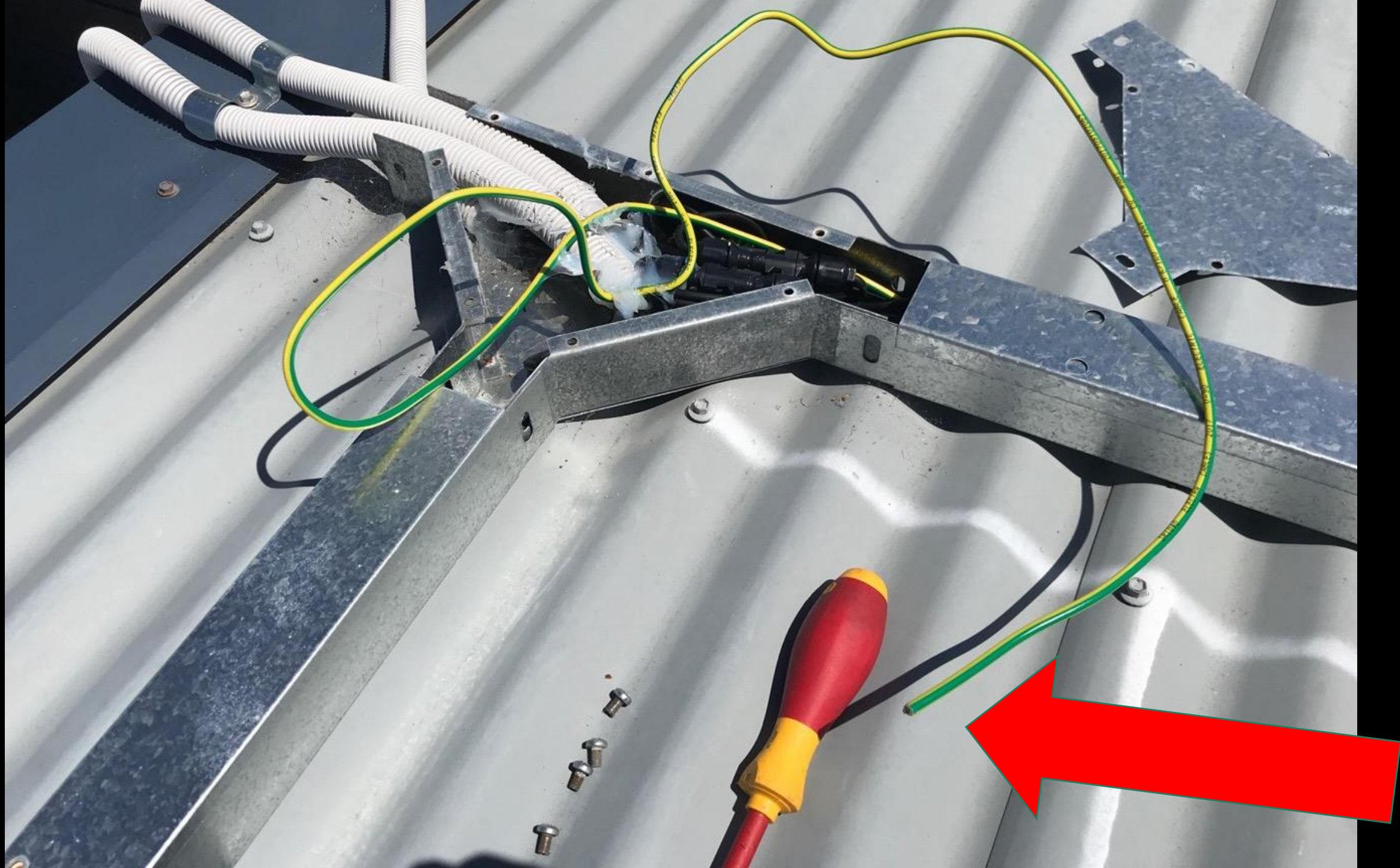
UDK5 - 125°C SOLAR DC CABLE (4) POLE



UDK5 - 125°C SOLAR DC CABLE (4) POLE







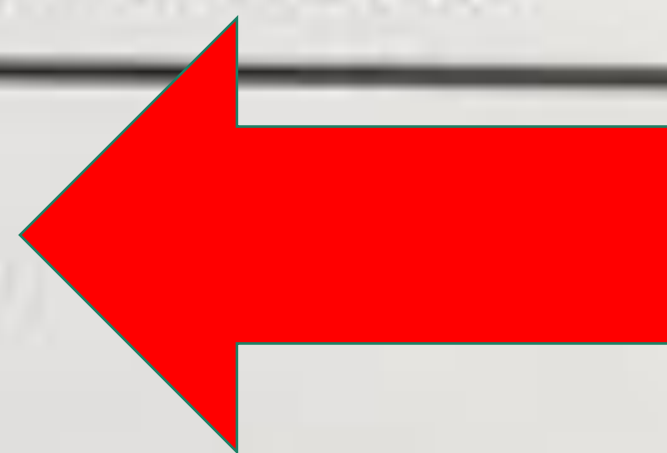


1111 P01 E 1111 DC LOAD 1000V

PV1-F 4mm² 1.0/1.8KVDC FOR DC USE

PV1-F 4mm² 1.0/1.8KVDC FOR DC USE

SOLAR INVERTER



d.c. Max. Input Voltage: 1000 Vd.c.

d.c. Input Current: 23 A/23 A/23 A

Isc: 34.5 A/34.5 A/34.5 A

d.c. MPP Range: 250 - 850 Vd.c.

Output Nominal Voltage: 400/380 Va.c.; 3 N ~ +

Nominal Operating Frequency: 50/60 Hz

a.c. Output Rated Power: 30 kVA

a.c. Output Max. Power: 33 kVA

Voc max on site:

- Longest strings: 24 modules
- Module Voc @ STC: 40.1
- Voc @ STC = 962.4 V
- Lowest temperature at nearest BOM weather station : -3.0 deg C.
- Difference from STC: $25 - -3.0 = 28$ degrees
- Module Voc temp coefficient is 0.29%/deg C
- $28 \times 0.29\% = 8.12\%$ increase in Voltage.
- Voc max = $962.4 \times 1.0812 = 1040.55 \text{ V DC}$



CONTROL

VOLTAGE
SENSING

PROTECTION RELAY



LGC METER







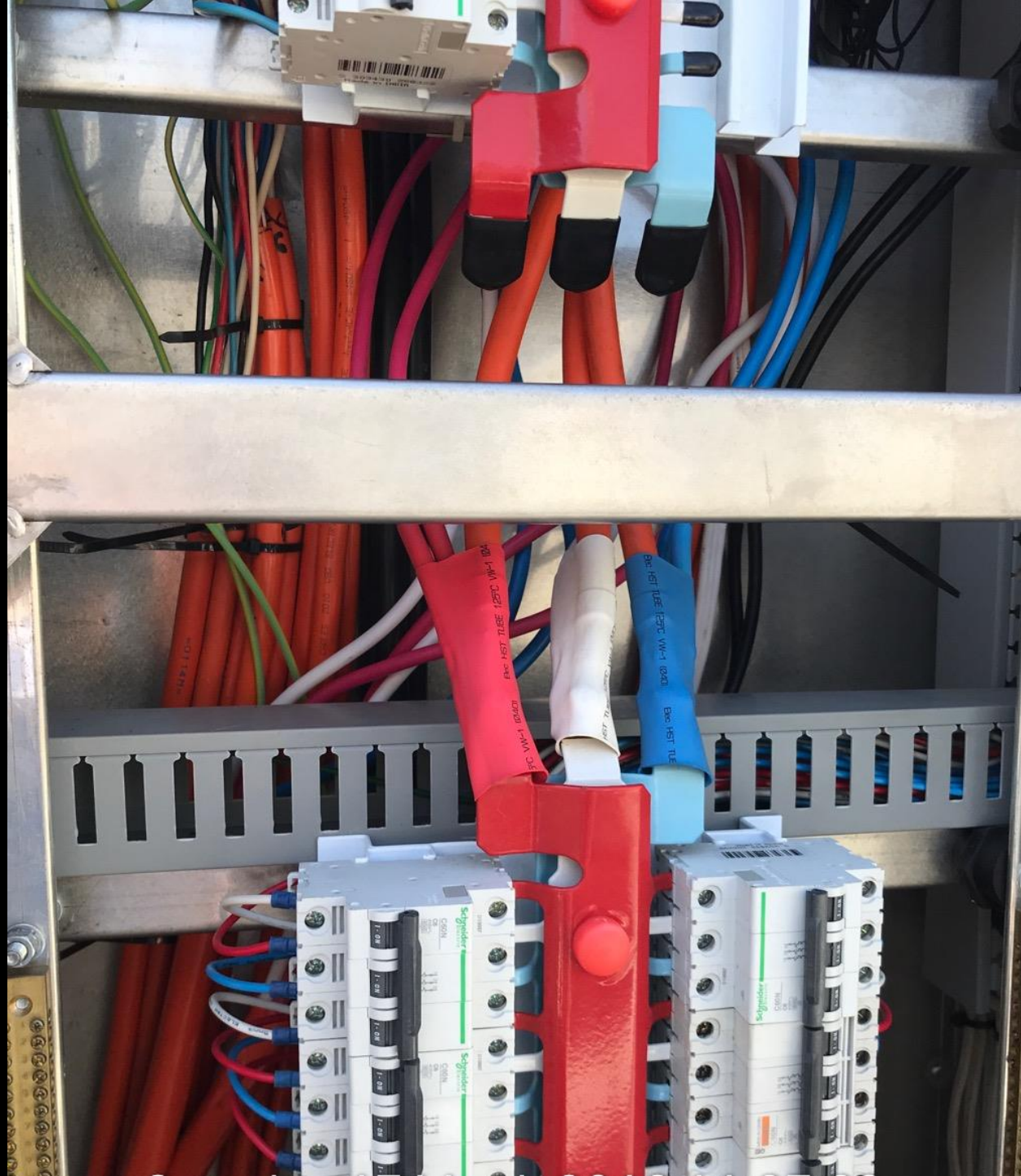
Pinched - Ouch !



Current Carrying Capacity: AS/NZS 3008

- **Total Inverter AC output (max): $5 \times 48\text{A} = 240\text{ Amps}$**
- **Solar Submain Cables:**
 - 2 paralleled 25mm² Cu XLPE orange circular
 - Sharing cable tray with air conditioning supply cables
 - In covered cable tray in the sun
 - Partially surrounded by insulation near roofing
- **Current Carrying Capacity after derating: 124.6 Amps**

No Circuit
Breaker =
No cable
protection



Thank You

Geoff Bragg
Director – Smart Energy Council
Chairman – NSW SEIA





Panel I



Durmus Yildiz
Managing Director



Thomas Bywater
Regional Sales Manager



Ryan Desharnais
Head of Engineering – Labs



Sebastien Ng
Application Engineer
Fronius

Presentation I



Oakland Fu
Technical Manager
DuPont Photovoltaic Solutions

Oct. 2018

DuPont PV Field Study

Oakland Fu

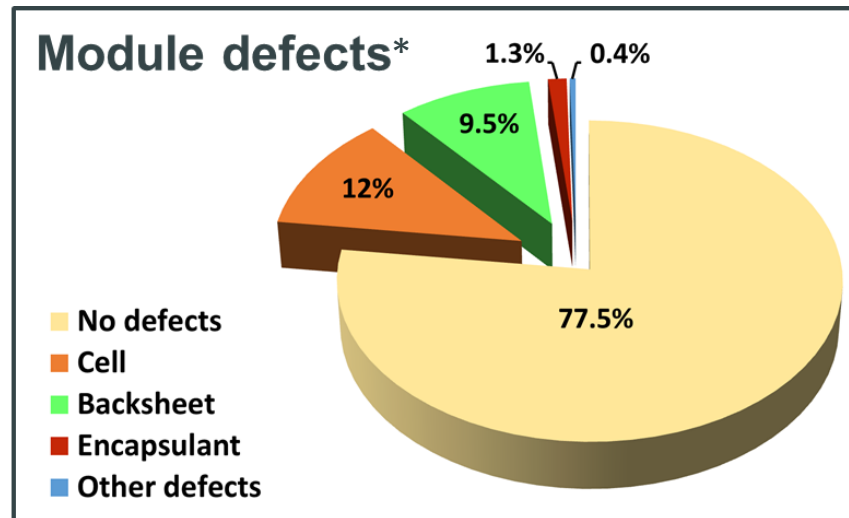
DuPont Photovoltaic Solutions



2018 DuPont global field data analysis summary

Highlights	2018
North America, Europe, Middle East, Asia/Pacific	
Installations	275
# of panels	4,234,324
# of module makers	92
Average age (years)	3.3
GW	1.047

- Over 1 GW of fields inspected
- Total module defects 22.3%; backsheet defects 9.5%
- Backsheet defects increased by 27%
- Polymer defects: hot > tropical > temperate
- Work highlighted and cited in 2018 DNVGL PV Module Reliability Scorecard



Defect types

Cell/interconnect: corrosion, hot spot, snail trails, broken interconnect, cracks, burn marks

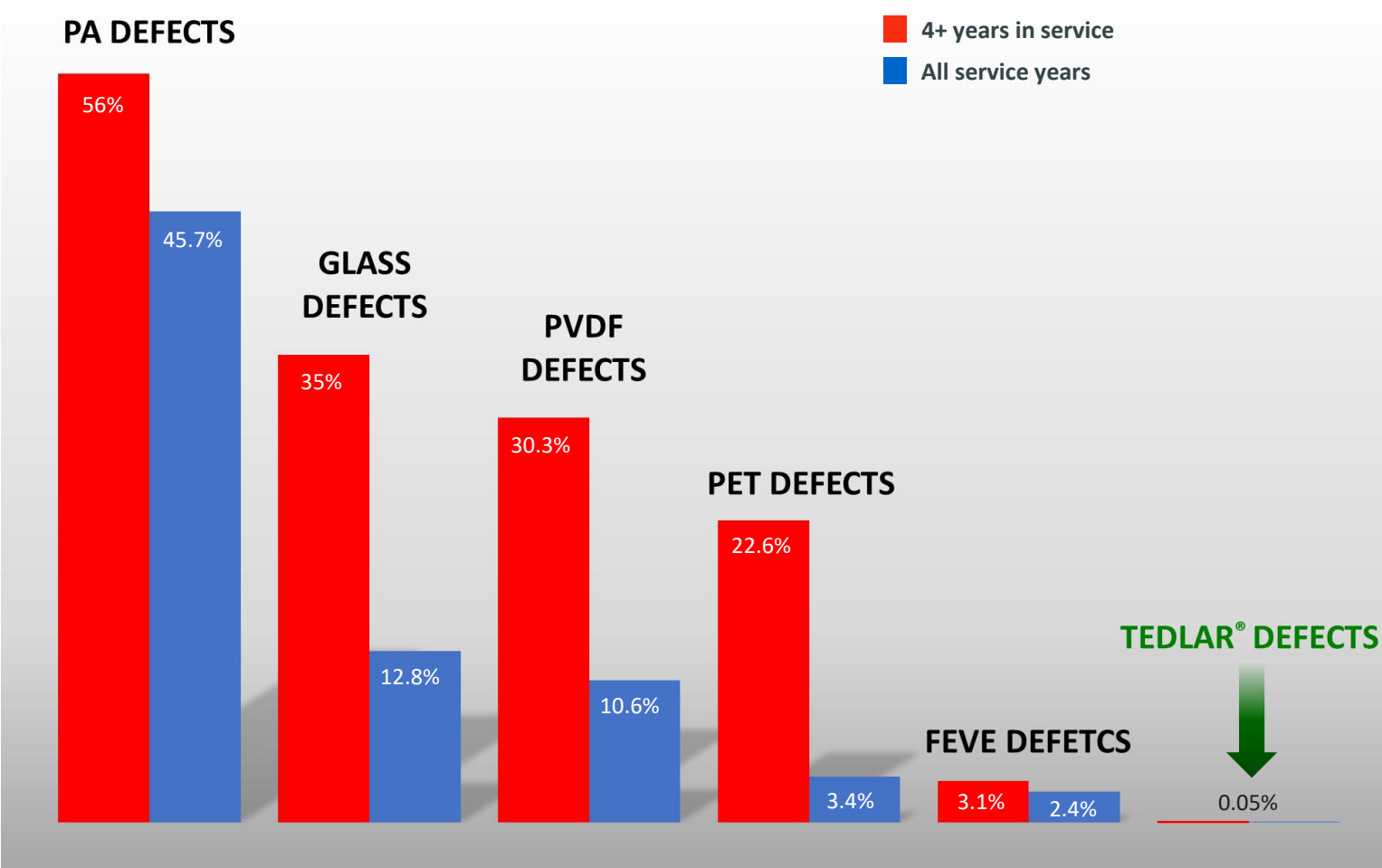
Backsheet: cracking, delamination, yellowing, inner layer crack

Encapsulant: discoloration, browning, delamination

Others: glass defects, loss of AR coating, junction box

* Actual module defects can be higher due to defects not picked up by inspection protocol (eg. cell cracking evidenced by EL, PID)

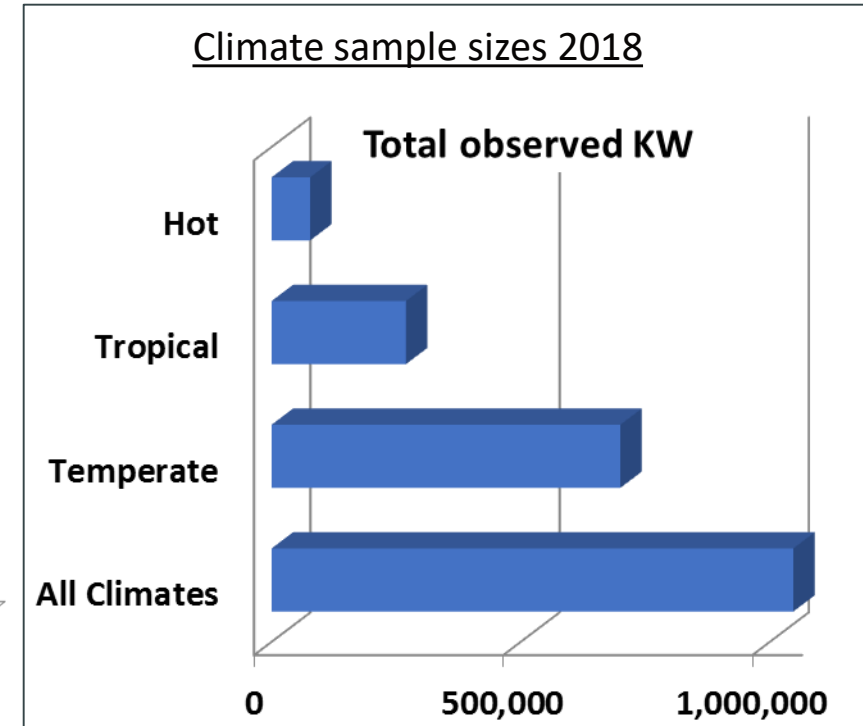
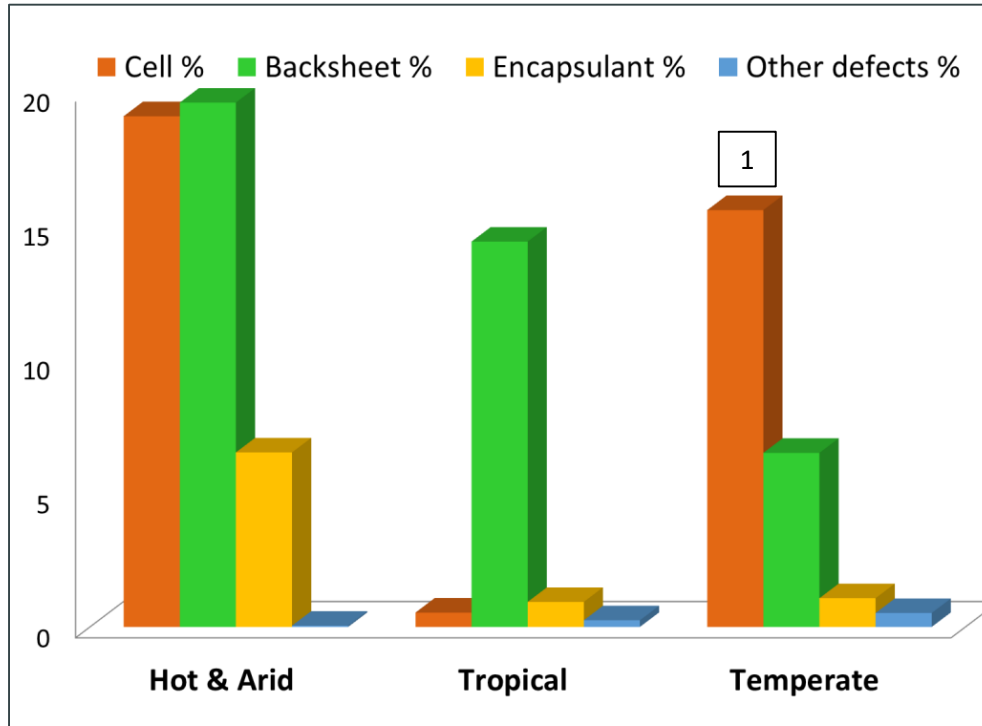
Defect rates of backsheets increase with service time in field



PA = Polyamide
PVDF = Polyvinylidene Difluoride
PET = Polyethylene Terephthalate
FEVE – Fluoroethylene Vinylether

* Data includes installations with minimum of 4 years of service life

Effect of climate on module components

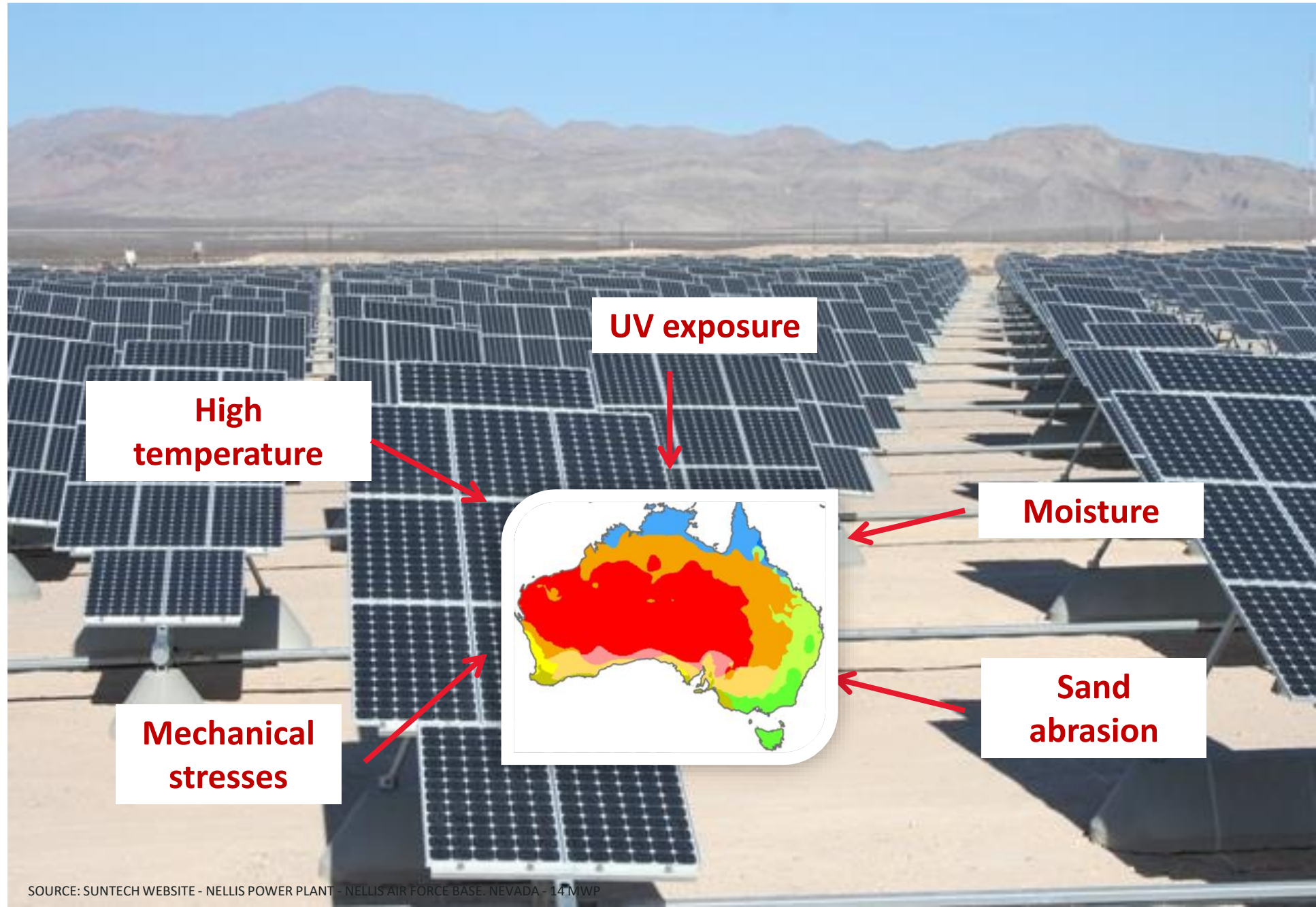


Cell and metallization show less or small effect with climate
Polymer components (backsheet and EVA) show stronger trend

- Hot arid > Tropical > Temperate
- Use Defect Rates to determine “harshness” of climates?
- Dominant factors are likely Temperature and UV

¹ Temperate cell defects are dominated by Snail Trails, likely due to sampling

Photovoltaic systems are impacted by climates



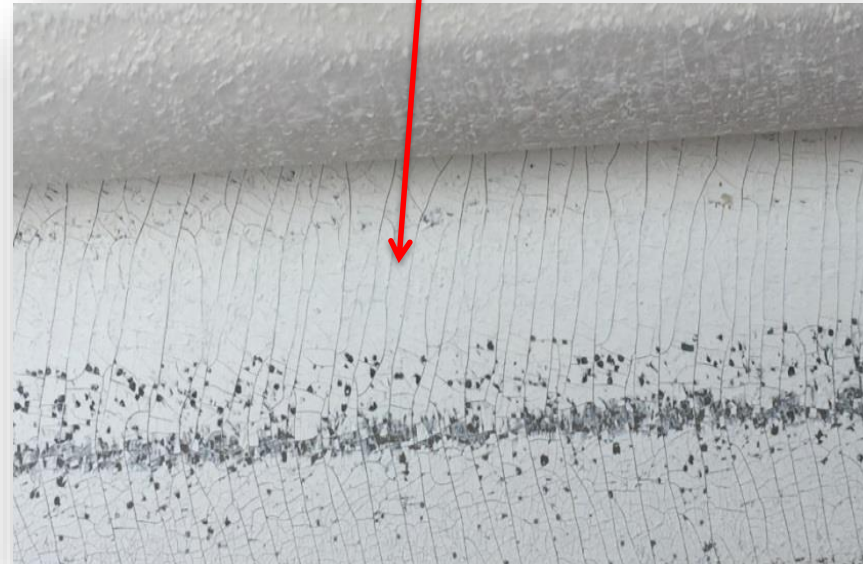
Inner layer cracking of PET backsheet

- Initial year of operation 2012
 - Service Time 6 years
 - Location North America
 - Mounting configuration Ground mount
 - Date of inspection 2018
 - Backsheet: PET
 - Technology poly-Si
 - Plant size 35+ MW
 - Climatic conditions Arid
- Backsheet inner layer cracked all over module in spaces between cells and around edges, this has been associated with ground faults and inverter tripping
 - 30% power loss in 5 years in hot and dry climate, average 6% loss per year in a 35+ MW field
 - Similar defects showing up in India and Australia



Inner layer cracking of PET backsheet

- Initial year of operation 2012
- Service Time 5 years
- Location Australia
- Mounting configuration Rooftop
- Date of inspection 2017
- Backsheet: PET
- Technology poly-Si
- Climatic conditions Arid

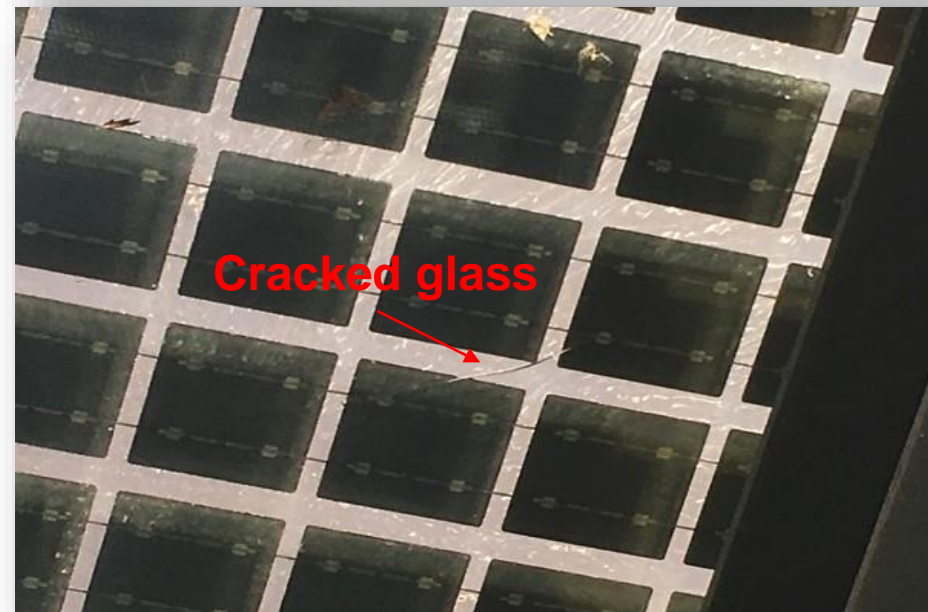


Significant discoloration and cracking of Glass-Glass modules

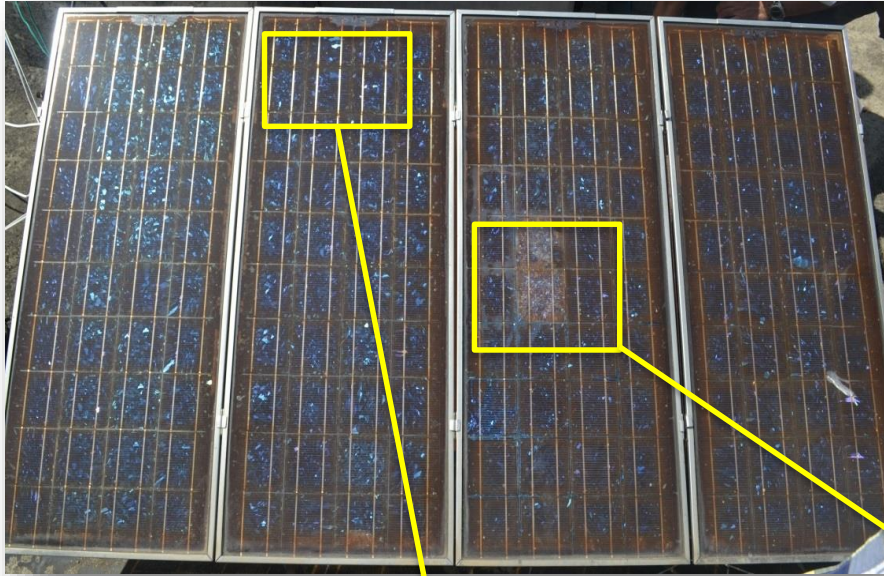
- Initial year of operation 2003
- Service Time 10 years
- Location ASU/Phoenix, Arizona
- # of modules 12
- System size 4.2 kW
- Date of inspection 2017
- Backsheet: Glass
- Encapsulant EVA
- Technology Poly- Si
- Climatic conditions Hot Dry Arid

Visual Observations:

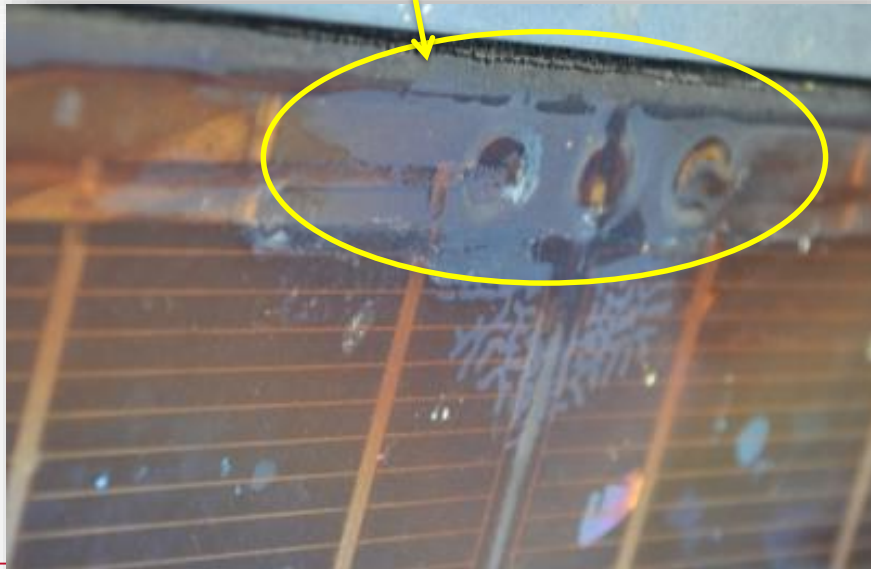
- Severe front-side browning and discoloration
- Severe and widespread delamination on the rear-side,
- Some cracking of the rear-glass



Significant corrosion and power loss of Glass-Glass modules



- Initial year of operation 1996
- Service Time 15 years
- Location Hainan, China
- # of modules 4*30
- Mounting configuration Rooftop, open rack
- Date of inspection 2015
- Backsheet: Glass
- Technology Poly-Si
- Climatic conditions Tropical



Cracking of frameless Glass-Glass modules

~10% glass breakage of 1MW bifacial modules, after 2 years installation in western China



PVDF film-based backsheet cracked in field



Summary of Inspection

- 36% modules with cracks and delamination in 69 installations in temperate climate
- 5 years service life
-
- Linked to loss of PVDF mechanical property
- Similar cracking showing up in China, Australia and Arizona

■ Initial year of operation	2012
■ Service Time	5 years
■ Location	North America
■ Date of inspection	2017
■ # of modules	4200
■ System size	993.6 kW

■ Mounting configuration	Ground open rack
■ Fixed tilt or tracking	Fixed Tilt
■ Backsheet:	PVDF
■ Module Maker	Same for both types
■ Technology	mono-Si
■ Climate	Temperate

Thank You



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Coffee break

Quality Roundtable at All-Energy Australia 2018



Keys to delivering quality arrays in a booming market

Gold sponsors



October 3, 2018 – Quality Roundtable at All-Energy Australia

pV magazine group

Agenda

Presentation II – Australian large scale market update

Presentation III – Battery technology and supplier risk

Quality Panel Discussion II – case study III

Utility scale co-MC, Aaron Zadeh

Final takeaways and networking

Presentation II



Warwick Johnston
Managing Director
SunWiz

A map of Australia with pie charts of varying sizes placed across different regions. The pie charts are color-coded, with segments in shades of blue, yellow, orange, and green. The size of each pie chart likely represents the volume of the PV market in that region. The map is dark gray, and the pie charts are the primary visual elements. Labels for various Australian states and territories are visible in a light gray font.

Key Trends in the Large-Scale PV Market

Northern
Territory

Queensland

West
Aust

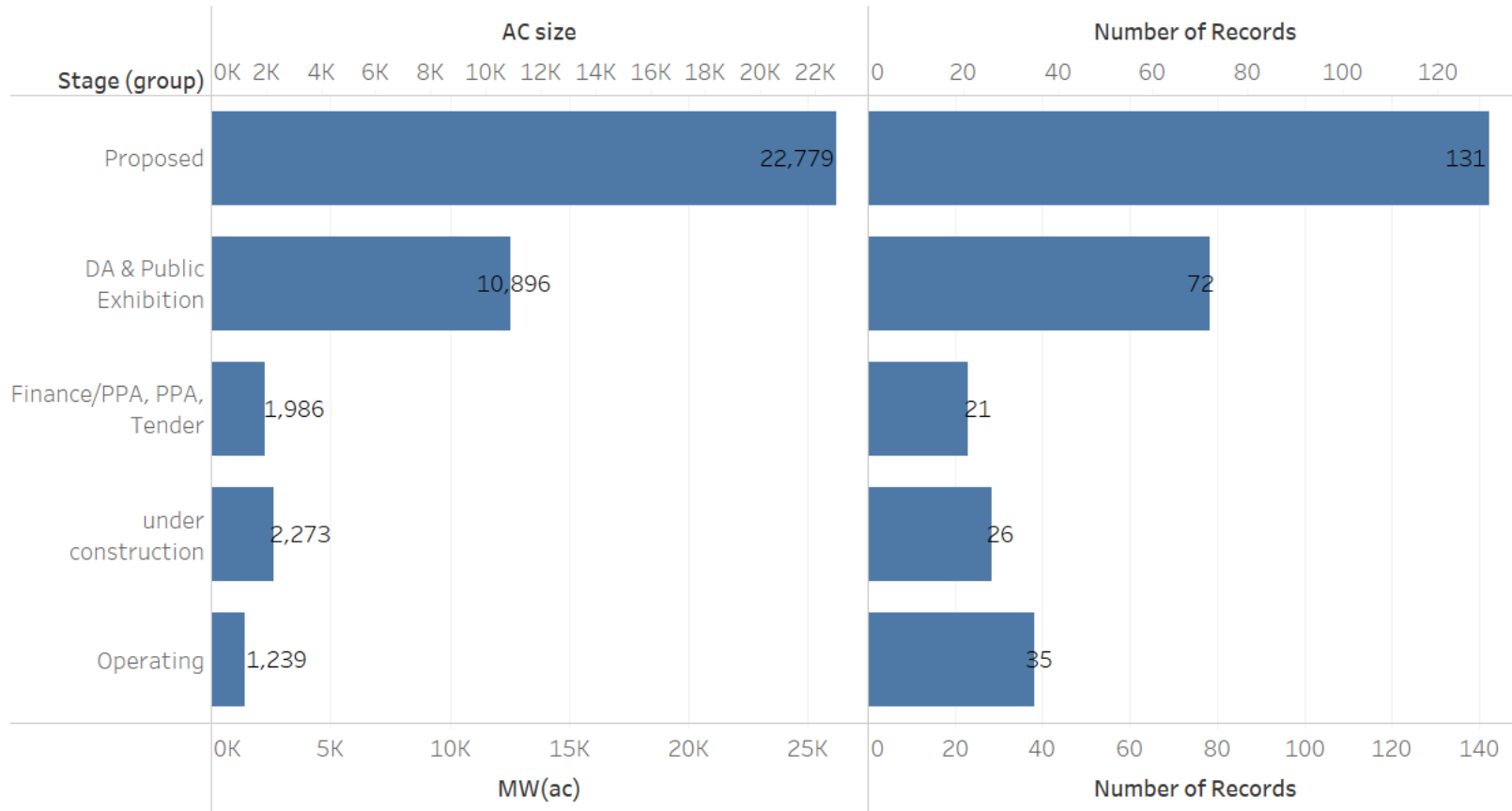
South
Australia

New
South
Wales

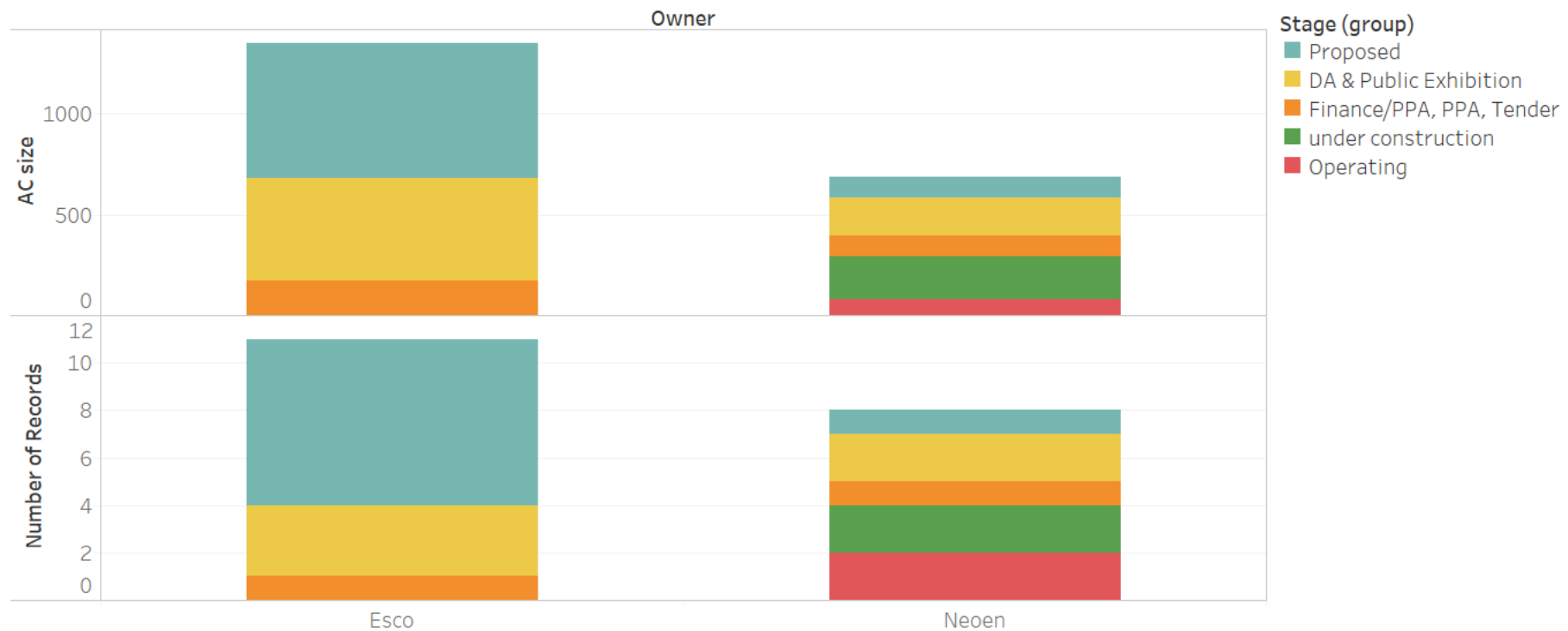
Australian
Capital
Territory

Victoria

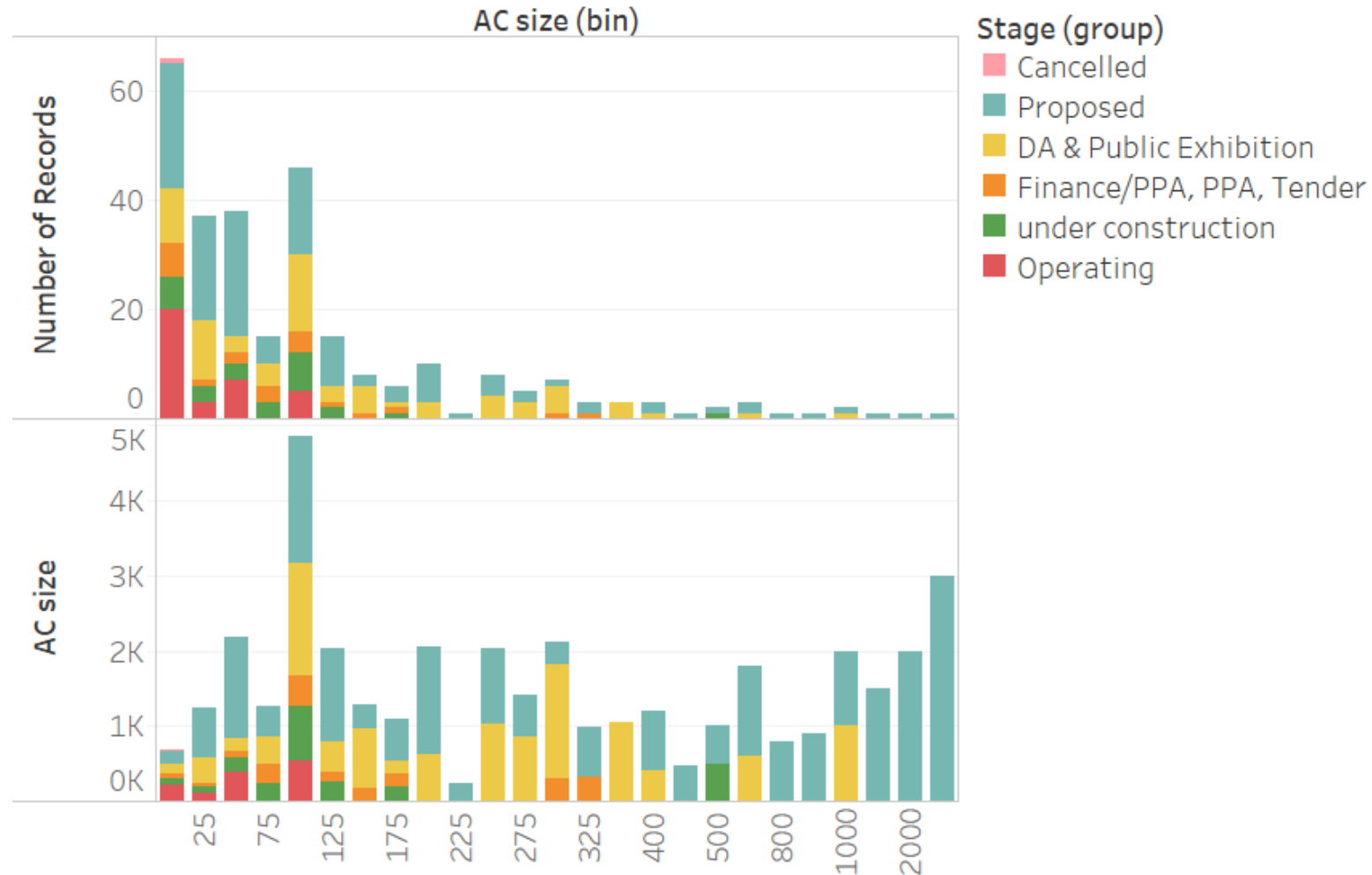
LRET= 5.5GW; 33GW more potential



Esco and Neoen amongst the leaders



Key Trend: 100-125MW sweet spot



Other trends

- Tracking
- Battery Ready



Warwick Johnston @SunWiz_ · Aug 22

Array Technologies has taken a 55% market share of solar **trackers**, from its 15 projects.



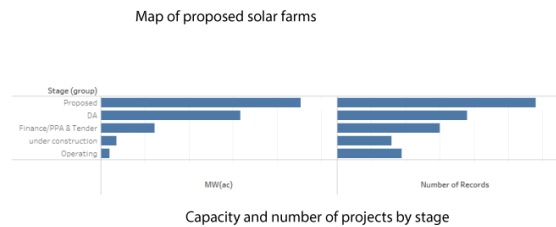
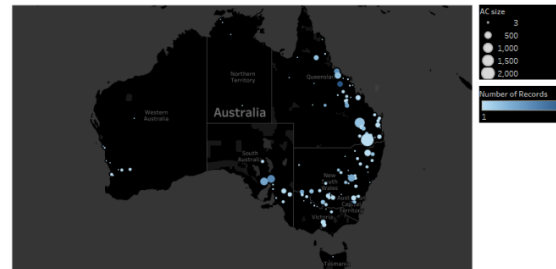
Array Technologies takes the top spot in Australia'...

Global solar tracker pioneer expands business to high-growth markets with impressive results.

reneweconomy.com.au

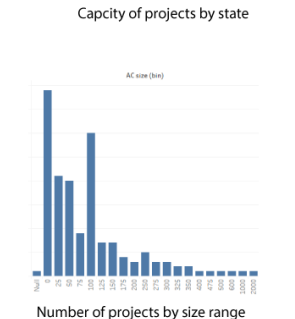
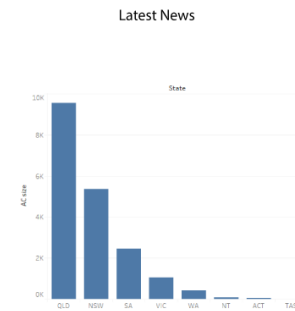
Name	Stage	AC size	State	Storage Amount
Granny Smith Mine	Announced	7.3	WA	2MW/1MWh
Sundown	DA	600	NSW	50MW/100MWh
Kidston Stage 2	DA	270	QLD	2000MWh
Western Downs	DA	250	QLD	50MW
Solar River stage 1	DA	220	SA	120MW/20MWh
Sapphire	DA	170	NSW	50MW/70MWh
Crystal Brook Energy Park	DA	150	SA	400MWh
Mungari	DA	100	WA	20MWh
Nowingi	Planned	250	VIC	80MW/160MWh
Cultana Stage 1	Planned	220	SA	100MW/100MWh
Buronga	Proposed	400	NSW	250MW
Solar River stage 2	Proposed	200	SA	150MWh
Pallamana	Proposed	178	SA	
Taliem Bend 2	Proposed	111	SA	100MWh
Cape York Solar Storage	Proposed	55	QLD	20MW/80MWh
Snowtown North	Proposed	44	SA	21MW/26MWh
Morgan Riverland	Finance/PPA	330	SA	100MW/400MWh
Kiamal	PPA	300	VIC	100MW/380MWh
Kennedy Energy Park	under constru	15	QLD	2MW/4MWh
Gannawarra (Solar Choice)	Operating	50	Vic	25MW/50MWh
Lakeland I (Conergy)	Operating	10.8	QLD	1.4MW/5.4MWh

Large Scale Lookout: \$A3500/year ex GST



Latest News

State	System Name	Capacity (MW)	Status	Notes
ACT	Royalita Solar Farm - ACT	100	Proposed	
ACT	Wagga Lane Solar Farm - ACT	100	Proposed	
ACT	Williamdale Solar Farm - ACT	100	Proposed	
ACT	Mount Major Solar Farm - ACT	100	Proposed	
ACT	Amara Solar - ACT	100	Proposed	
ACT	Harrogate Solar - ACT	100	Proposed	
ACT	Nash Solar - ACT	100	Proposed	
ACT	Kamberra Willyer Solar - ACT	100	Proposed	
ACT	Shadbin Street Solar - ACT	100	Proposed	
ACT	Renewable Solar - ACT	100	Proposed	



Presentation III



George Touloupas
Director of Technology & Quality





Battery technology & supplier risk

The role of quality assurance in a dynamic supply chain

Author:	George Touloupas, Director of Technology & Quality
Date:	3 October 2018
Event:	pv magazine Quality Roundtable, All Energy Australia 2018
Version:	v1

Company Snapshot

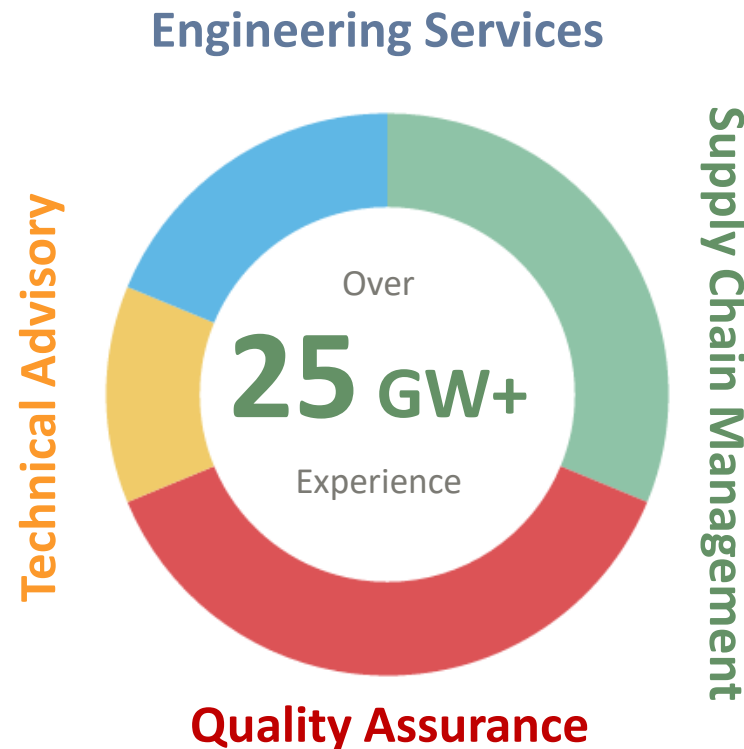
- CEA is a solar and storage advisory firm that is able to provide unrivaled insight into the manufacturing process to ensure the success of solar and storage energy projects worldwide

More than
60 Employees

Over
35 Engineers

Over
10 Years history

A presence in
10 Countries



Client engagements in

40+ Countries



Audited over

140+

Solar Factories
Worldwide



Certified by

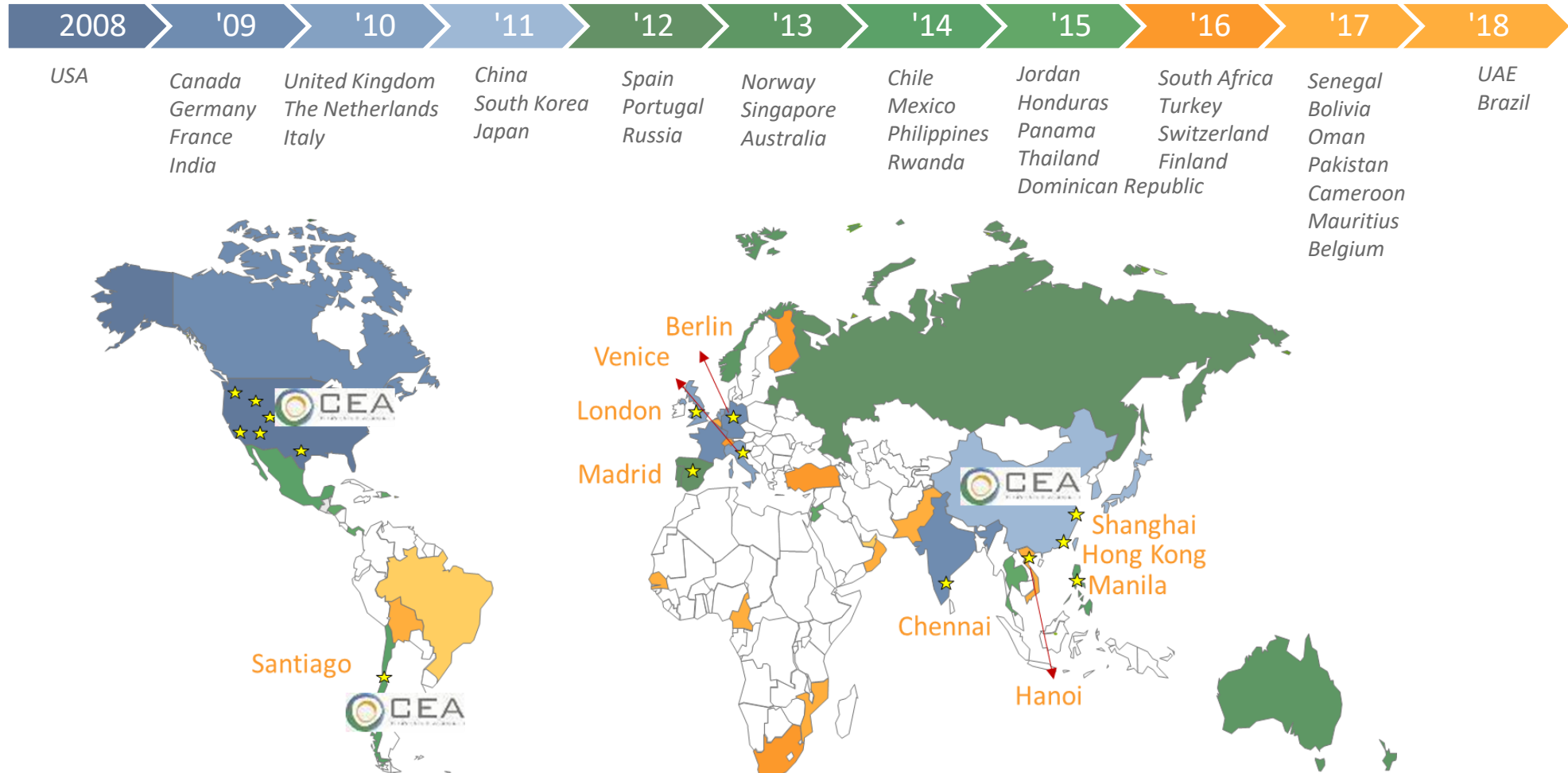


Proud member of



Global Footprint

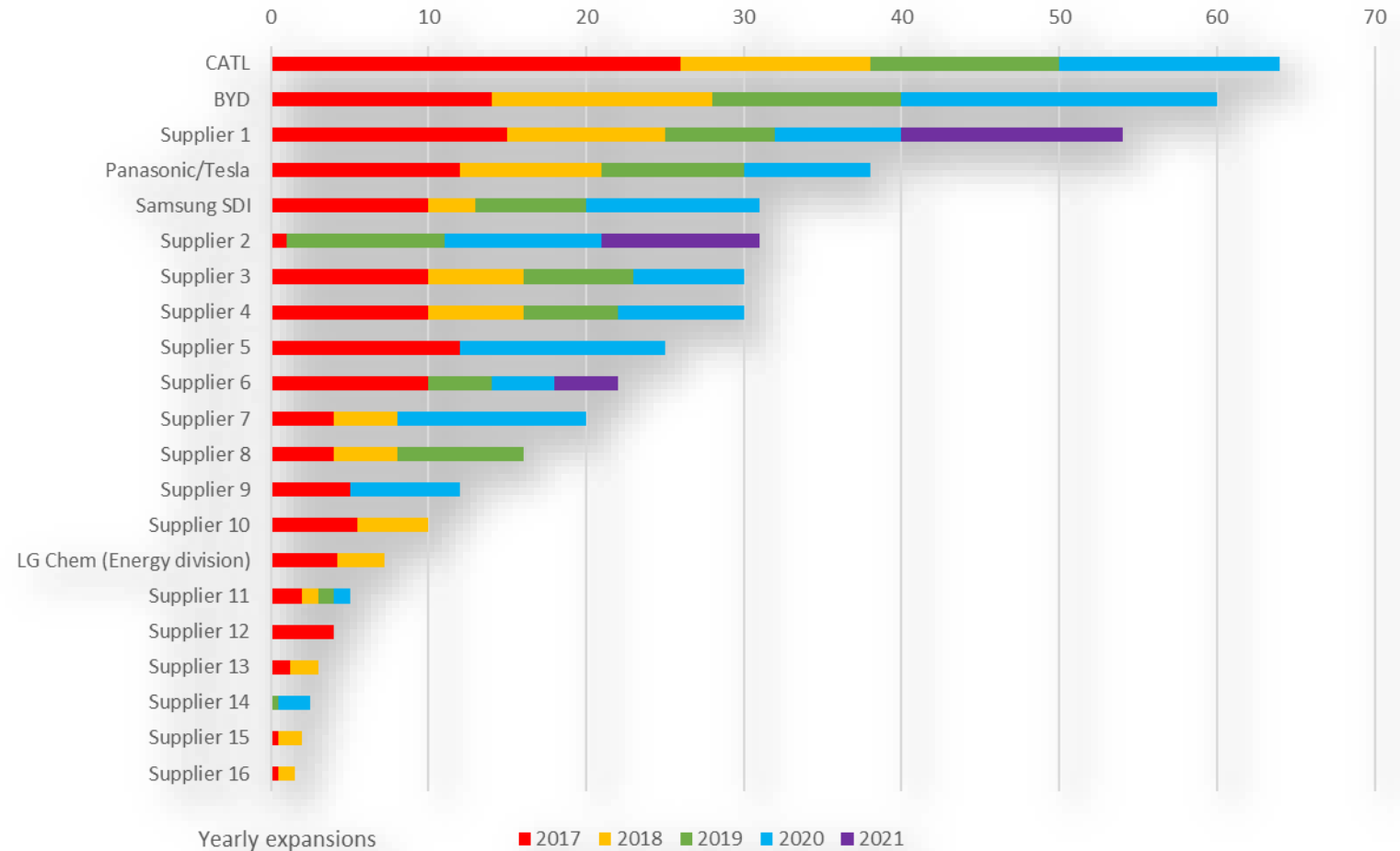
- Since 2008, CEA has developed successful client engagements in 40+ countries and increased employee presence across 10 countries



China takes the lead

- CEA has conducted a research focused on the China Lithium-ion BESS supply chain to help buyers diversify sourcing.
- The global growth of EVs drives the building of new battery factories.
- China has a stable, aggressive EV adoption policy that lures many new players in the battery business.
- The recent booming of the Korean and Japanese domestic ESS markets created a supply bottleneck for the traditional players (LG, Samsung, Panasonic).
- The supply chain is rapidly changing and China is taking the lead.
- The market will have to consolidate.

Lithium-ion Cell Manufacturing Capacity, GWh per year



Capacities of researched suppliers

Source: CEA

A complex supply chain

- The supply chain gets more complex because of the lack of integration capabilities of many cell suppliers.
- Cell suppliers typically integrate the modules and racks/packs.
- PCS suppliers are key players in integrating the battery modules in complete systems.
- Partnerships are very important.
- Battery suppliers are developing integration capabilities, and PCS suppliers plan their own cell factories.

Researched Suppliers	Cell	PCS	Residential Integration	Large-scale Integration
Supplier 17	✓	×	✓	✓
Supplier 14	✓	×	⌚	×
BYD	✓	✓	✓	✓
Supplier 9	✓	×	×	×
CATL	✓	×	×	✓
Supplier 1	✓	×	✓	✓
Supplier 10	✓	✓	✓	✓
Supplier 18	✓	⌚	×	⌚
Supplier 19	⌚	✓	✓	✓
Supplier 20	×	✓	✓	✓
Supplier 5	✓	⌚	✓	✓
Supplier 8	✓	×	✓	✓
Supplier 6	✓	×	×	✓
Supplier 3	✓	×	✓	✓
Supplier 11	✓	×	×	✓
Supplier 21	×	✓	✓	⌚
Supplier 22	×	✓	×	×
LG Chem (Energy division)	✓	×	⌚	⌚
Supplier 2	✓	×	⌚	⌚
Supplier 4	✓	✓	×	✓
Supplier 13	✓	×	✓	✓
Supplier 23	✓	×	×	✓
Panasonic	✓	✓	✓	⌚
Supplier 16	✓	×	✓	✓
Samsung SDI	✓	×	×	×
Supplier 15	✓	×	×	×
Supplier 24	⌚	✓	✓	×
Supplier 7	✓	×	×	×
Supplier 12	✓	×	×	×
Sungrow-Samsung	⌚	✓	✓	✓
Supplier 25	×	×	✓	✓
Supplier 26	⌚	✓	✓	⌚

Capabilities of researched suppliers

Source: CEA

Forms and chemistries of lithium-ion batteries

- Different form factors have been adopted, with pros and cons for each application.
- Pouch is the densest, but also most difficult to protect.
- NCM (Nickel Cobalt Manganese) is the densest but less safe chemistry.
- LFP (Lithium Ferrous Phosphate) is the safest, but less dense chemistry,
- Chinese government has initially promoted safe LFP, which is mandatory for e-buses. All NCM in China goes to EV, because of high density, and all BESS use LFP.
- NCM with high nickel content (811) is in the roadmap of all suppliers, but safety issues are the main roadblock.



Pouch



Prismatic



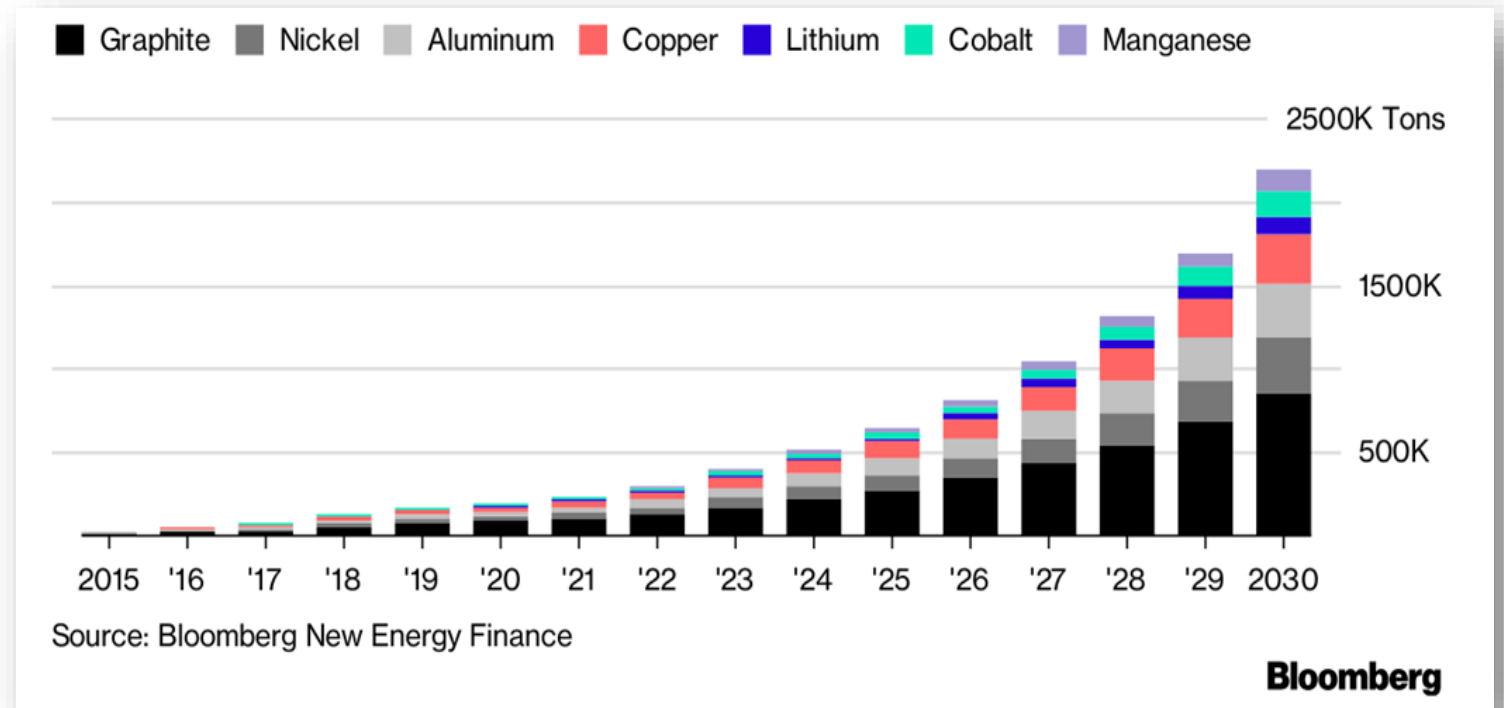
Cylindrical

	2016	2017F	2018F	2019F	2020F	2021F	2022F
Korea							
LG Chem	NMC 1st		NMC622		NMC811 and higher-Ni NMC		
SDI	NCA & NMC 1st		NMC622			NMC811	
SKI	NMC 1st		NMC622			NMC811	
Japan							
Panasonic		NCA/NMC			High-Ni NCA/NMC		
China							
CATL	NMC 1st		NMC622		NMC811 & Solid state		
BYD	LFP		NMC 1st		NMC622		
Lishen	LFP	NMC1st			NMC622		
Guoxuan high-tech	LFP		LFP & NMC1st		NMC622		
Wanxiang	LFP	NMC1st			NMC622		

The migration away from LFP and towards nickel-rich NCM (NMC) chemistries
 Source: SNE research

Minerals

- Lithium ion batteries use 7 key elements, some of which do not have adequate mining capacity to satisfy fast growing demand.
- It takes around 7 years to fund and develop a new lithium mine.
- About 60% of cobalt comes from DRC, with a lot of artisanal mining taking place.
- Chinese companies either control or have stakes in all of the world's important lithium and cobalt mining operations.

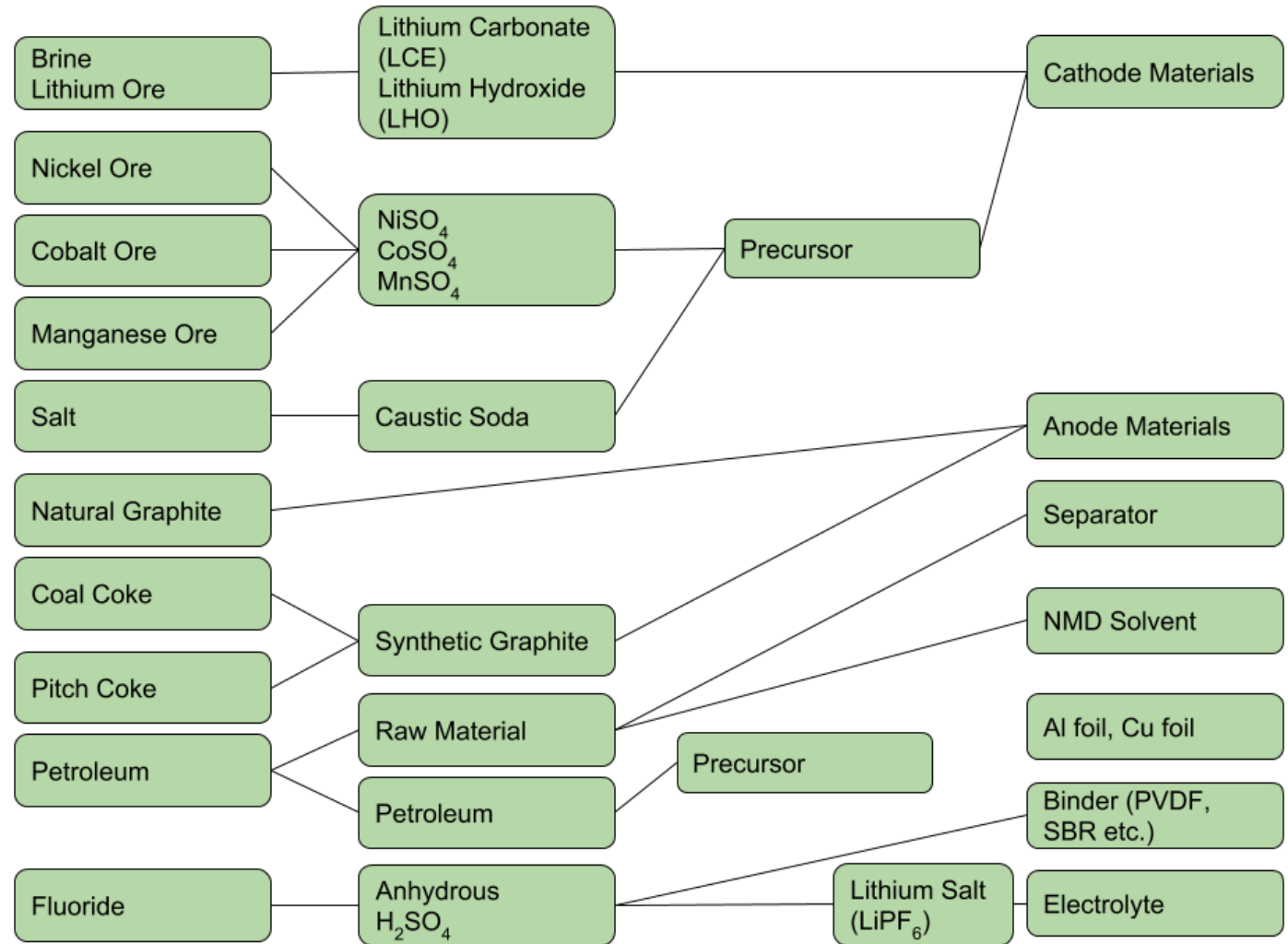


Growth in demand for raw materials from the lithium-ion battery industry

Source: BNEF

Precursor materials

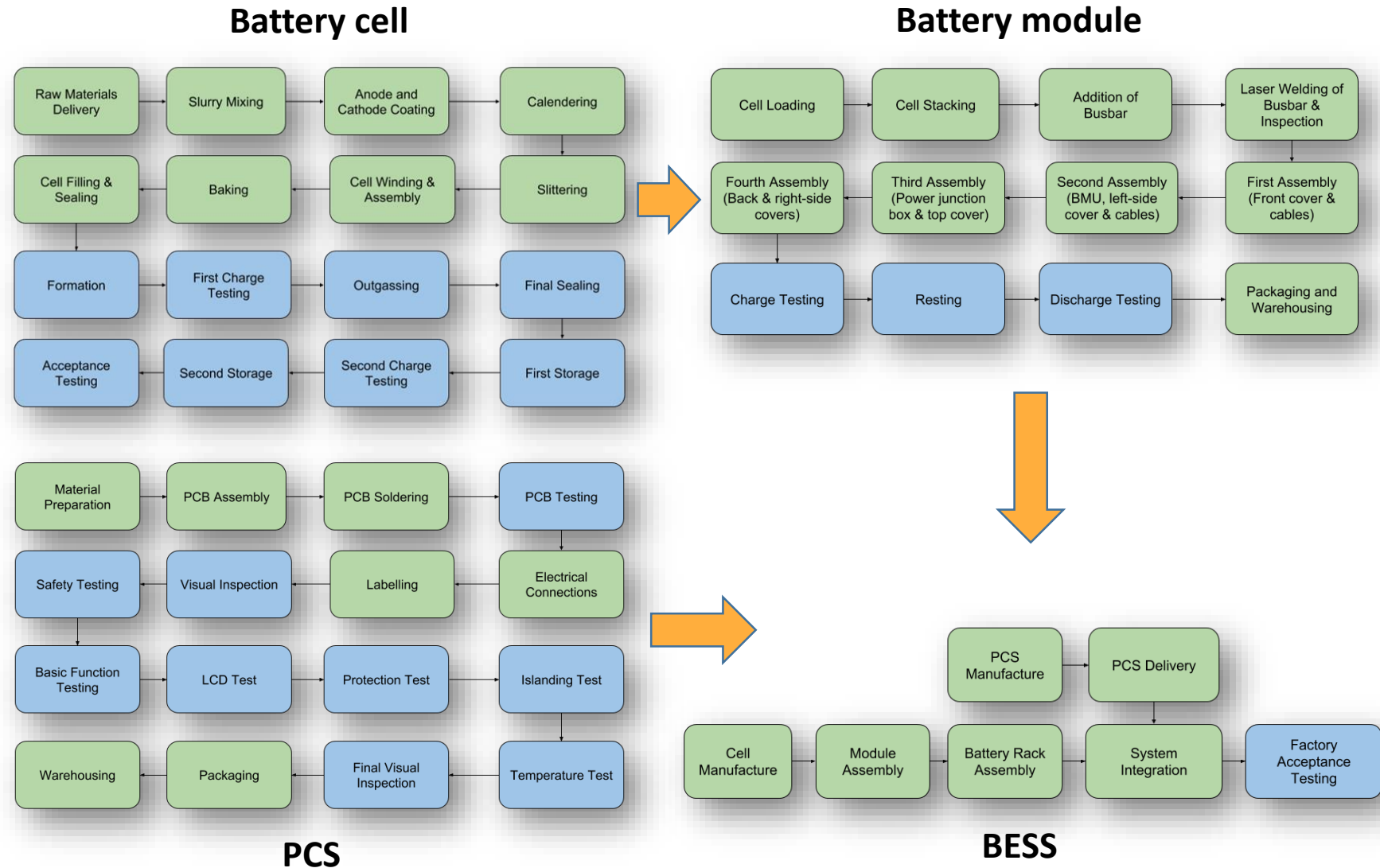
- A complex chain transforms the raw materials to precursor materials for cell manufacturing.
- Korean, Japanese and Chinese companies control the supply chain.
- A large part of the refining operations are taking place in China to cater for the very big local manufacturing needs.



An outline of the lithium-ion raw material chain
Source: CEA

The manufacturing process: from cell to BESS

- The road from cell to BESS is complex, with many players.
- Cell factories are very clean, and highly automated environments. Contamination and weak processes can lead to massive serial failures.
- Cell suppliers typically assemble the cells into modules and racks, integrating the BMS, which is a critical part.
- Final integration is usually performed by the PCS supplier, who can be different to the cell supplier.

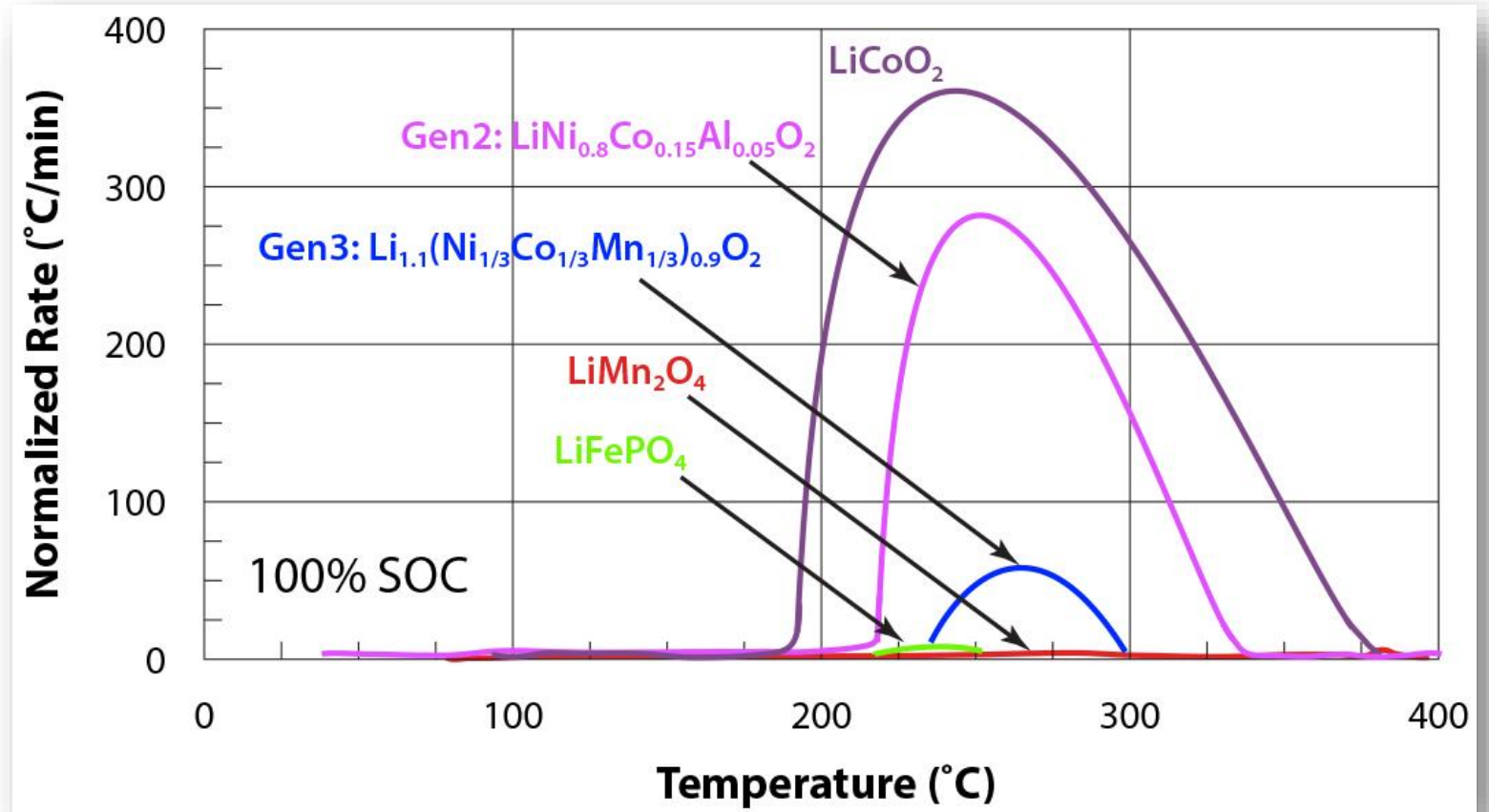


Manufacturing and integration processes
Source: CEA

Failure modes and risks

Failure modes of battery systems

- Cell design & process defects
 - poor module design
 - poor quality control
 - contamination
- Cell abuse
 - over-charging/discharging
 - penetration/crushing
 - safety mechanism failure
 - improper BMS operation
 - poor thermal management
- Electronics failure
 - PCB failure
 - corrosion
- System failure
 - PCS failure
 - poor thermal management
 - fire

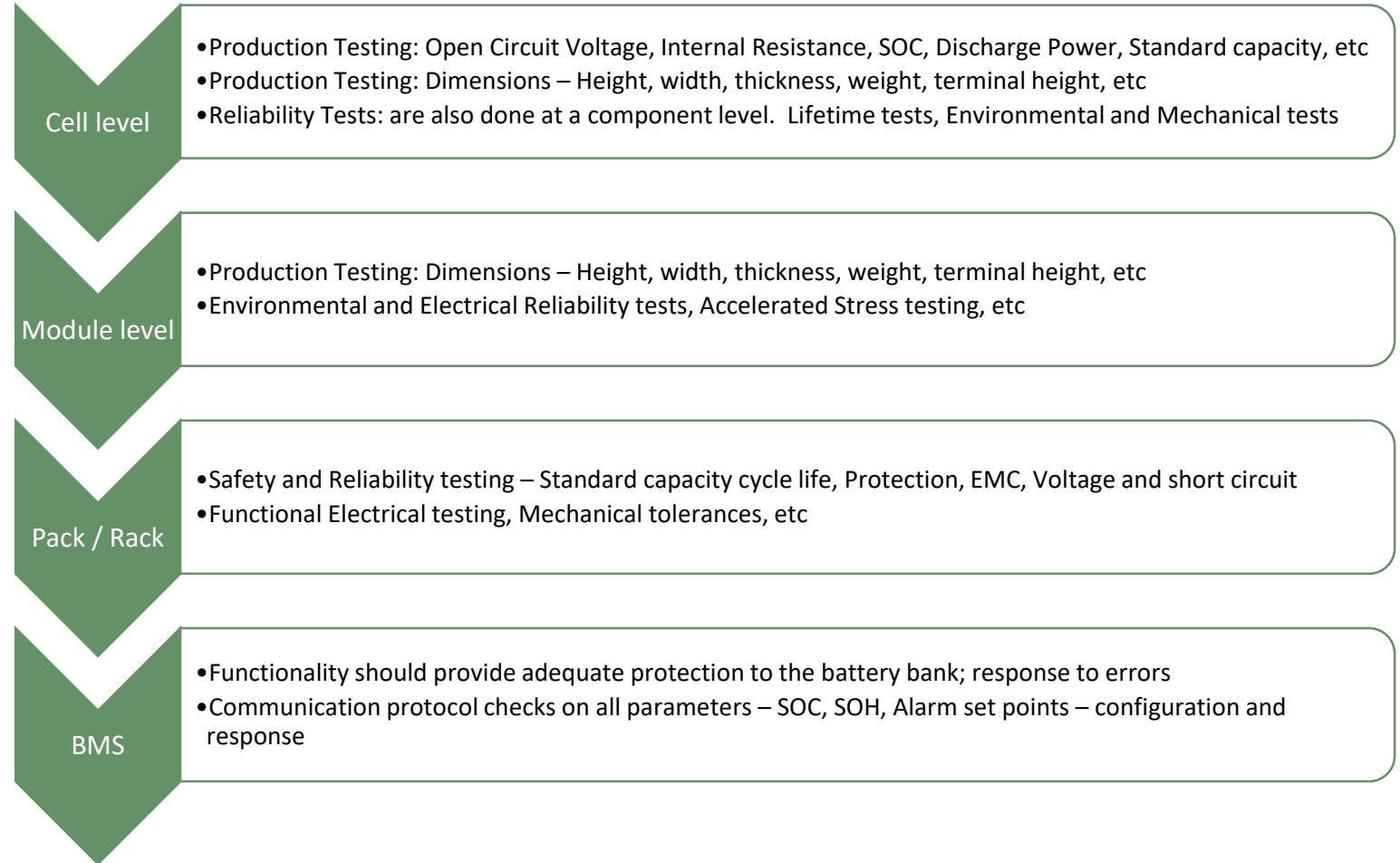


Overview of thermal runaway for different cell chemistries

Source: Sandia National Laboratories

Quality assurance: mitigating the risks

- Cell processes, inline testing and characterization are critical checks.
- The module/rack assembly, with the integrated BMS and electronics is the base unit of the BESS and must perform to specs.
- The BESS must have functioning systems that protect the batteries and ensure the planned services and revenues are provided.
- Thermal management design is typically approved by the cell supplier.
- Warranty policies depend on use parameters, but also on future extrapolation of cell prices.



High level outline of the quality assurance checks for cell to rack integration steps
Source: CEA



Thank you!

Panel II



Panel II



Marty Rogers
VP of Global Asset
Management and Support



Daniel Parsons
Business Development
Manager



Anika Giller
Senior Business
Development Manager



Hugh Carr-Harris
CEO



ACTING ON DATA FOR INCREASED PLANT RELIABILITY

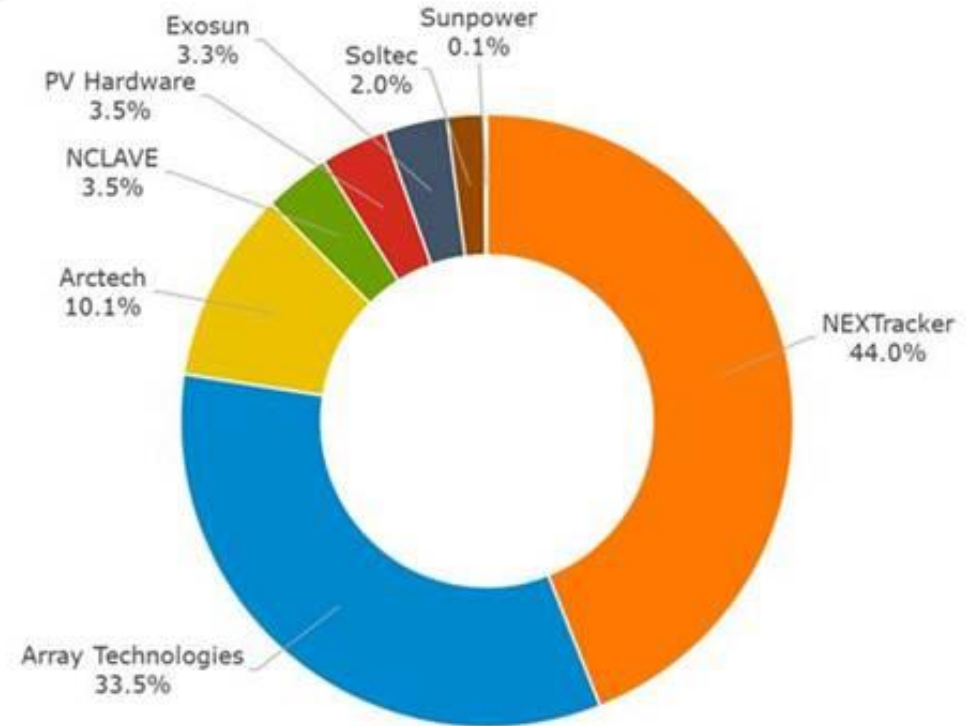
All Energy Australia, Oct. 3, 2018

Martin Rogers, VP Asset Management and Support, NEXTracker

LOCAL TEAM: DRIVING QUALITY, SCALE AND LIFETIME RELIABILITY

- 14.5 GW solar trackers delivered globally
- Acquired by Flex (formerly Flextronics), an investment grade company, \$25Bn annual revenues
- 2 GW in Australia to date
- Local office: sales, project engineering, project management, construction, support and O&M
- Established PowerworX Installer Training Academy (trained over 500 graduates worldwide)

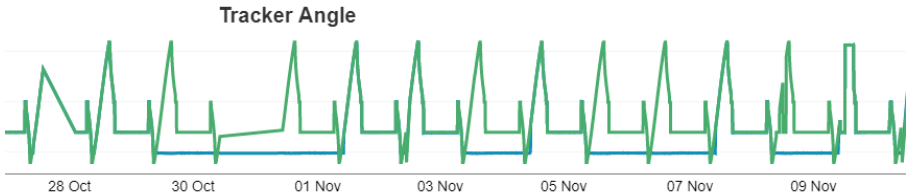
Solar tracker market shares, Australia (contracted capacity)
Percentage



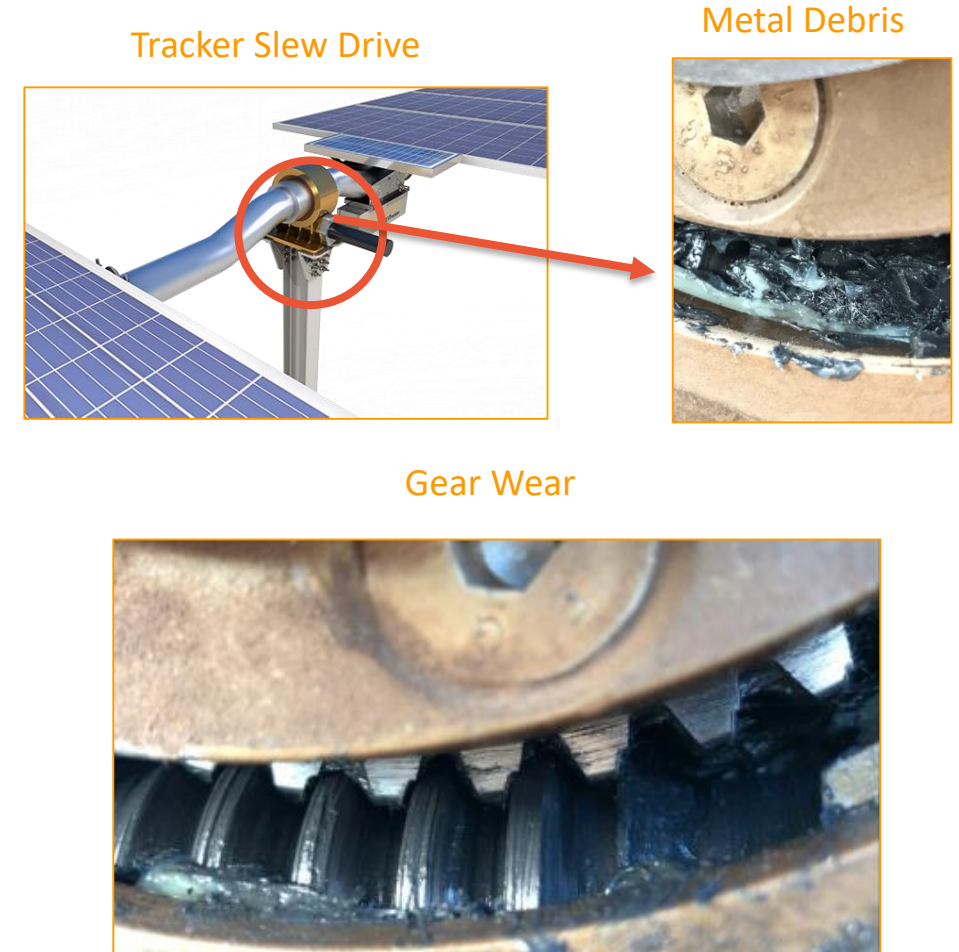
Source: Rystad Energy's SERA Tracker

BIG DATA - TREND ANALYSIS LEADS TO HIGHER QUALITY SYSTEMS

Our Data Analysis Methodology

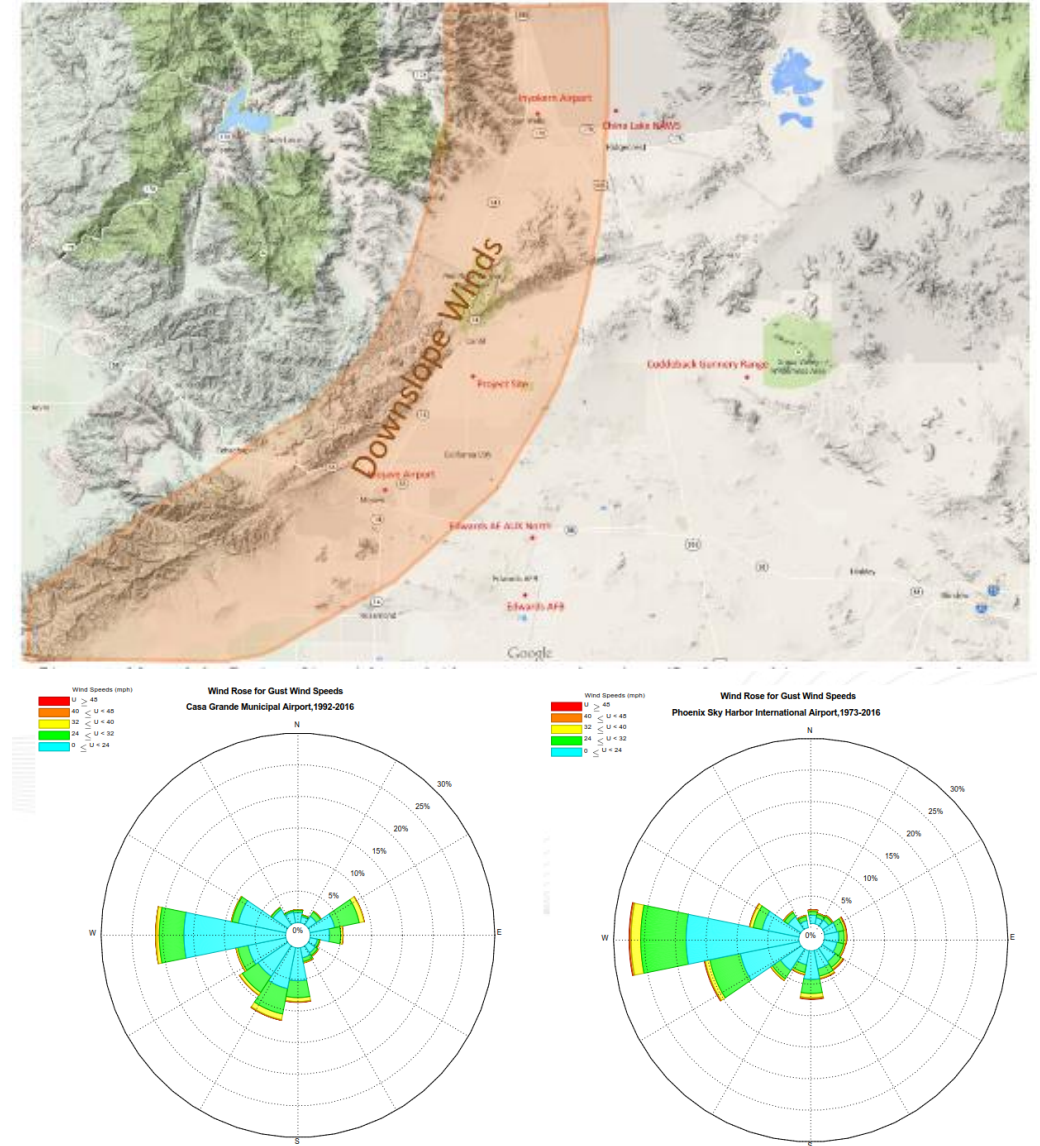
- Analyze available data
 - Determine trends
- 
- Tracker Angle
- 28 Oct 30 Oct 01 Nov 03 Nov 05 Nov 07 Nov 09 Nov
- Create signature
 - Use signature to find issues
 - Create work order, evaluate cost vs. action, close quality and engineering circle.

Case Study: NEXTracker slew gear



DATA HELPS FUTURE PROOF AGAINST EXTREME WEATHER

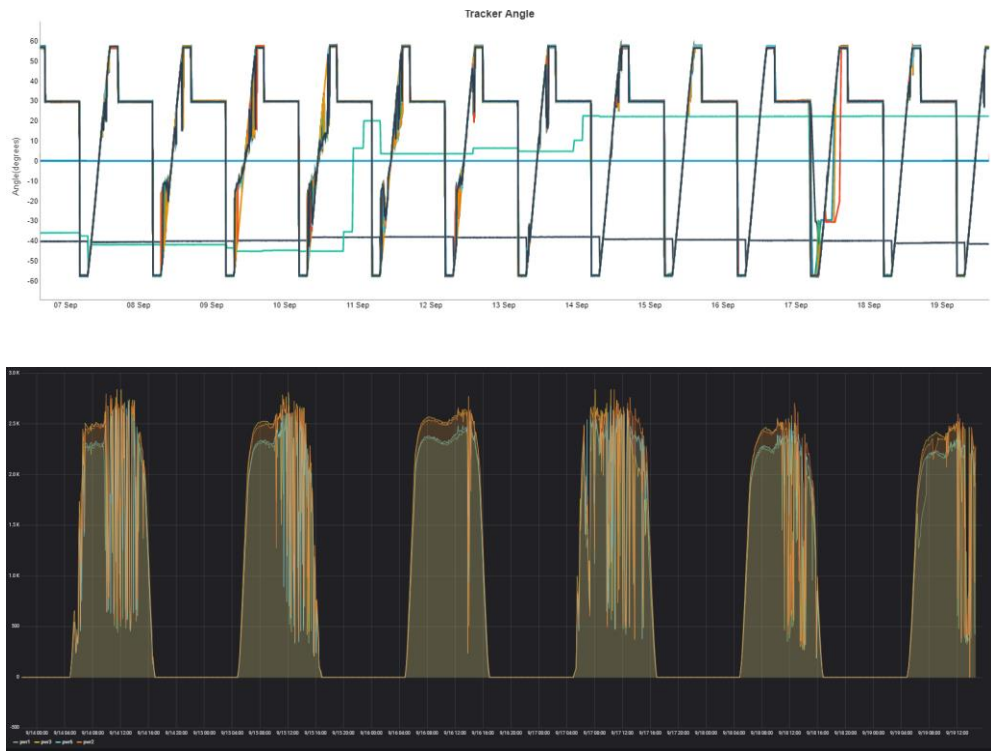
- NEXTracker works with CPP Wind Engineering, a world renowned wind industry consultant whose principle is a leading structural wind committee member of ASCE
- We employ Site Specific Wind analysis as is allowed by Code, using local weather stations data to assess exact location wind speeds rather than wind speeds over large regions (design wind maps)
- Wind speed, direction, and frequency data are analyzed to create site specific calculations, determinations, and project design



TRUECAPTURE SMART CONTROL SYSTEM

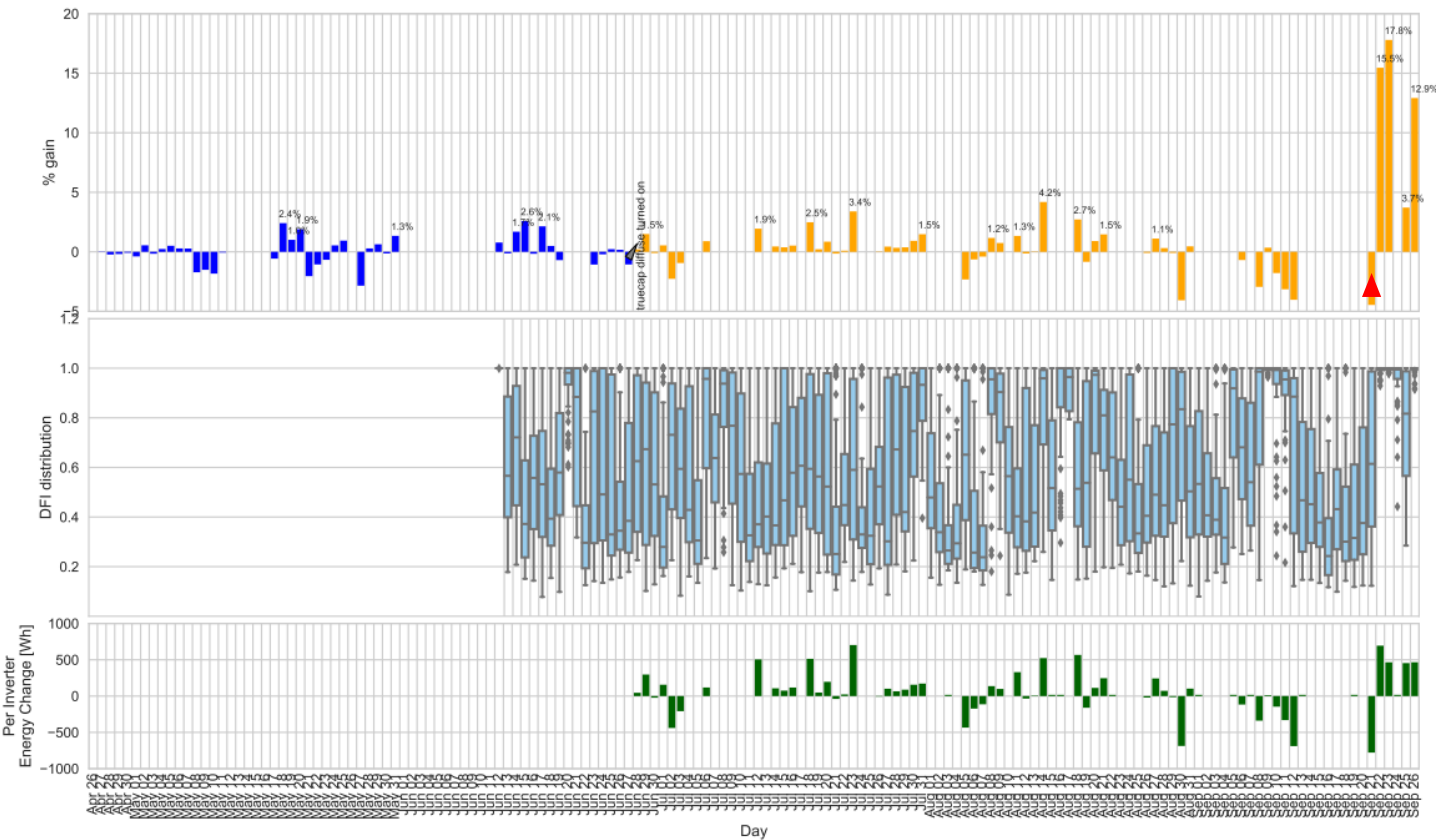


DATA: SMART CONTROL SYSTEM ENERGY GAINS

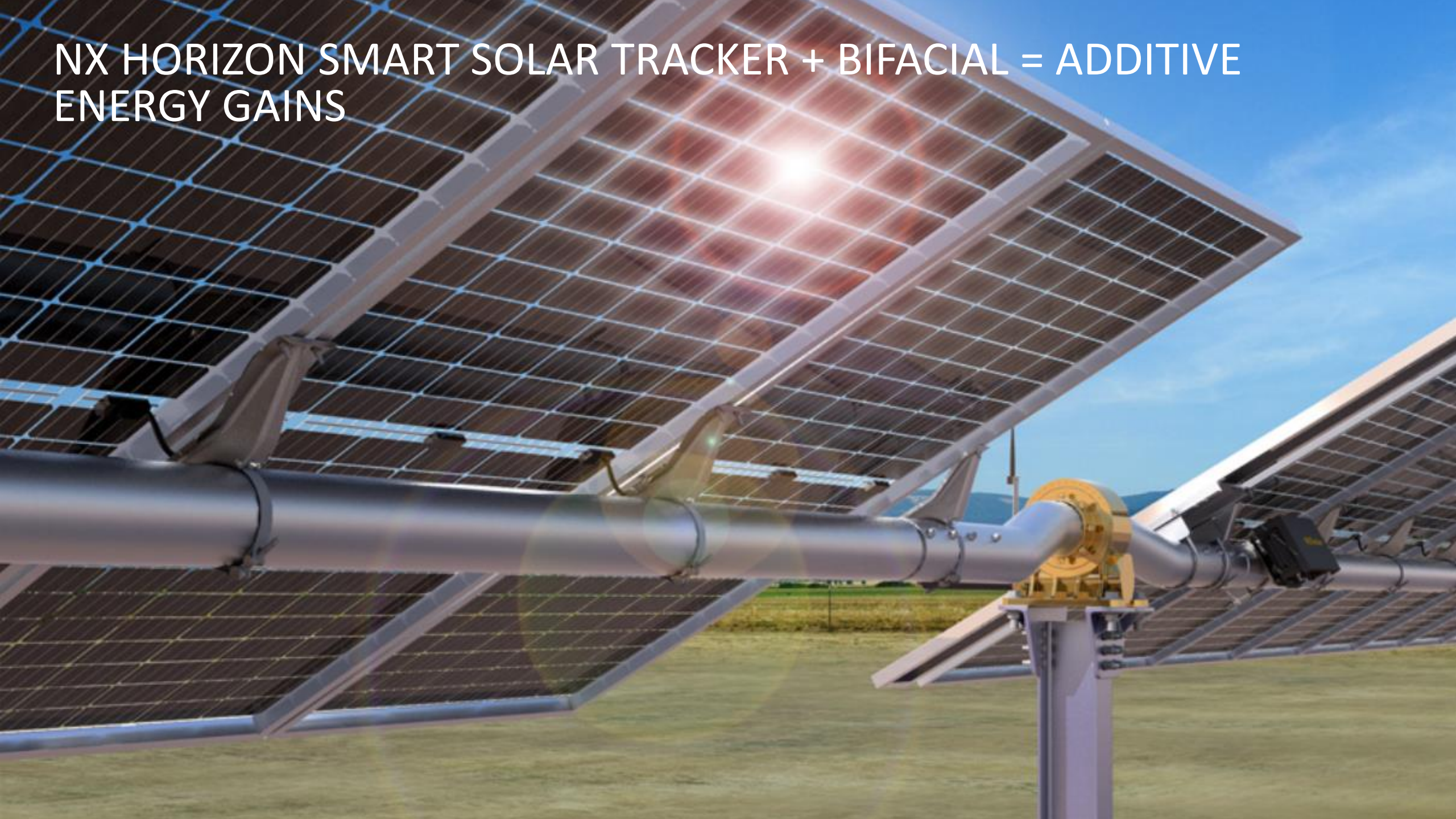


Providence Diffuse TrueCapture Field Trial Inverters 6 (TC-Diffuse) & 2 (Baseline)

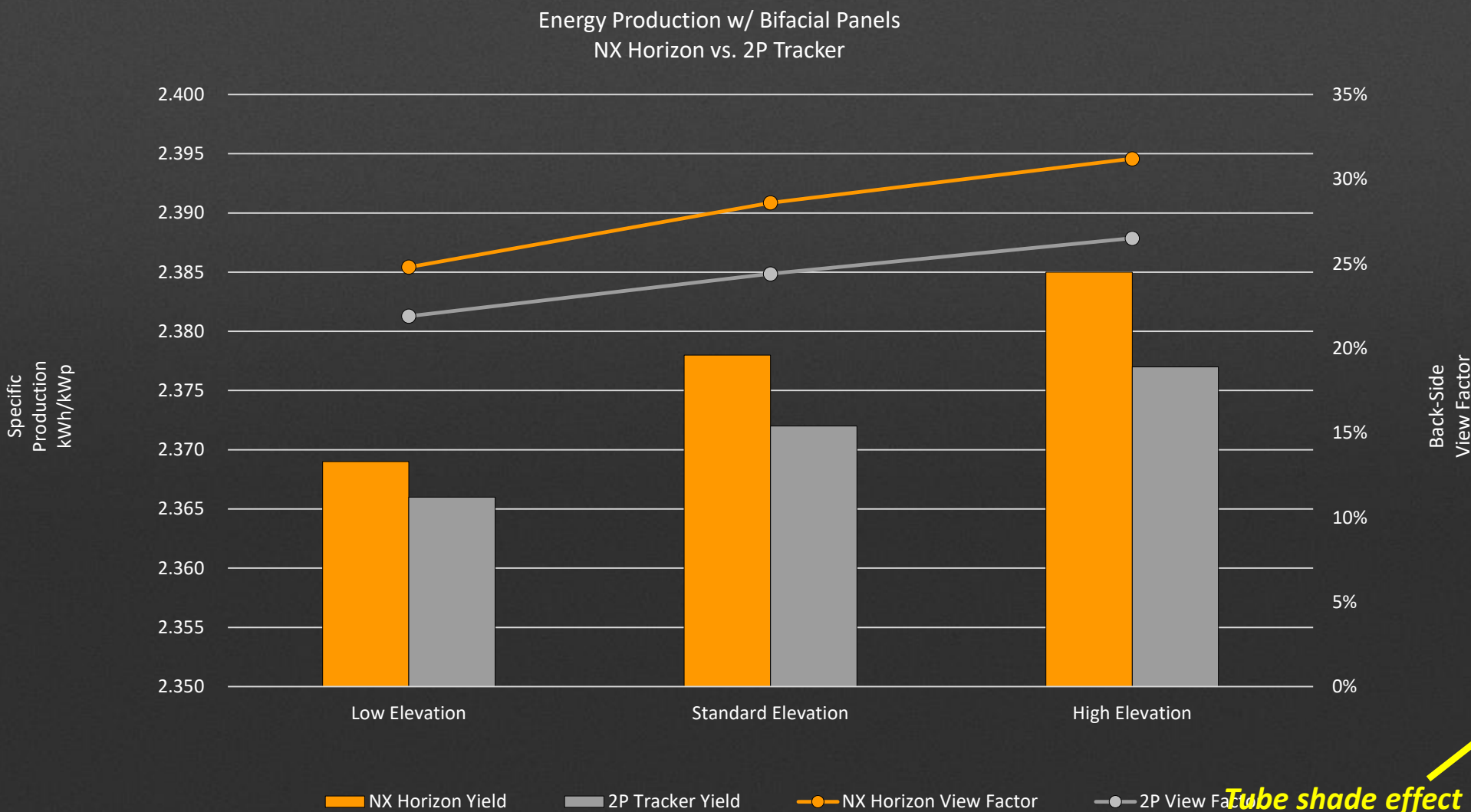
Cumulative TrueCap Energy Gain: 0.334%



NX HORIZON SMART SOLAR TRACKER + BIFACIAL = ADDITIVE
ENERGY GAINS



PVSYST ANALYSIS: NX HORIZON vs. 2P TRACKER



0.3%
More
Energy vs.
2P



Modeled with PV Syst v6.72

- Blythe CA
- TMY3 weather data
- "Horizontal unlimited trackers" simulation method
- 90% bifacial PV modules
- 20% ground albedo
- 40% ground cover ratio
- +/- 60° tracking range
- 1.20 DC/AC ratio
- 6.5% back-side shade factor for NX Horizon vs. 3.0% back-side shade factor for 2P tracker

Tube shade effect included

A wide-angle photograph of a solar farm in a desert. Rows of solar panels, mounted on adjustable metal frames, stretch into the distance under a clear blue sky. The ground is sandy and dry. The perspective is from between two rows, looking down a central path. The solar panels are dark blue with silver frames. The metal frames are light grey. The sky is a deep blue with a few wispy clouds. The ground is a light tan color. The overall scene is bright and sunny.

THANK YOU

BayWa r.e. Solar Projects Company Overview

PV Magazine Quality Roundtable Discussion, October 3rd, 2018

Australian experience

Since entering the Australian market, BayWa r.e. is active in solar and wind project development

- BayWa r.e. **Solar Projects** entered the Australian market through the acquisition and subsequent development of a 240 MWp portfolio in Queensland and Victoria
- The **Wind Projects** team was established through the acquisition of a local developer, Future Energy, and its project pipeline. The existing Future Energy team has remained with BayWa r.e.
- **O&M and Commercial services** (new regional remote monitoring centre in Bangkok) and **solar distribution** complete our portfolio of products and services in Australia
- BayWa r.e. is a **global renewable energy developer, service supplier, wholesaler and energy solutions provider**, and is a wholly owned subsidiary of BayWa AG. We employ more than **1,400 people worldwide** and have contributed more than **A\$ 60m EBIT last year (2017)** across the 20 countries we are active in and **service a portfolio** of more than **5.2 GW of Wind and Solar assets**.



- **Melbourne** Headquarter for Wind & Solar Projects including **O&M services**
- **Mildura** office for the construction of the solar projects in Northern Victoria (combined 219 MW_{DC})
- **Perth** office, **Headquarter for Solar distribution** and small to medium sized **onsite solutions**

Selected reference projects in Australia

Since entering the Australian market in 2017, BayWa r.e. has completed its first large scale solar farm in Queensland and is currently constructing further wind and solar projects across Victoria

Completed assets



Hughenden Solar Farm, Queensland

First large-scale solar project completed by BayWa r.e. in APAC

- **Capacity:** 20MW_{DC}
- **Status:** sold



Maroona Wind Farm, Victoria

Two turbine project developed by Future Energy

- **Capacity:** 6.9MW
- **Status:** completed



Chepstowe Wind Farm, Victoria

Three turbine project developed by Future Energy

- **Capacity:** 6.2MW
- **Status:** completed

Assets under construction



Karadoc Solar Farm, Victoria

Largest single-axis solar project for BayWa r.e. globally

- **Capacity:** 112.5MW_{DC}
- **Status:** in construction



Timboon Wind Farm, Victoria

First onshore wind project undertaken by BayWa r.e. in Australia

- **Capacity:** 7.2MW
- **Status:** in construction



Yawong Wind Farm, Victoria

Two turbine project developed by BayWa r.e.

- **Capacity:** 7.2MW
- **Status:** in construction

Karadoc construction highlights

Australia is a key market to BayWa r.e. and its investment is testament to the Australian renewable energy market

300
construction
and installation
workers

involvement of
local community
on the labour
force (incl. 15
apprentices)



corporate PPA
with CUB



nominal
 90MW_{AC} output

enough
electricity to
power over
110,000 homes



Connected to
Powercor at
66kV



BayWa r.e.
office
established in
Mildura

Tier 1
components
procured by
BayWa r.e.

Thank You

BayWa r.e. Solar Projects Pty Ltd

Daniel Parsons: Managing Director of BayWa r.e. Solar Projects

Head Office: Level 1, 79-81 Coppin St, Richmond, Victoria 3121

Phone: +61 3 9429 5629

Email: Daniel.Parsons@baywa-re.com

Website: <http://www.baywa-re.com.au/en/>

Stand: #3228



Case study III

RCR Tomlinson difficulties highlight impact of PV project commissioning delays

Delays in achieving the full commissioning of Australian PV power plants are beginning to seriously impact project EPCs. Diversified engineering and infrastructure company RCR Tomlinson has postponed its annual financial results, with speculation mounting that delays to the commissioning of a solar project has caused “a material negative impact” on its earnings.

AUGUST 23, 2018 JONATHAN GIFFORD

INSTALLATIONS UTILITY-SCALE PV AUSTRALIA



The Sun Metals solar farm was officially opened in August.

Photo: RCR Tomlinson

RCR Tomlinson suffers \$57 million write-down on two solar farms

Speculations that delayed financial results spelled troubles have proved remarkably accurate – one of Australia’s leading EPC contractors has taken a huge write-down on two Queensland solar projects, and reported \$16 million net loss.

AUGUST 30, 2018 MARIJA MAISCH

FINANCE GRIDS & INTEGRATION INSTALLATIONS MARKETS & POLICY
UTILITY-SCALE PV AUSTRALIA



The 100 MW Houghton Solar Farm is another project of RCR Tomlinson located in Northern Queensland.

Utility scale - Background



Reports of delays first reported late 2017, early 2018 (Gullen Range 10 MW).

S5.2.5.4 – came into effect July 2018, require “continuous uninterrupted generation” in the event of grid events.

AEMC determination this month.

Kane Thornton, CEC Chief Executive: *“If you have been developing a project that is getting closer to commercial close, or going through the connection process, and all of a sudden the goal posts move or will potentially move, gee, that’s a big deal.”* [Reneweconomy Podcast]



Utility scale - Background

AEMO response

*“The **system strength** and **inertia** rule changes came into effect on 1 July 2018. The rule changes were triggered by the learnings from the South Australian system black in September 2016, which enabled us to better understand the challenges that new technologies were introducing to the current and emerging power system. These rule changes also clarify the role that each participant (for instance the transmission networks, the market participants and AEMO) plays in enabling a safe and secure power system.”*



Utility scale - Background

“It is important to note that AEMO has no intention of holding anyone up from connecting to the power system but that this process needs to occur in a way that does not impact the security of the grid.”

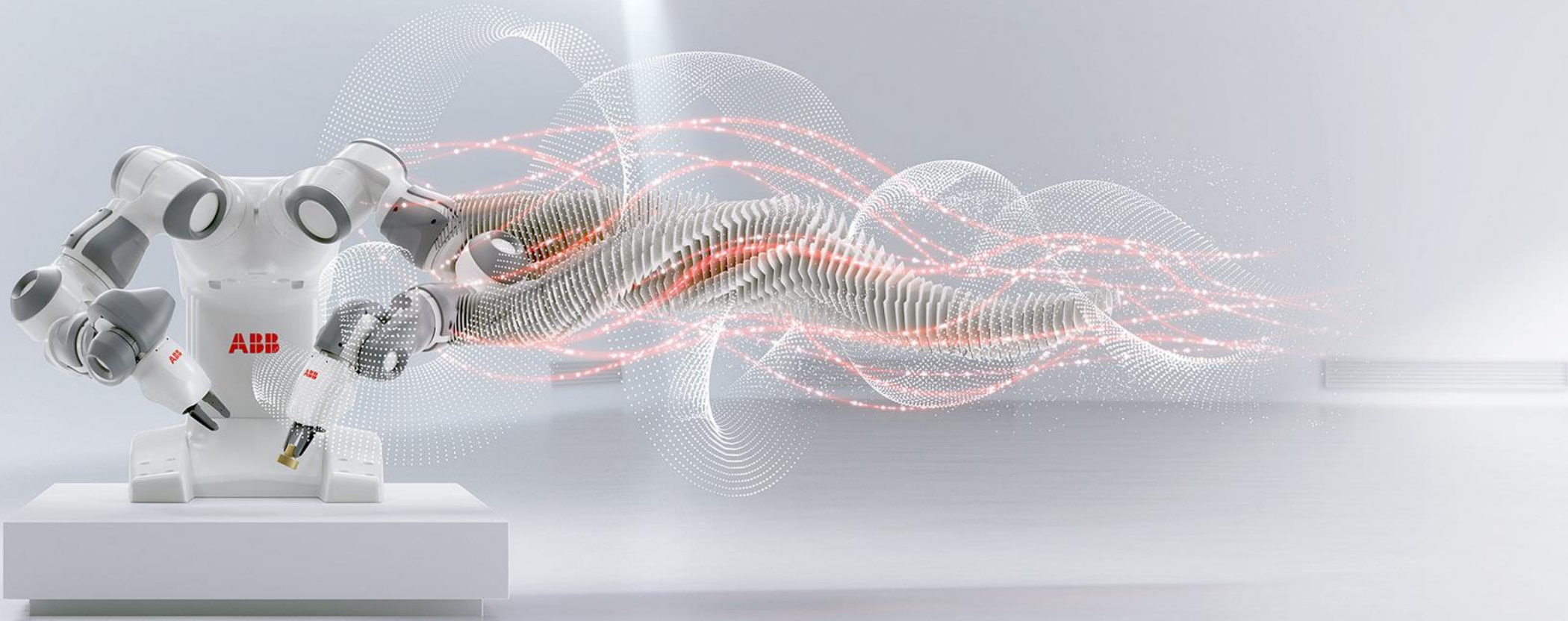
“In 2016 we connected over 700 MW to the system. In 2017 we connected just over 1200 MW to the system. in 2018 we are seeing/managing connection requests and enquiries in the order of 19,500 megawatts.”

Utility scale co-MC



Aaron Zadeh
Product Marketing Manager – Utility Solar





3 OCTOBER 2018 / ALL ENERGY AUSTRALIA, MELBOURNE

ABB Solar Inverters

Next Generation Central Inverter for Utility-scale Solar Applications

Aaron Zadeh, Product Marketing Manager – Utility Solar



Central inverter with ultimate performance

Next generation central inverter for utility scale applications

Low Levelized Cost of Energy (LCOE)



High performance

- High overall efficiency
- High uptime
- Inbuilt redundancy



Long lifetime

- Superior cooling system
- Shared power conversion and control platform.
- Corrosion resistive dual layer enclosure.
- High ingress protection class



Low maintenance with serviceability

- Simple preventive maintenance
- Service supporting design
- Modularity



Next generation simulation models

Next generation central inverter for utility scale applications

Exact representation of inverter firmware



Industry leading model accuracy

Base model design:

- Core design in Matlab/Simulink from inverter firmware
- No handwritten C code
- One to one (1 : 1) parameter compatibility between model and actual inverter Software

Framework approach:

- Certificated Core .dll with interface support for I/O signals
- Interface manages connections to 3rd party software

Supported modelling software:

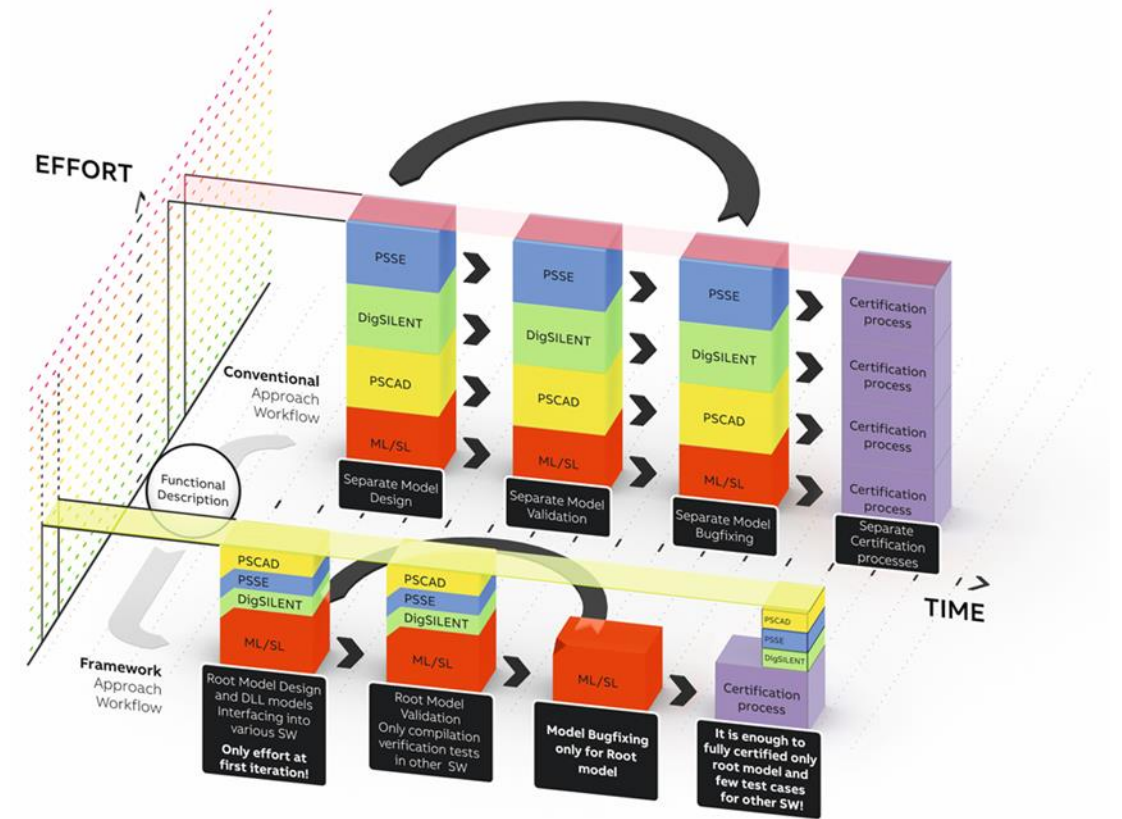
- PSCAD
- Siemens PSS/E
- DigSILENT PowerFactory

Next generation simulation models

Next generation central inverter for utility scale applications

Customer benefit

- Simulation model can be released same time as actual inverter SW. => No delay on the simulation model updating.
- Inverter tuning/parameter change during simulation phase can be implemented in real life without any need of parameter or setting interpretation.
- Fast support as development 100% ABB in-house.
- Faster certification cycle due to need of only root model validation by 3rd party.
- Faster commissioning times as parameters already tested and approved with simulation model



Grid support and simulation tools

Modelling, designing, testing and verification

Model development and maintenance

Market specific Fortran representation of product – It is difficult to capture all control influences and protective functions in the Fortran translation for the product.

The model requires assessment following any firmware changes.

Matlab/Simulink verified model imported to PSSE gives the model the best chance of representing the exact product reactions and minimises ongoing model maintenance.

ABB local Product Experts can provide 1 to 1 advice on complex tuning challenges, with further support available from ABB Global R&D

Design phase with advanced simulation models – R1 testing

ABB provides accurate simulation models, which are implementing the internal operation of the inverter firmware, instead of just mimicking the operation.

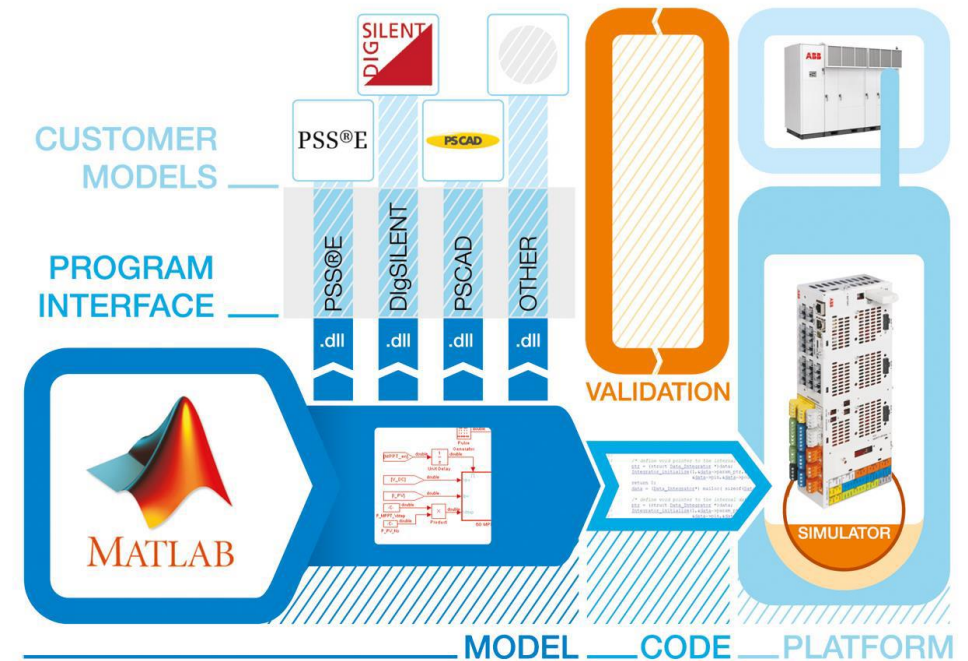
Customer does not need to worry which supported tool to choose, because all of the models are using the same code and models are always up-to-date with actual inverter firmware functions.

Grid support and simulation tools

Modelling, designing, testing and verification

Parametrization and profiles for commissioning – R2 testing

- In commissioning phase, the pre-made parameter sets, which are verified with simulation can be loaded to inverters.
- R2 validation often requires investigation into small discrepancies between the commissioning results and model using simplified computer representations. This is due to the fact that the most models are not a direct clone of the product firmware.



Simulation framework

Summary

- Root model of the framework is a faithful representation of the actual grid related functionality of the inverter firmware.
- Model follows the same parameterization as actual inverter without any interpretations.
- Root model is validated against the real measurements by third party (BDEW/TR4).
- Wrapped models are validated against the root model, and it can be done automatically.
- Framework and models are constantly developed at the same pace.
- If new feature is added to the inverter software, only root model needs to be updated (fast response of changes).
- Improvements/new features are delivered to all models.

Framework approach ensures that models match the real inverter with a high degree of accuracy and all models are equally accurate, resulting in shorter GPS negotiations and de-risking the R2 testing and validation process.

Next steps on central inverter

Next generation central inverter for utility scale applications

PVS980-58 future releases

Larger inverter and station size

- Driving the cost further down

Connectivity and predictive maintenance

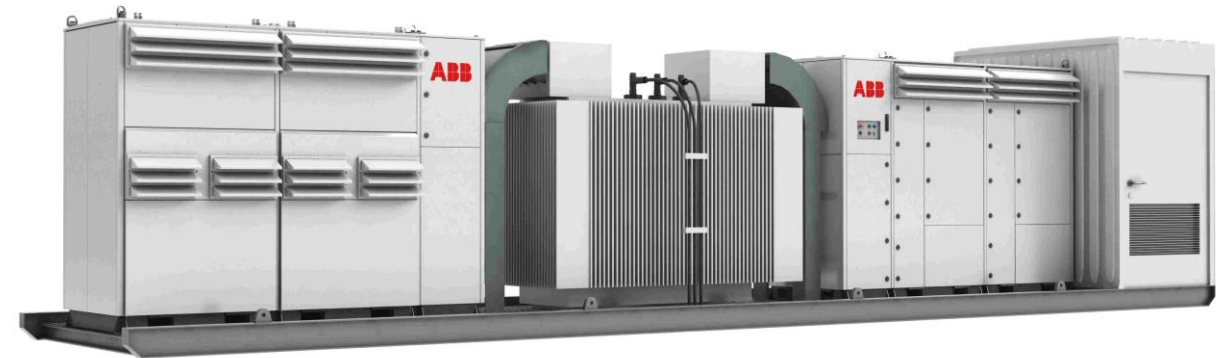
- ABB Ability

Micro grid support integration

- Control interface and supporting functions

PV inverter battery support

- Fast, inbuilt support for battery energy storage systems



ABB



Panel II



Marty Rogers
VP of Global Asset
Management and Support

Daniel Parsons
Business Development
Manager

Anika Giller
Senior Business
Development Manager

Hugh Carr-Harris
CEO



Final takeaways

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