

# Large-format Modules (LFM) and Solar Trackers: Key Considerations and Impact on Plant LCOE

## PRESENTED BY



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Vice President EMEA Sales  
**Nextracker**



**Tomaso Charlemont**  
Global Solar Procurement  
Leader  
**RES-Group**



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## MODERATED BY



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Senior News Editor  
**PV Tech**



**nextracker**  
A Flex Company



**FICHTNER**





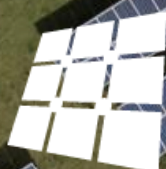
# Large Wafer Modules: considerations from the developer side

Tomaso Charlemont, Global Solar Procurement Leader

April 21, 2021



**FICHTNER**





## RES Overview

### Large Wafer Modules: considerations from the developer side:

- An unprecedented revolution
- Plenty of interesting features
- Every medal has a reverse side

## Conclusion

19<sub>GW</sub>

PROJECT  
PORTFOLIO

40

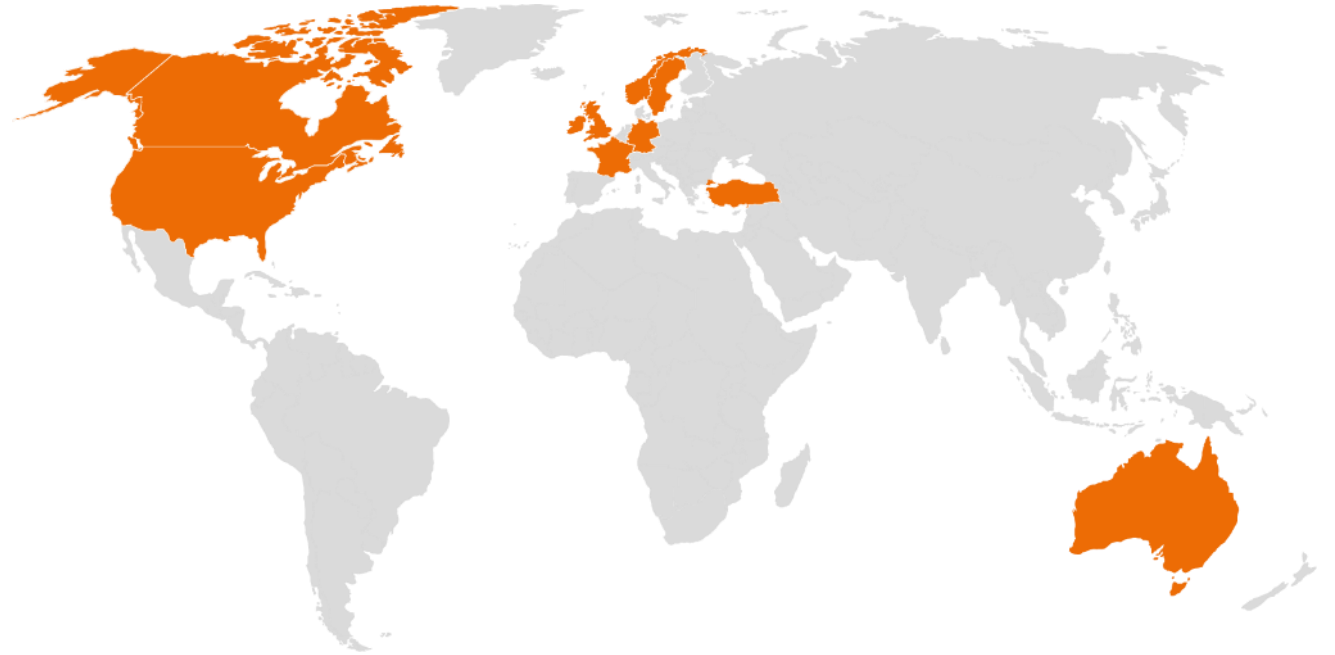
YEARS OF  
EXPERIENCE

7<sub>GW</sub>

OF OPERATIONAL  
ASSETS SUPPORTED

3,000

EMPLOYEES



#### ACTIVITIES



DEVELOP



CONSTRUCT



OPERATE

#### TECHNOLOGIES



WIND



SOLAR



STORAGE



T&D



**1981:** RES (Renewable Energy Systems) established, performing research in wind technology.



**1992:** RES develops and constructs UK's second utility scale wind farm in Cornwall.



**2001:** Creates the world's largest wind farm at the time, the 278MW King Mountain Wind Project in Texas, USA.



**2010:** First 5MWp Solar Project developed, constructed and operated by RES in France.



**2013:** 345km 300MW 230kV Montana - Alberta, US - Canada transmission line completed.

**2014:** First 4MW (2.6MWh) energy storage project becomes operational in Ohio, US.

**2018:** Understanding the unique needs of corporate clients, RES secured over **1.5GW of power purchase agreements (Corporate PPAs).**

**2020:** America's largest bifacial solar project, 216MWp/160MWac begins commercial operations in Georgia, USA.



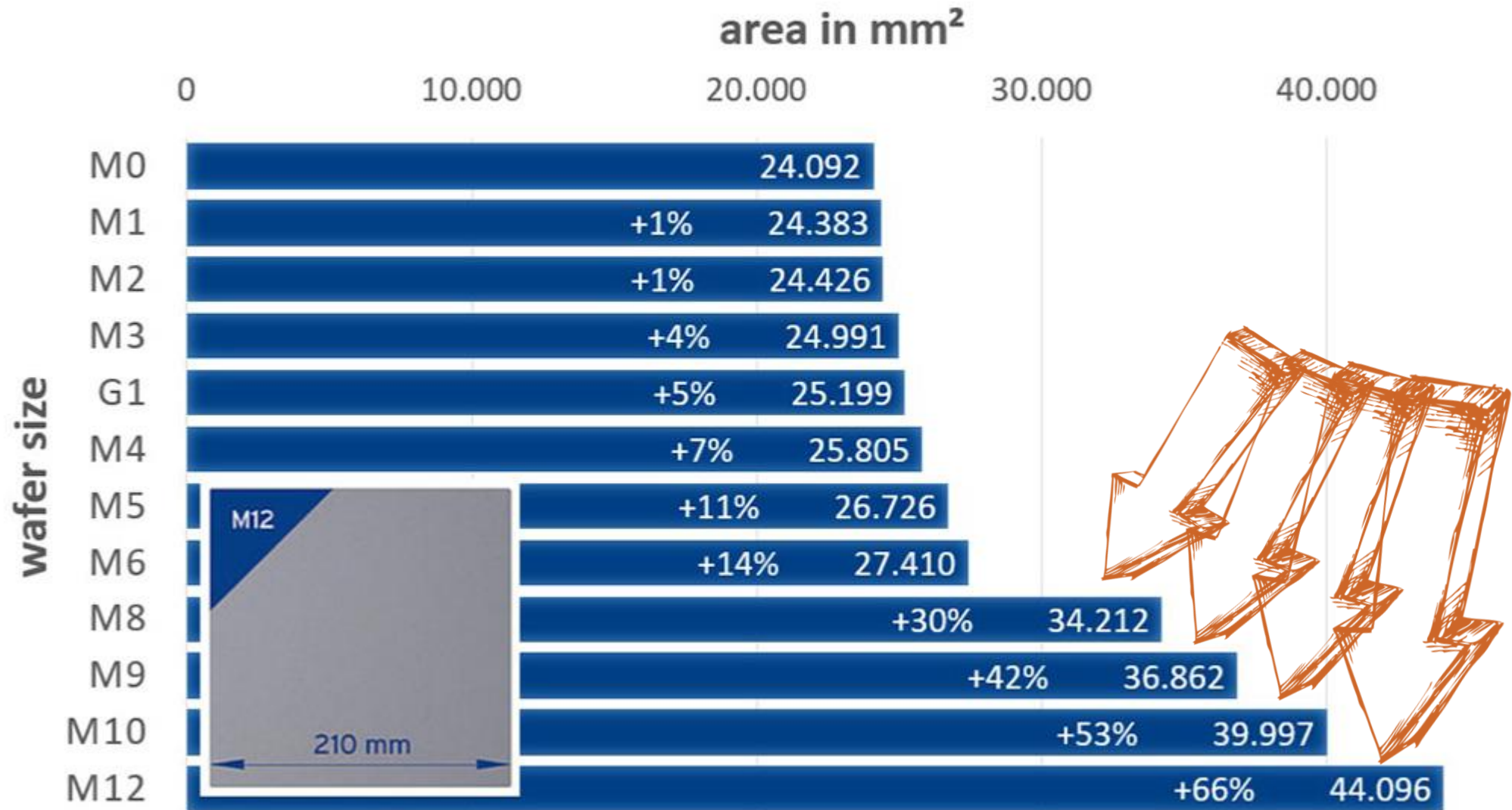




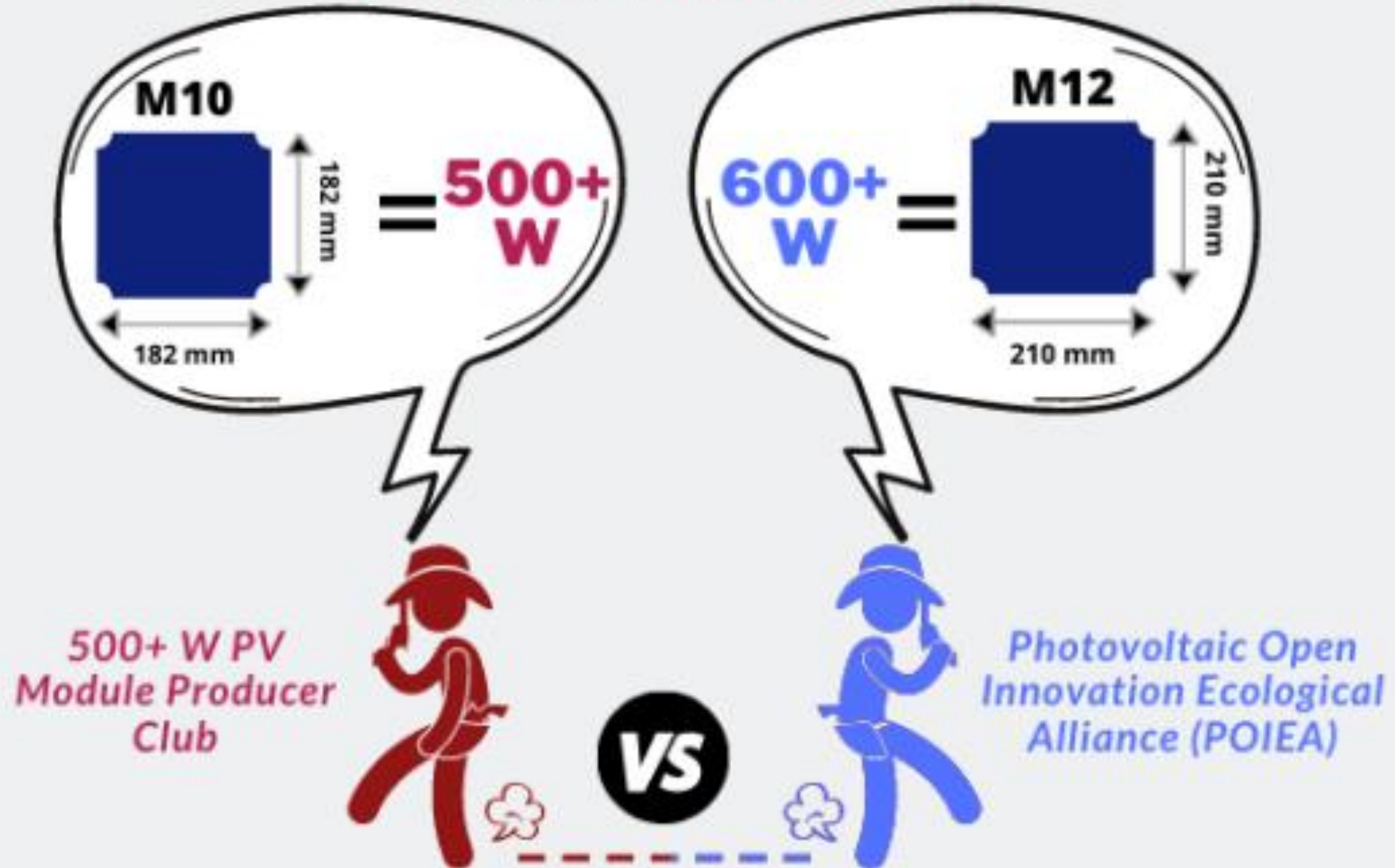




## EFFECTIVE WAFER SIZE DEVELOPMENT









## 2GWp+ Ground-Mount Project Portfolio to date

Country	State	MWp	Tracker	Module	Project type	Status	COD
USA	Iowa	128	2 MIP	G1	RES EPC	Constr	20-Q4
USA	Texas	319	1 MIP	G1	RES EPC	Constr	21-Q3
USA	Ohio	202	1 MIP	G1	RES EPC	Constr	21-Q4
FRA	N. Aquitaine	10	1 MIP	M10	RES DEV+EPC	Constr	22-Q1
USA	Texas	132	1 MIP	G1	RES EPC	Award	22-Q2
USA	Ohio	200	1 MIP	M10	RES EPC	Award	22-Q3
USA	Texas	170	1 MIP	M10	RES EPC	Award	22-Q3
USA	Arkansas	135	1 MIP	M10	RES DEV+EPC	Constr	22-Q4
USA	Missouri	135	1 MIP	M10	RES DEV+EPC	Constr	22-Q4
CAN	Alberta	115	1 MIP	M10	RES DEV	Devel	22-Q4
AUS	New South Wales	245	1 MIP	M10	RES DEV	Devel	22-Q4
AUS	South Australia	187	1 MIP	M10/M12	RES DEV	Devel	23-Q1
TUR	various	78	1 MIP	M10/M12	RES DEV	Devel	25-Q1



## 2GWp+ Ground-Mount Project Portfolio to date - 70% already with LFM

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USA	Texas	170	1 MIP	M10	RES EPC	Award	22-Q3
USA	Arkansas	135	1 MIP	M10	RES DEV+EPC	Constr	22-Q4
USA	Missouri	135	1 MIP	M10	RES DEV+EPC	Constr	22-Q4
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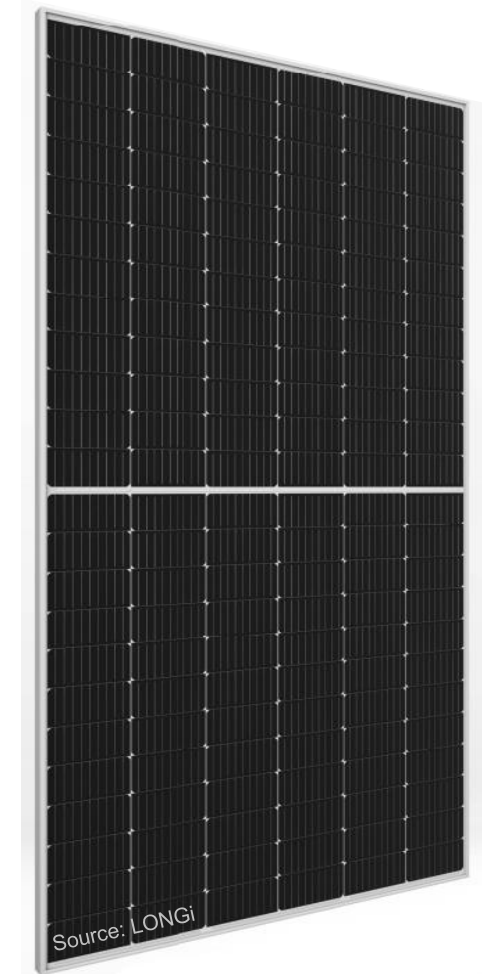
- ✓ Larger Wafers reduce production cost per Wp (more watts produced in the same time).



Source: PV Tech

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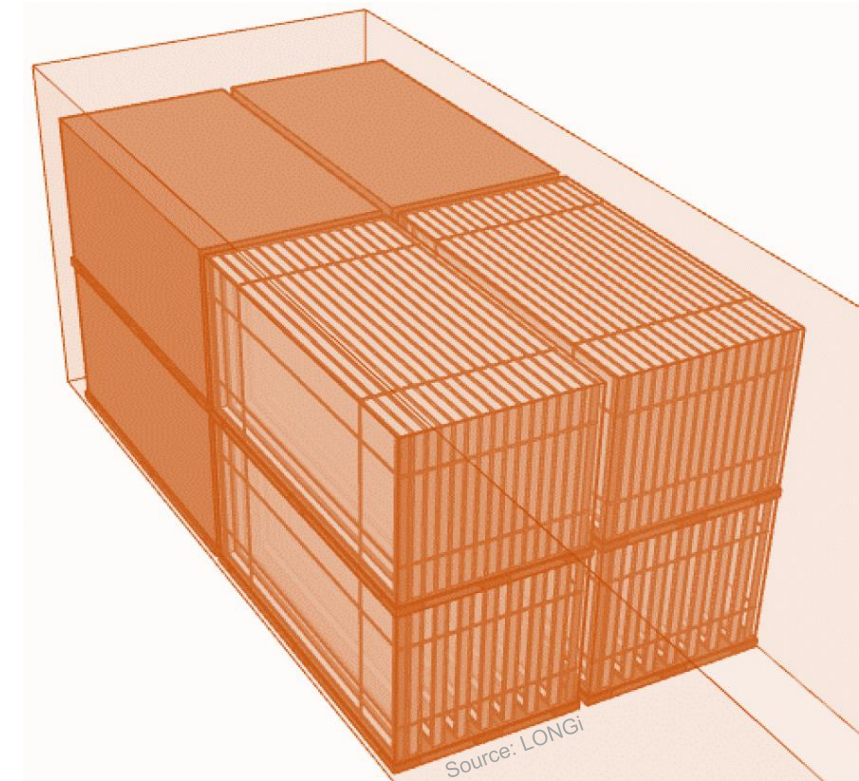
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- ✓ Multiple PV manufacturers collaborate for an industry standard for PV modules.

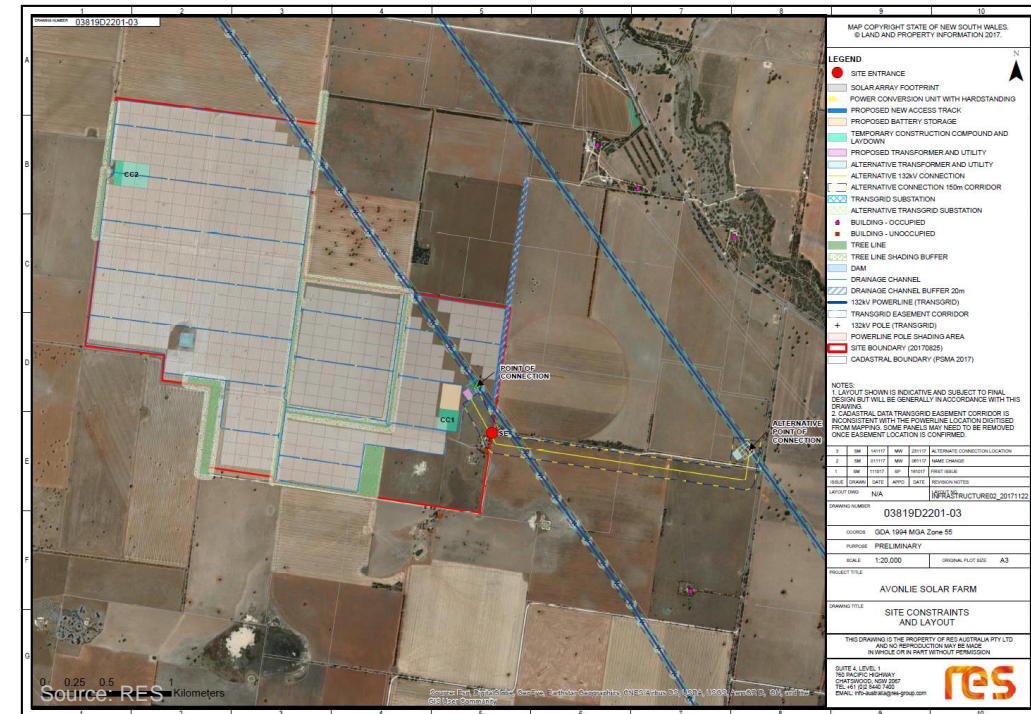


What highly convincing presentations, webinars and white papers do not show, is the reverse side of the medal (yes, every medal has one)



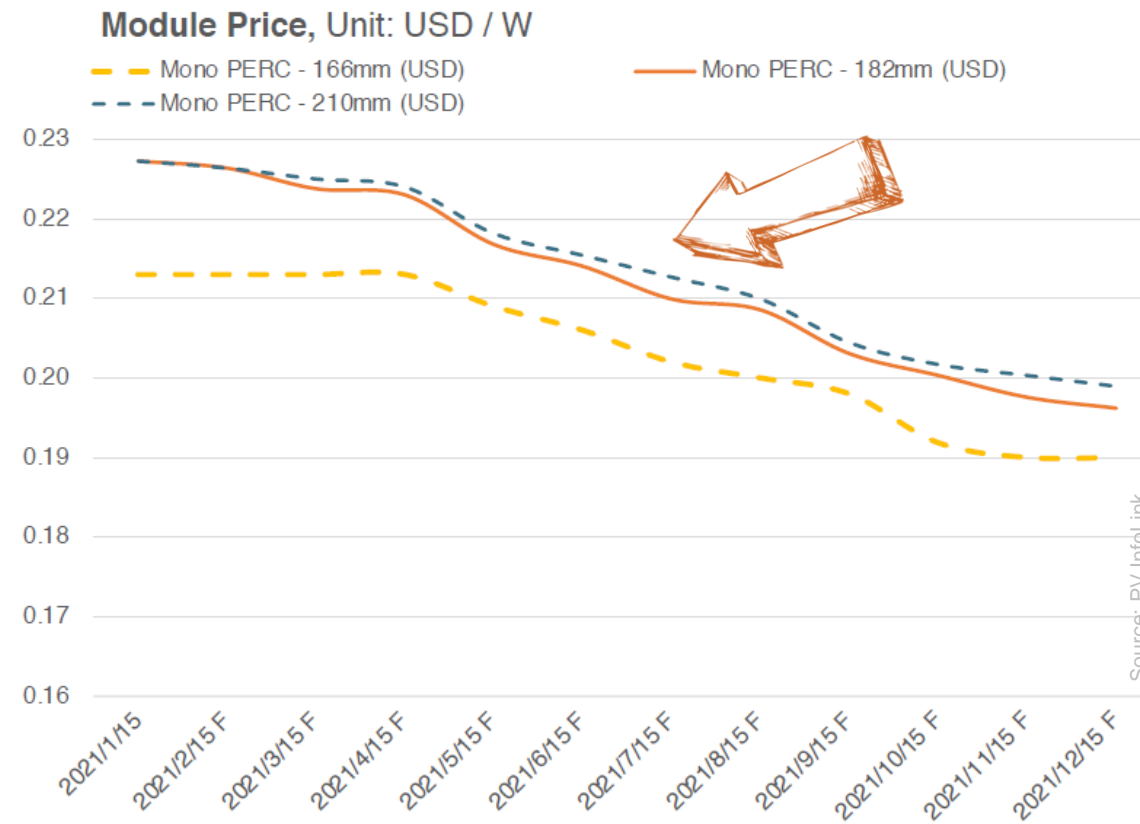
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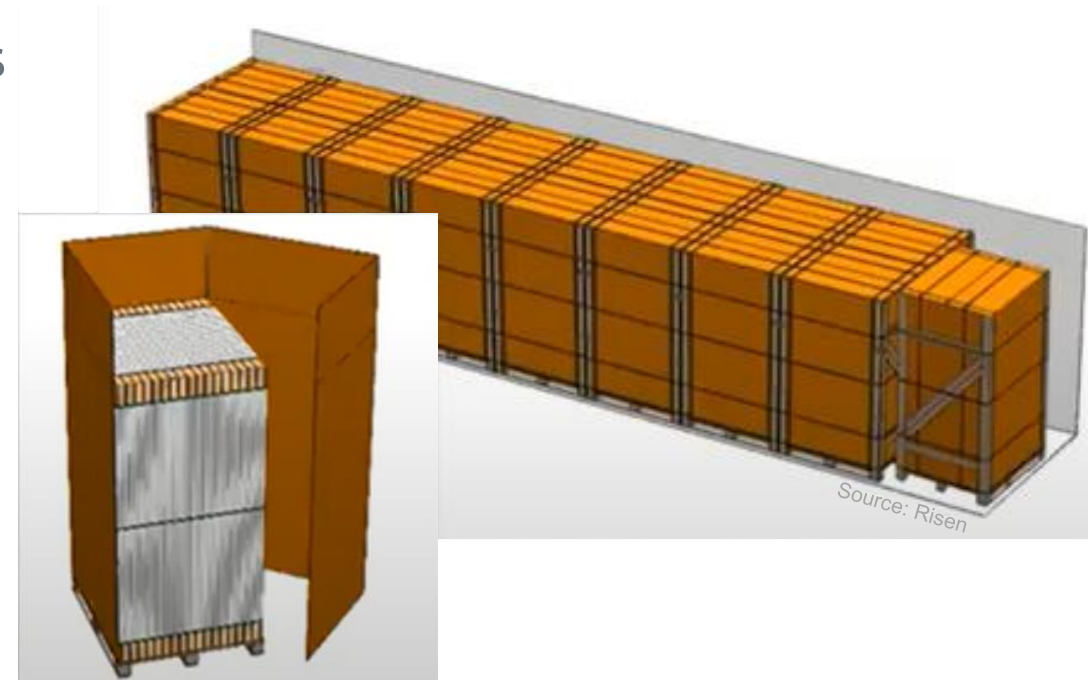
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- ✓ Larger modules are up to 40% heavier; the installation cost per module may increase - but by how much?



Source: RES



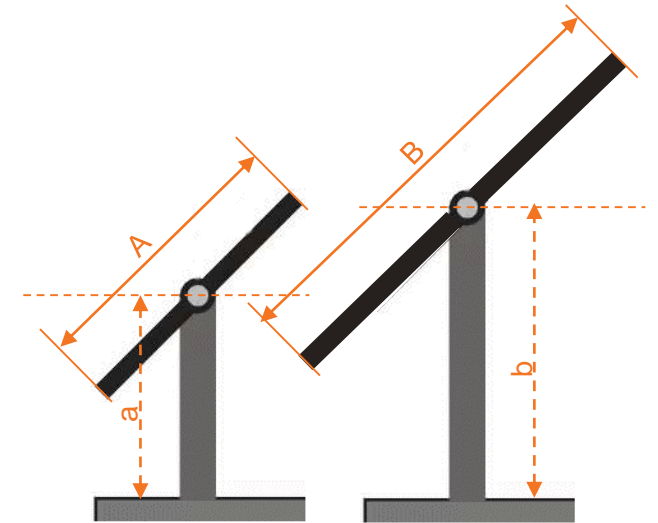
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- ✓ Larger modules are up to 40% heavier; the installation cost per module may increase - but by how much?
- ✓ Different voltages/currents allow more modules per string:
  - this impacts the design of support structures / trackers
  - conventional electrical layout is no longer applicable
  - inverters require new DC protection fuse ratings
  - cable harnesses with over-molded fuses may face limits



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- ✓ The arrival of LFM on the market can cause long lead times and waiting lists at 3<sup>rd</sup> party test labs.



Reports	Number of Reports	Typical Contents	Tentative Timeline (from NTP date)
Witness Report	One	Detailed BOM listing, brief production overview	~1 month from witness date
Intake Report	One	Incoming inspection, initial flash and EL results	1 ~ 2 months
LID Report	One	Light soak to stabilization results on 17 modules	2 ~ 4 months
PAN File and Report	One	PAN measurement results with accompanying PAN file	3 ~ 4 months*
IAM Report	One	IAM measurement results	3 ~ 4 months*
Interim Reliability Report	One	At least: TC200; DH1000; SML+DML; PID96; LeTID162	3 ~ 4 months
Final Reliability Report	One	TC600; DH2000; Full MSS PID192; Full LeTID;	6 ~ 7 months
Interim FE Report	One	6-month capacity test; interim characterizations	7 ~ 8 months
Final FE Report	One	12-month capacity test; final characterizations	14 ~ 15 months

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- ✓ Many EPCs still lack solid experience building projects with large format modules.
- ✓ Some investors are still skeptical due to the limited track record of large format modules.
- ✓ As manufacturing of modules with smaller cells is being phased out, asset management and O&M companies may face module replacement issues on existing sites.







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- ➔ Key equipment evaluation and selection needs to be in tandem with **installation best practices** for maximum optimization of Large Format Modules.



- ➡ The tidal wave of Large Format Modules comes at a cost with **benefits to be proven over time in the field.**
- ➡ Key equipment evaluation and selection needs to be in tandem with **installation best practices** for maximum optimization of Large Format Modules.
- ➡ Collaboration with **trusted industry partners and advisors** is key to understand, evaluate and successfully implement the Large Format Modules deployment.

# Questions? Thank you!

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nextracker<sup>™</sup>  
A Flex Company

# Large PV Modules and Solar Trackers

Preparing for Bigger Things to Come



FICHTNER **res**

Mario Riello

Spring 2021



# Agenda

1. Nextracker intro & track record
2. Nextracker Large format Module (LFM) preparedness
3. LCOE/LFM considerations

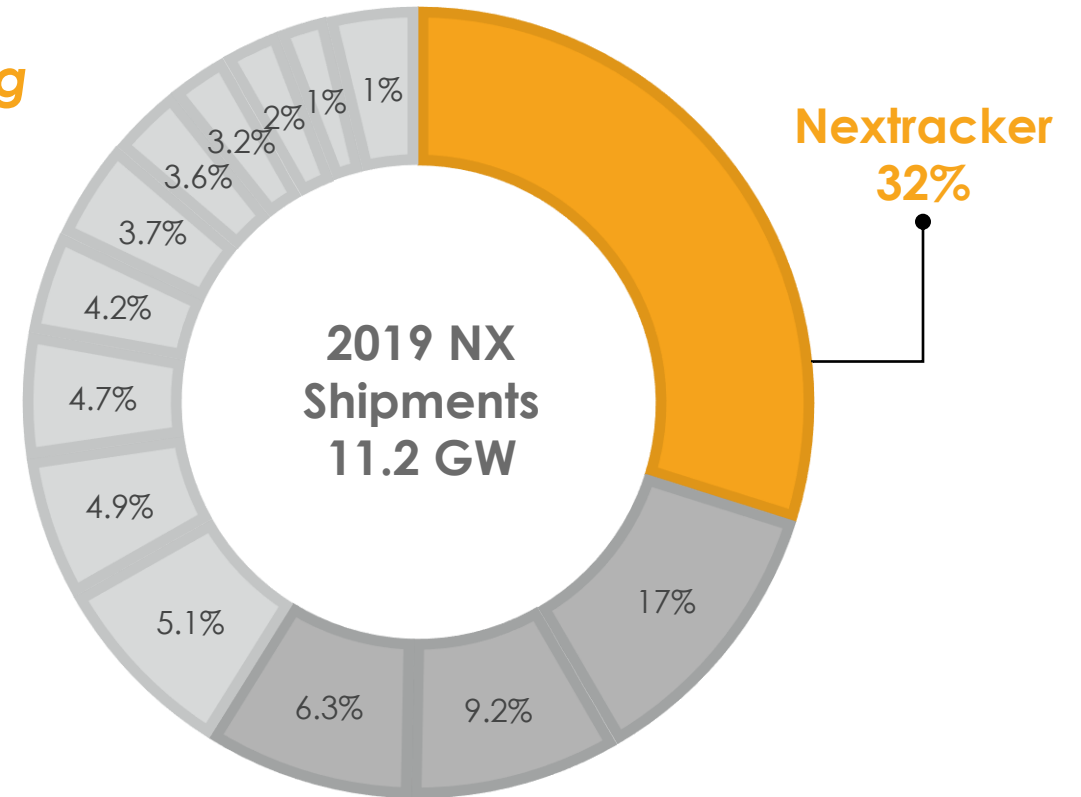
# Company Overview

## #1 Global Market Share Leader in Solar Tracking

- **Shipped 13 GW in 2020 with 50 GW** of solar tracker systems in operation or under construction in 6 years
- **A Flex company**
  - \$25Bn annual revenue, \$14Bn balance sheet
- **Global presence**
  - 400 staff worldwide, 8 global offices
- **Robust product lines**
  - Solar trackers, software and controls, digital O&M
- **Deep PV expertise and experience**
  - 350 years of collective PV experience on executive team

**Our Vision-** Renewable energy powers the world – delivering clean, affordable power to all.

**Our Mission-** To be the world's leading energy solutions company delivering the most intelligent, reliable and productive solar power for future generations.



**#1 market share leader six consecutive years: 2015-19**

Source: IHS Markit, July 2020

# Nexttracker Industry Firsts

Nexttracker has led the industry in features & capabilities that increase performance while reducing costs for customers and owners



## Independent Rows Balanced Tracker

93 module row, 1500V 120° tracking range, torsional limiter each pier



## Self Grounded Tracker

UL2703 & 3703 certification, no need for separate grounding components



## Self Powered & Smart Tracker

Eliminates AC power; integrated UPS; wireless communications; smart module



## Predictive Analytics & Digital O&M™

Auto-commissioning, remote monitoring & control; NERC-CIP compliant



## Smart Controls & Software

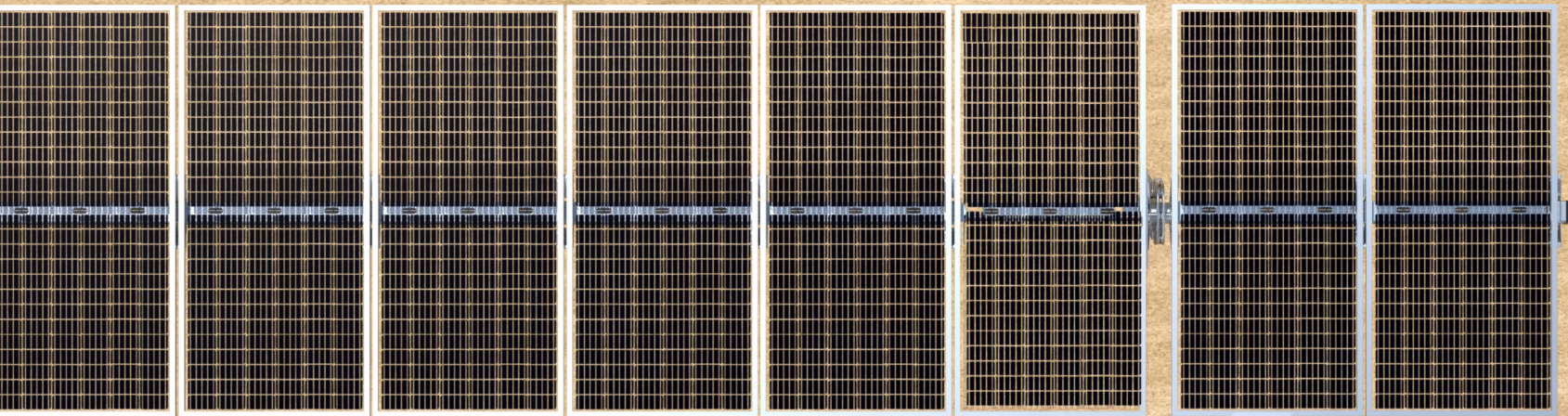
Using machine learning and weather data, TrueCapture & NX Navigator™ enhance energy yield; and mitigates risk of hail stow, hurricane, and snow



# Agenda

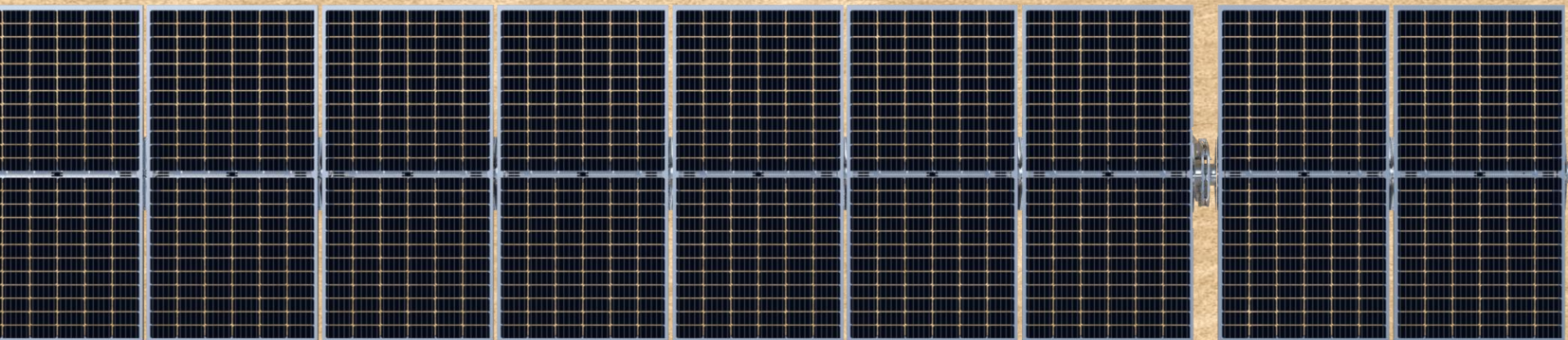
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- 2. Nextracker Large format Module (LFM) preparedness**
3. LCOE LFM considerations





## **Nextracker: Going Big the Right Way**

*Preparing for a future of large format PV modules*

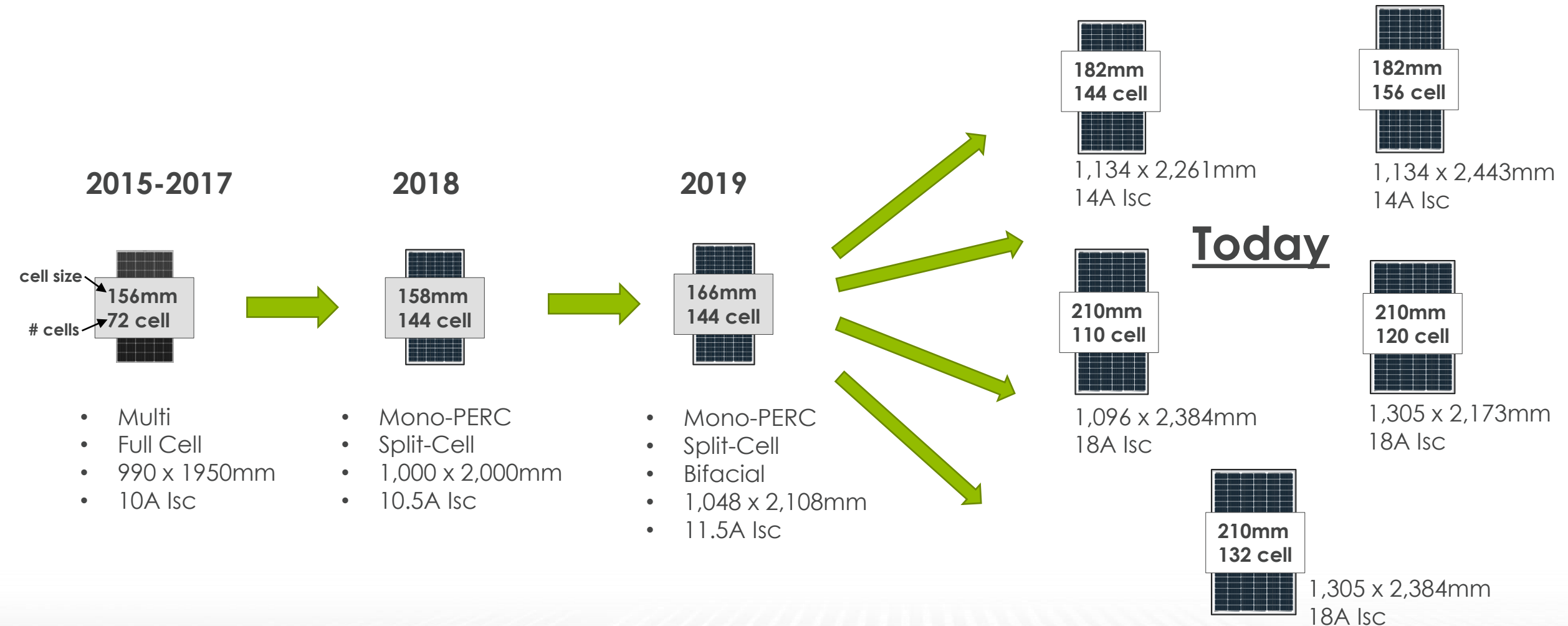


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A Flex Company



# The Evolution of PV Module Size Formats

*Increasing cell size & efficiency to decrease costs*



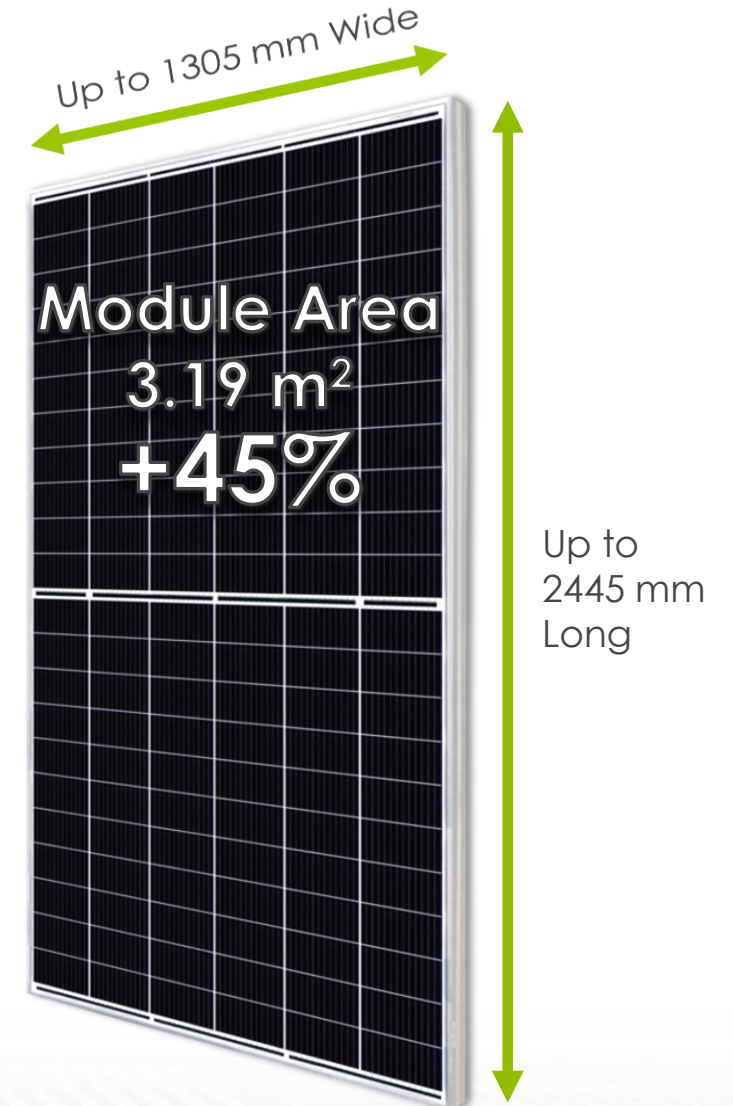
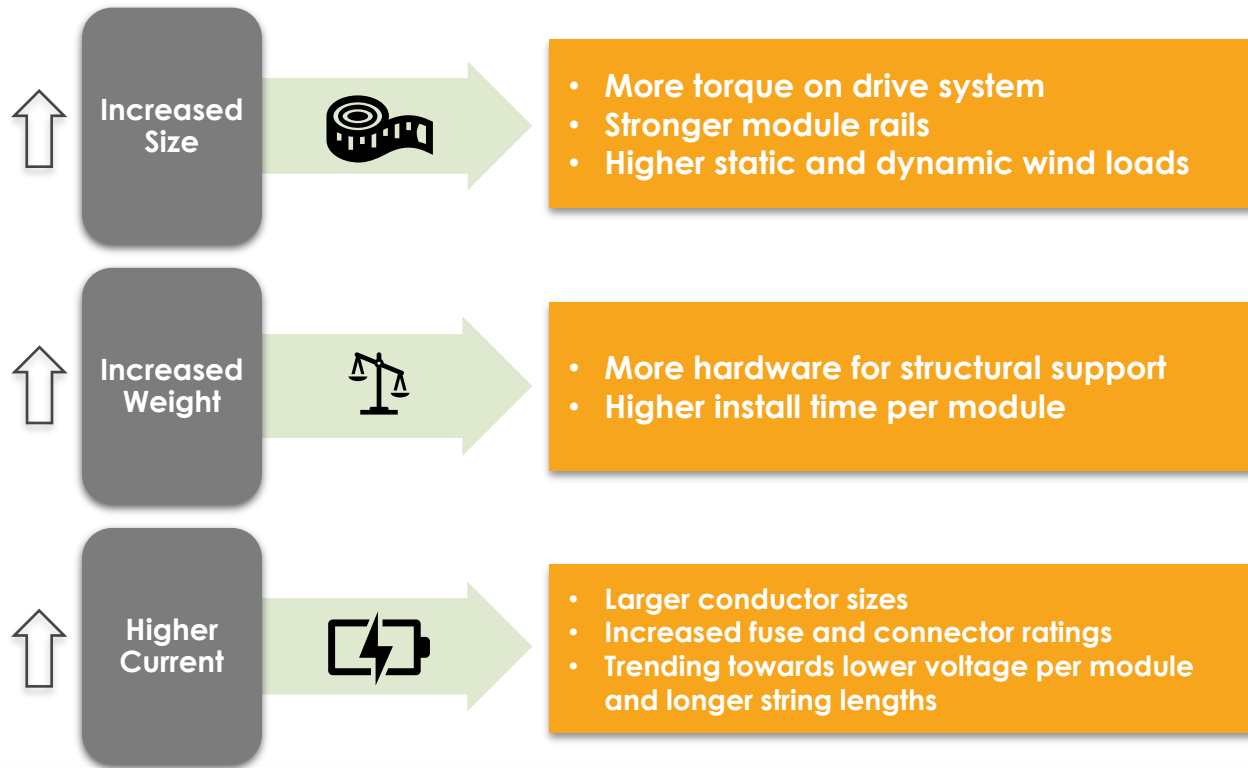


# Implications of LFM for Tracking Systems

## Key considerations for tracker preparedness

### Module Changes

### Tracker Impact



# Large Module Preparedness



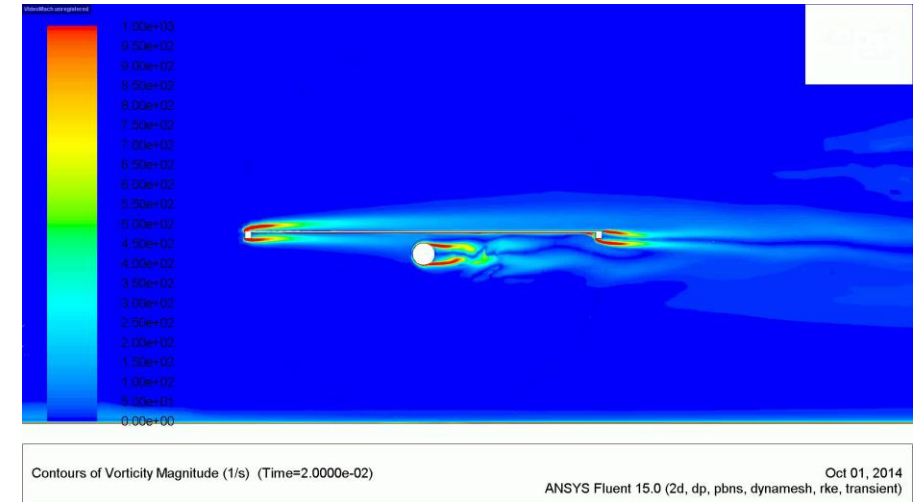
## New Wind Tunnel Testing for Large Modules

- Updated wind tunnel testing by CPP
- Ensures stability with even the biggest module form factors

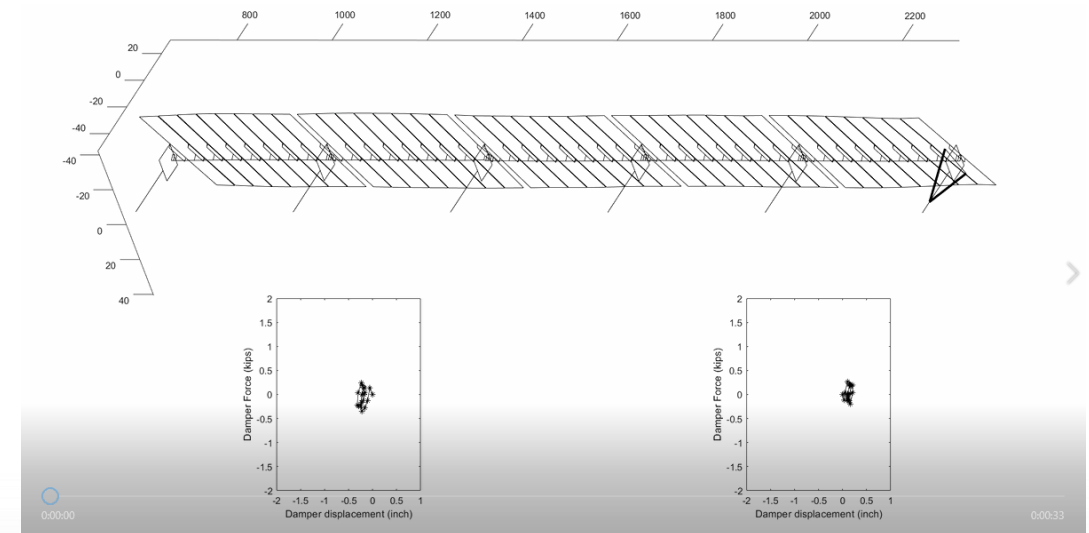
## Advanced Dynamic Analysis

*Developed by Nextracker and CPP*

- Pioneered and completed the most advanced dynamic analysis in the industry
- Predicts and analyzes multiple dynamic modes for large modules with the most state-of-the-art methods



## Dynamic Response of a Tracker



## Dynamic Load Analysis

# Future-proof: PV Module Validation Program

## Nextracker Validates Each Module Type

*by both Nextracker and Module Suppliers*

- Module Brand
- Dimension
- Weight



**Nextracker Test Lab:** Nextracker goes to great lengths to test for each module in our very own test lab.



**LONGI** Solar

 **risen**

 **CanadianSolar** 

**Q CELLS**  
a Hanwha company

**JA** SOLAR

**Trina**solar



**Supplier Test Lab:** A load test with Nextracker's system at JinkoSolar testing facility.



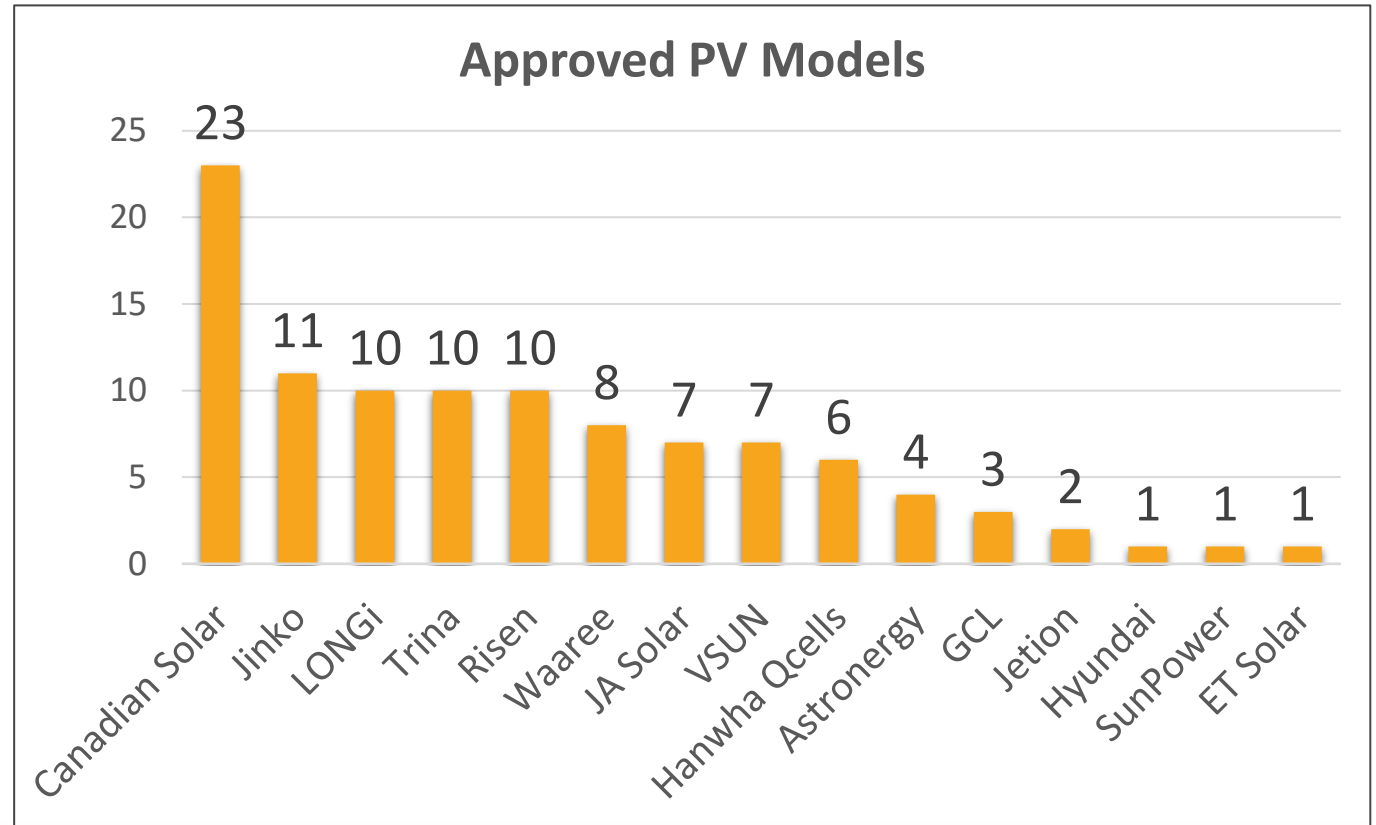
# Future-proof: Taking No Chances

Testing for Each and Every PV Model Type with our Tracker

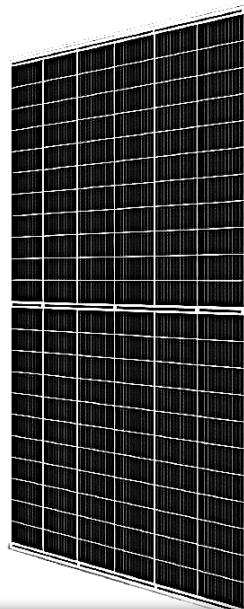
And Many More ....

## Ensuring the Highest Quality and Reliability in the Field:

- 100+ PV Module types tested and approved
- Written letter of approval from PV supplier



**Approved for LARGEST module size forecast for the next 2-3 years**



# CanadianSolar

# BiHiKu7

- ✓ 2384 \* 1303 mm
- ✓ 660W

Module #	Mod. Dimension L x W x H(mm)	NX Tracker version	Fastener Clearance	
			Dim 'Y' (mm)	Dim 'X' (mm)
CS7N-xxxMB-AG (BiHiKu 7)	2384 x 1303 x 35	2.4	23.7	10.1
CS7L-xxxMB-AG (BiHiKu 7)	2172 x 1303 x 35	2.4	23.7	10.1
CS7N-xxxMS (HiKu 7)	2384 x 1303 x 35	2.4	25	10.5



Publication Date	Feb. 5 <sup>th</sup> , 2021		
Module Manufacturer	Canadian Solar		
NEXTracker Version	NXH & NX100		

**Scope**

This document is to approve the full compatibility between NEXTracker Parts (Standard Rail and Supplemental Rail for High Pressure Zones on NX Horizon) Model Numbers mentioned in Table 1.

**Details**

**Table 1: Maximum Pressure Rating with NX PV Module Mounting Solution**

Module #	Max. Dimension L x W (inches)	NX Tracker version	Fastener Orientation		NX Standard Load (lbs)		Standard Short Rail (200' standard length)		Standard Short Rail + Supplemental Rail (200' standard length + 1' supplemental rail)		10/17/19 Loading Revision				
			Wind (°)	Snow (°)	Wind Spanned (ft)	Wind Design Load (PSF)	Incremental Spanning (ft)	Wind Spanned (ft)	Wind Design Load (PSF)	Wind Spanned (ft)	Wind Design Load (PSF)	Allow. #	Incremental Spanning (ft)		
1770x-nx400-40 (Standard)	1770x x 1200x x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
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1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000	2	1200	8 x 124	1200	12000	120 x 120	120
1770x-nx400-40 (Standard)	1770x x 1200 x 40	2.4	12/17	12/19	1000	7 x 120	1200	12000							

Date: Feb. 20<sup>th</sup>, 2021

**Approved:**

Date: Feb. 20<sup>th</sup>, 2021

**Approved:**

Date: Sept. 25<sup>th</sup>, 2011

Approved

Date: Sept. 25<sup>th</sup>, 2020

Approved



## PV Supplier Approval Letters



# Agenda

1. Nextracker intro & track record
2. Nextracker Large format Module (LFM) preparedness
3. LCOE/LFM considerations



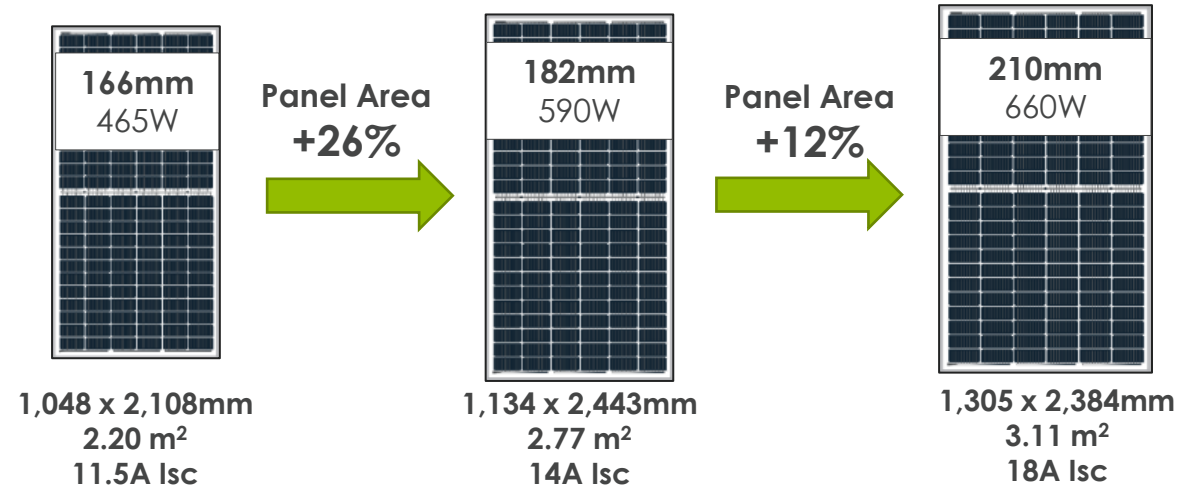
# LFM Impact on LCOE

## Trackers and LFM Highlight:

- More power per tracker row
- More power per total area

## Downstream Impact per MW:

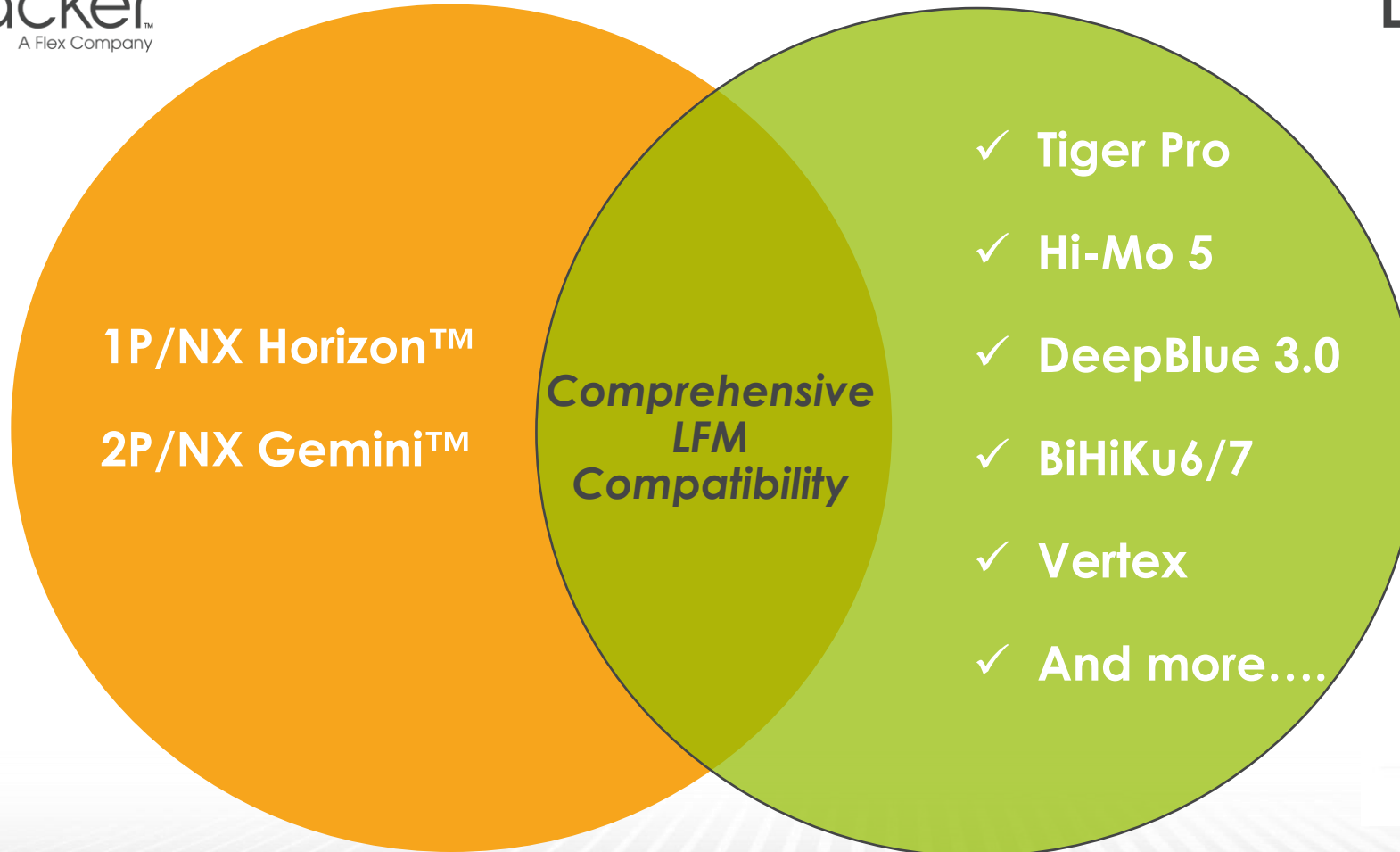
- 18 to 22% labor reduction
- 13 to 16% pier reduction
- Less total wiring
- Less land area



Module Type	Module Power	# of Strings per row	Modules per String	Total # of panels	Power per Tracker Row	Total Panel Area	Power per Area	Power per Row Delta vs. 166mm
166mm	465W	3	28	84	39.0 kW	186 m²	207 W/m²	
182mm	590W	3	26	78	46.0 kW	216 m²	212 W/m²	+17% ↑
210mm	660W	2	31	62	40.9 kW	193 m²	212 W/m²	+4.9% ↑

Typical Row Configurations

# Nextracker + Top Tier Module Suppliers



## LFM Suppliers



# Additional Resources – White Paper

- Available at [www.nexttracker.com](http://www.nexttracker.com)

## White Paper: Mitigating Extreme Weather Risk

**PART 1:** Understanding How Differentiated Design and Control Strategies Unlock New Opportunities for Solar Development

**Part 2:** Surviving High-Wind Events and Dynamic-Wind Effects with Differentiated Solar Project Design and Control Strategies

“At a minimum, owners and insurers need to ask for a simple explanation as to how companies are achieving lower cost without increasing risk.” – **David Banks, President, CPP**







nextracker<sup>™</sup>  
A Flex Company

Thank you!

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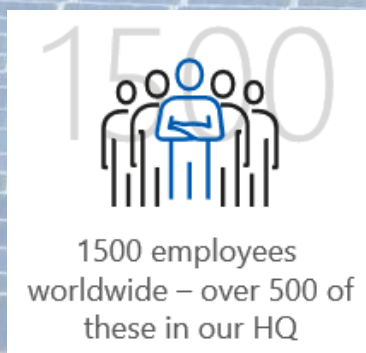
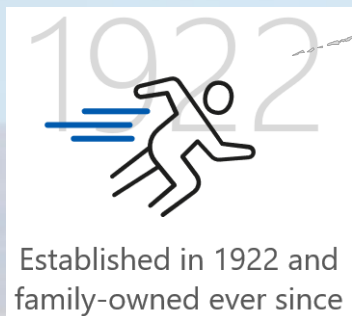
[www.nextracker.com](http://www.nextracker.com)



from the Advisor's perspective:

## Large-format Modules (LFM) and Solar Trackers: Key Considerations and Impact on Plant LCOE





**Centers of PV expertise in Germany, Italy, Spain, Great Britain, Turkey, Saudi Arabia, UAE and Malaysia**

**> 500 projects in more than 70 countries with a capacity of >50 GW**

- 200+ Lenders-Engineering-Projects
- 20+ Owners-Engineering-Projects
- 100+ Feasibility Studies



## Range of Services

The Fichtner Group can call on a network of highly qualified engineers and consultants to cover all aspects of solar photovoltaic power generation and hybrid solutions.

- Owner's Engineer (OE), all project phases
- Lender's Technical Advisor (LTA)
- Transaction Advisor on large scale IPP projects
- Technical Due Diligence
- Feasibility Studies (concept design, yield simulation...)
- Construction supervision
- Witnessing the commissioning, acceptance and performance tests
- Monitoring of plant operation and maintenance



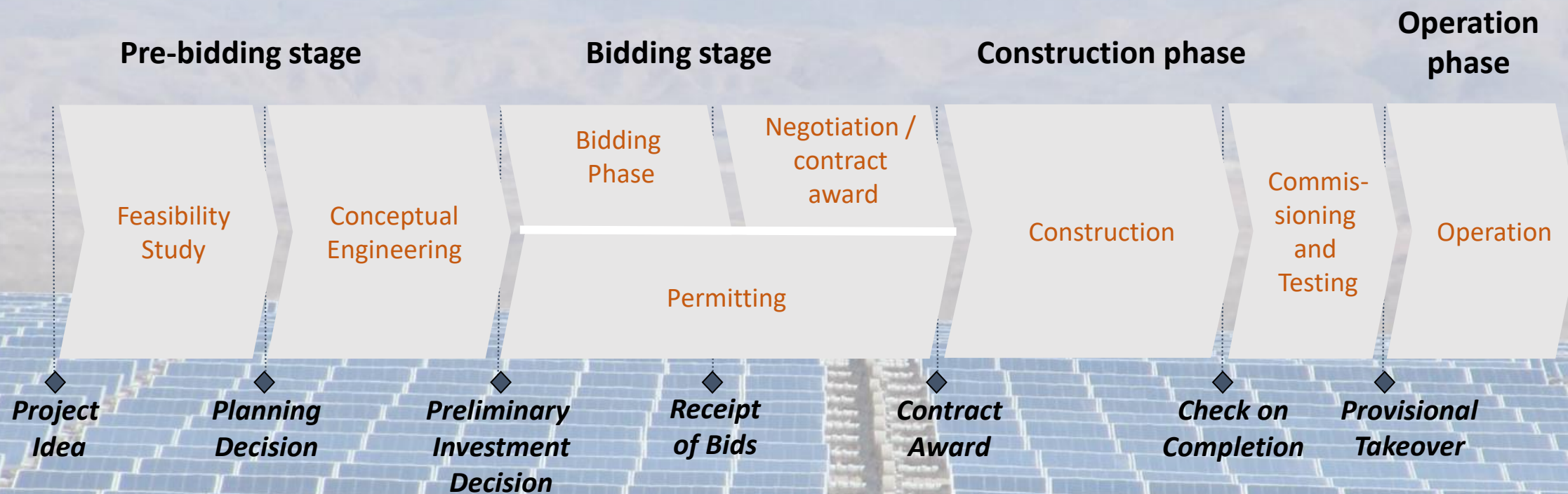
Source: Fichtner

## Recent project highlights

- Talasol PV plant in Spain, 300 MW
- Sweihan and Al Dhafra in Abu Dhabi, 1,170 MWp and 2,101 MWp
- MBR Solar Park Phases III and V in Dubai, 800 MW and 900 MW
- Ibri II and Manah PV IPP's in Oman, 3x 500 MW
- Sakaka, Saudi Arabia, 300 MW

## Can Large Format Modules (LFM) work reliably with trackers while meeting LCOE requirements?

- Proper design and quality control is essential for a successful project implementation and operation
- Different quality criteria in different phases of a project
- Early involvement of tracker supplier during all project phases





## Pre-bidding stage

## Bidding stage

## Construction phase

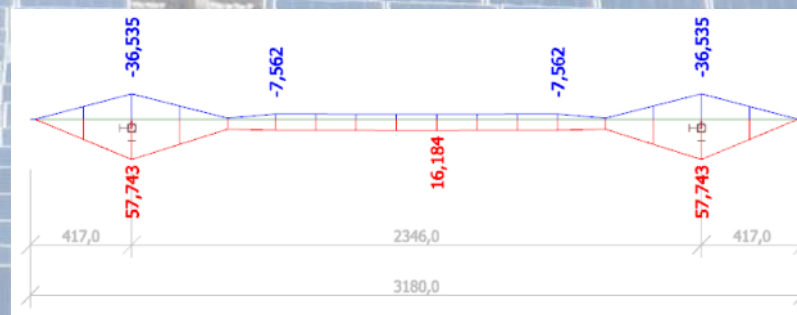
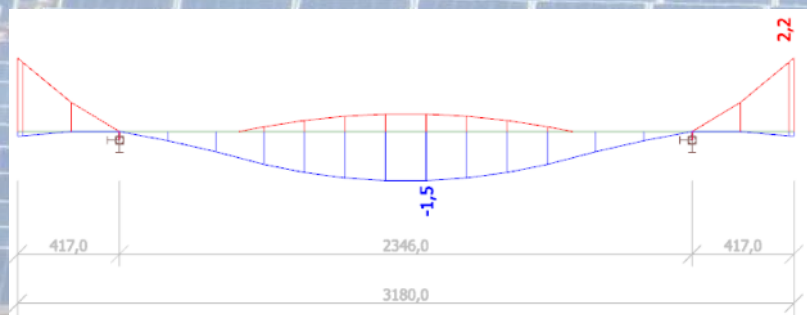
## Operation phase

## Consideration of impact of larger modules on trackers, e.g. :

- PV module eligibility requirements
- Track record & certificates
- Confirmation of compatibility with the (pre-)selected tracker
- Structural requirements
- Track record & tests: wind tunnel tests, tracker dynamic analysis, full scale outdoor tests (module size, loads, bifacial operation)
- Adjustment of stow strategy
- Adjustment of module cleaning procedure (cleaning robots)
- **Option:** independent certification and due diligence for pre-qualification of tracker suppliers or product

## Example for module eligibility requirements

- Track record / references from a renowned PV module supplier
- Relevant certificates, e.g.
  - IEC 61215 type approval
  - IEC 61730 module safety
  - IEC 60068-2-68 Environmental testing
  - IEC TS 62804-1 PID free
  - IEC 61701 Salt mist corrosion testing
- product warranty > 10 years
- power output warranty 30 years





Pre-bidding stage

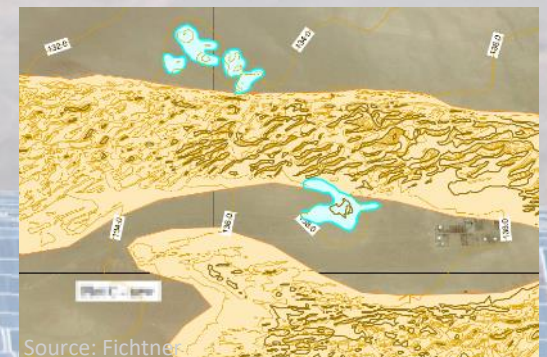
Bidding stage

Construction phase

Operation phase

**Bidding stage:**

- Minimum Function Specification (MFS) defines all requirements for the overall system and the components:
  - Site specific
  - Civil
  - Electrical
- Consideration of the site conditions for the bid-design:
  - Design wind speed (ref. at 10m as 3 sec gust and 10 min average)
  - Geotechnical survey (core samples, test pits: drilling / ramming)
  - Topographic study
- Responsibilities to be clarified for the site-specific design: structure, foundation, installation
- Warranties for the tracking system to be well structured with clearly defined interfaces





## Pre-bidding stage

## Bidding stage

## Construction phase

## Operation phase

**Requirements during the construction phase:**

- Procedure and criteria to be defined for a potential PV module replacement during late procurement phase
- High-quality and complete set of documents available at early stage for the detail design review
- Commissioning with sufficient and experienced staff
- Role of the Owner's Engineer
  - design review
  - check quality of supplied materials (e.g. coating thickness)
  - construction supervision (e.g. foundation, structure and module installation)
  - supervise the QA/QC procedure from the EPC contractor who must comply with the design and the specification
  - attend the commissioning, acceptance and performance tests





Pre-bidding stage

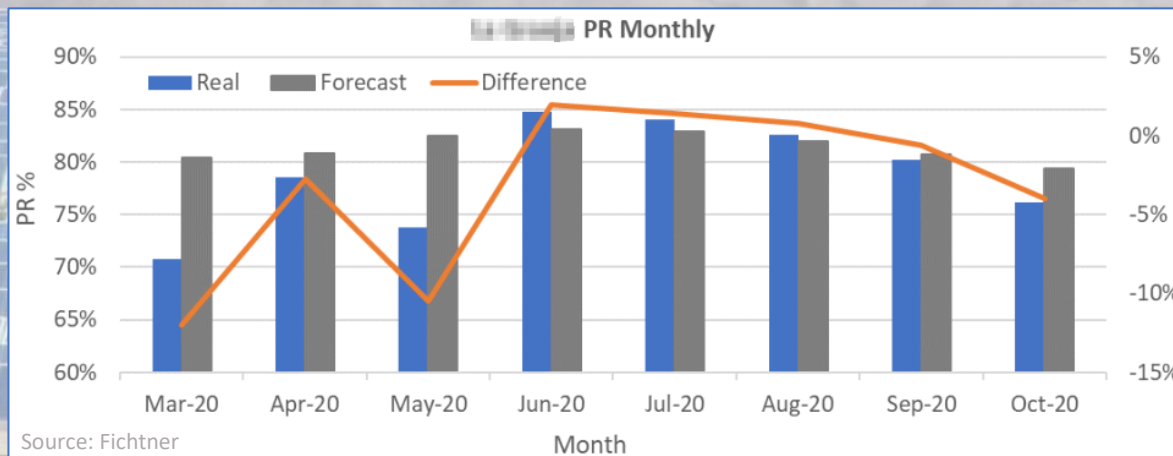
Bidding stage

Construction phase

Operation phase

## Operation phase:

- On-site presence is the responsibility of the EPC contractor, but if required: tracker supplier stays at the site during the first weeks after PAC/COD for finetuning
  - Signal exchange, SCADA / monitoring
  - Quick reaction time for teething problems
- Frequent module cleaning (dry or water, manual or automatic) as well as high tracker availability can lead to the expected generation and a high PV plant performance (PR)






## Lessons learnt - examples

### Lessons learnt:

- real site conditions are considered (design wind speed, soil conditions, topography)
  - wind mast with sufficient height is installed at the site
  - manpower is sufficient to unpack and mount large and heavy modules
  - tracker unavailability is properly defined in the contracts
- Avoidance of delay, downtime, underperformance, corrective actions, warranty claims, LD's...



Thank you!

The Fichtner logo, consisting of a stylized cross made of four grey bars of varying lengths, with the longer bars intersecting at the center.

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