



## *JinkoSolar EU*

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**What is the impact of Tiger PRO modules on the LCOE of utility scale projects?**

# Tiger PRO - introduction

*TIGER* Pro72 TR  
Up to 535 Wp



*TIGER* Pro 78 TR  
Up to 585 Wp



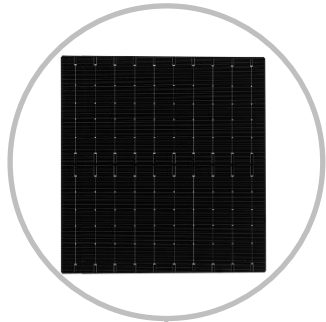
*Benchmark*

	Cheetah 410	Tiger 475		Tiger Pro 535	
Weight (kg)	22	25		29	
Area (m <sup>2</sup> )	2.00	2.25	<b>+12.5%</b>	2.53	<b>+26.5%</b>
Modules/container (pcs)	770	620		620	
Power/container (Wp)	315,700	294,500		331,700	<b>+5%</b>

# Tiger PRO - Technology

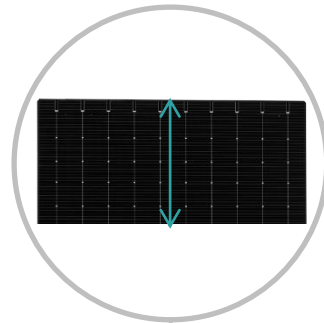
## MBB

Decrease power loss effectively



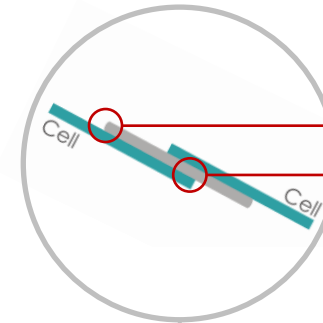
## HC Technology

Improve shading tolerance because of splitting a full-cell into half



## Tiling Ribbon (TR)

Eliminate cell gap to increase module efficiency significantly.



Using circular ribbon

Overlap on each cell to eliminate the gap

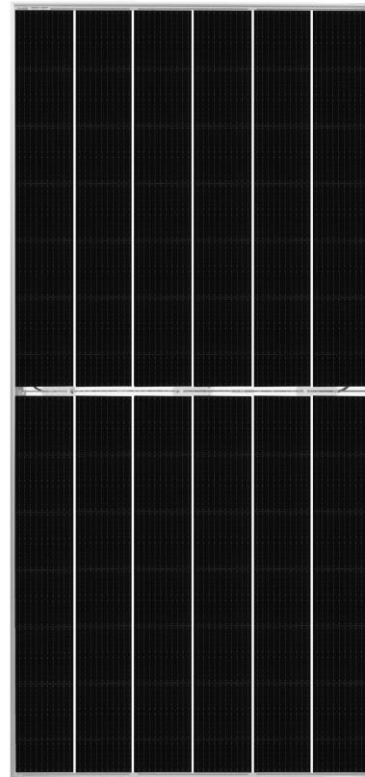


# How Tiger PRO can reduce the LCOE?

## Tiger PRO Brings Saving on System Cost

### Power Class Maximization

- Tracker cost
- Foundation cost
- Site clearance
- Module installation cost
- Tracker installation cost

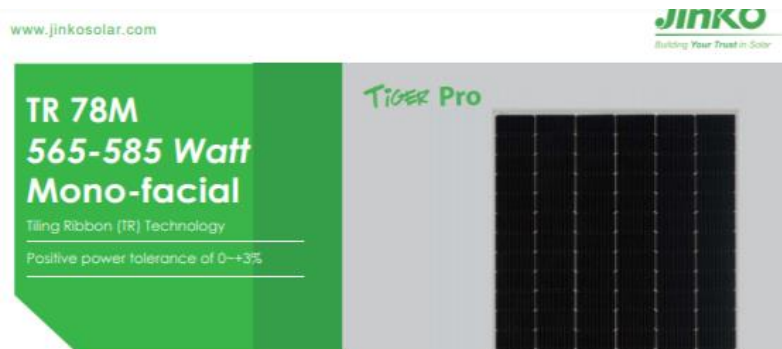


### Module Technical Innovation

- Highest efficiency
- Lower VoC
- Higher power output
- Highest compatibility with the inverter and mounting system
- Advanced Warranty



# Technology Components Impacting LCOE

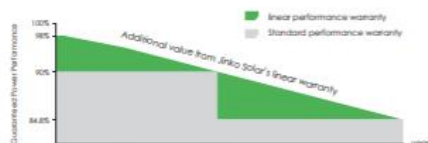


## KEY FEATURES

- TR technology + Half Cell**  
TR technology with Half cell aims to eliminate the cell gap to increase module efficiency (mono-facial up to 21.40%)
- MBS instead of SB**  
MBS technology decreases the distance between bus bars and finger grid line which is benefit to power increase.
- Higher lifetime Power Yield**  
2% first year degradation, 0.55% linear degradation
- Best Warranty**  
12 year product warranty, 25 year linear power warranty
- Strengthened Mechanical Support**  
5400 Pa snow load, 2400 Pa wind load

## LINEAR PERFORMANCE WARRANTY

12 Year Product Warranty • 25 Year Linear Power Warranty  
0.55% Annual Degradation Over 25 years



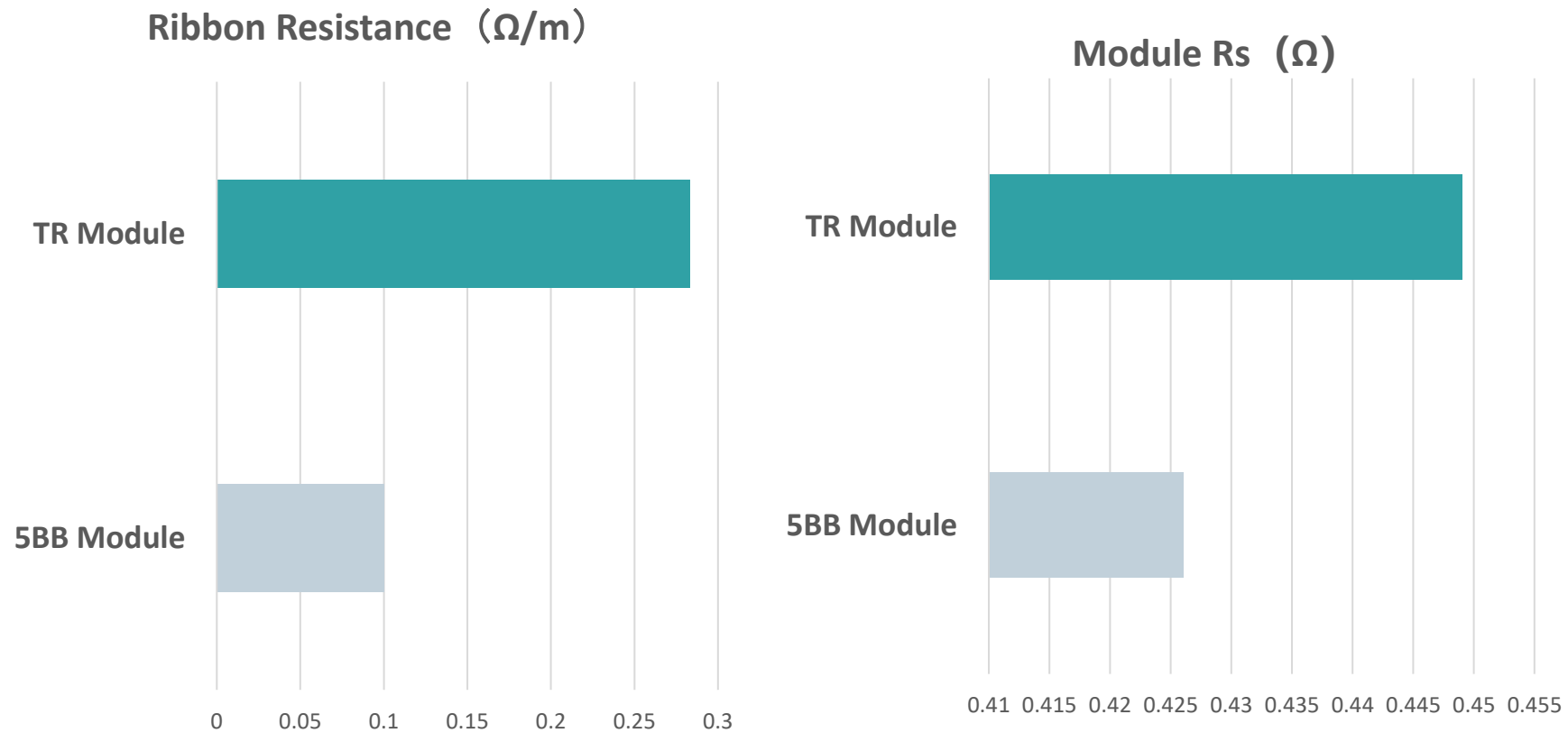
ISO9001:2015, ISO14001:2015, ISO45001:2018  
certified factory

IEC61215, IEC61730 certified product

- Rated Power
- Cell Technology
- Efficiency
- Electrical Parameters
- Temperature Coefficients
- Module Dimensions
- Warranties
- Project Design
- Energy Yield Assessment
- BOS Specification

# Low Irradiance Performance

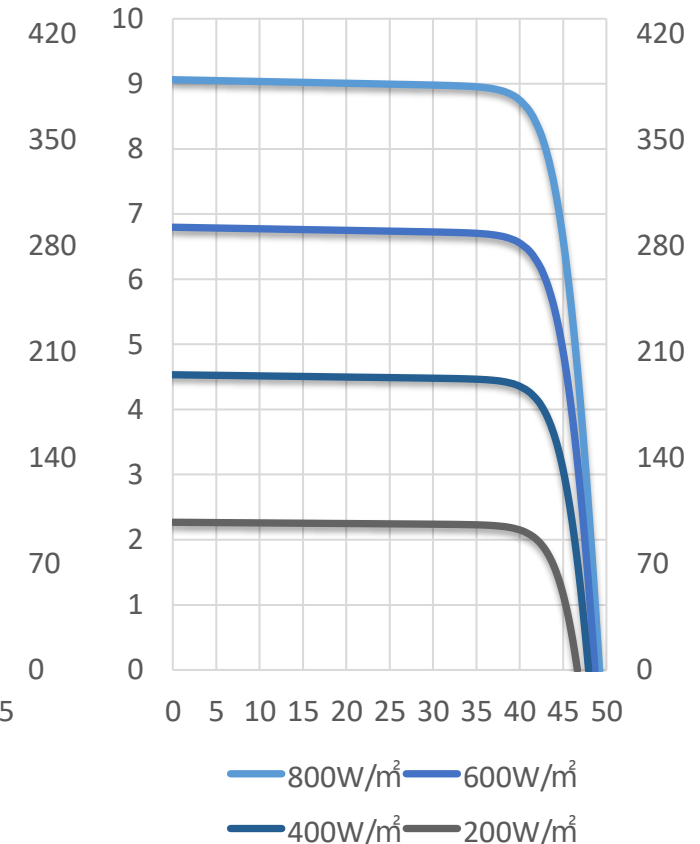
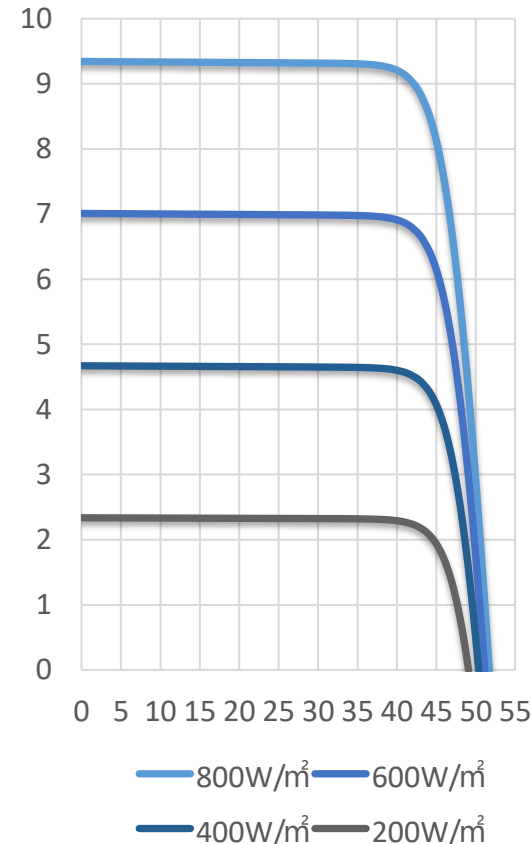
Compared with Traditional 5BB Module, the reflection of Tiger will increase about 5.4% and shows better performance in low irradiance environment.



# Low Irradiance Performance

Comparing with normal module, Tiger module shows better performance in low irradiance environment.

Module	Power	Gain
<b>800W/m<sup>2</sup></b>		
<b>Tiger 470w</b>	380.2w	<b>80.9%</b>
<b>Traditional 5BB Module 440w</b>	353w	80.2%
<b>600W/m<sup>2</sup></b>		
<b>Tiger 470w</b>	286.4w	<b>60.9%</b>
<b>Traditional 5BB Module 440w</b>	264.4w	60.1%
<b>400W/m<sup>2</sup></b>		
<b>Tiger 470w</b>	190.7w	<b>40.6%</b>
<b>Traditional 5BB Module 440w</b>	175.3w	39.8%
<b>200W/m<sup>2</sup></b>		
<b>Tiger 470w</b>	94w	<b>20.0%</b>
<b>Traditional 5BB Module 440w</b>	86.1w	19.6%



# 3rd Party Result

TABLE: IEC61853-2 : 2016					—
Test Date [MM/DD/YYYY].....:		02/14/2020			—
Sample #.....:		04			—
Angle(θ)	Isc(θ) [A]	Isc(θ)diffuse [A]	Isc(θ)corr [A]	Isc(θ)corr /cos(θ) [A]	relative transmission τ(θ)
85	0.612	0.201	0.223	2.125	0.857
80	0.788	0.332	0.469	2.845	0.932
75	1.378	0.533	0.863	3.408	0.963
70	1.961	0.749	1.256	3.718	0.982
65	2.510	0.871	1.652	3.954	0.991
60	3.214	1.102	2.073	4.065	1.000
50	3.876	1.262	2.789	4.265	1.000
40	4.722	1.335	3.391	4.298	1.000
30	5.294	1.423	3.878	4.451	1.000
20	5.676	1.511	4.193	4.462	1.000
10	5.887	1.542	4.415	4.398	1.000
0	6.053	1.581	4.503	4.622	1.000

TABLE: MEASUREMENT OF TEMPERATURE COEFFICIENTS			—
Test date [MM/DD/YYYY] .....		02/11/2020	
Irradiance [W/m²].....		Corrected to 1000	
Module temperature [°C] / high - low ... :		24.81 – 50.06	
Sample #	Item	Measured [%/°C]	
02	$\alpha$	0.048	
	$\beta$	-0.29	
	$\gamma$	-0.347	



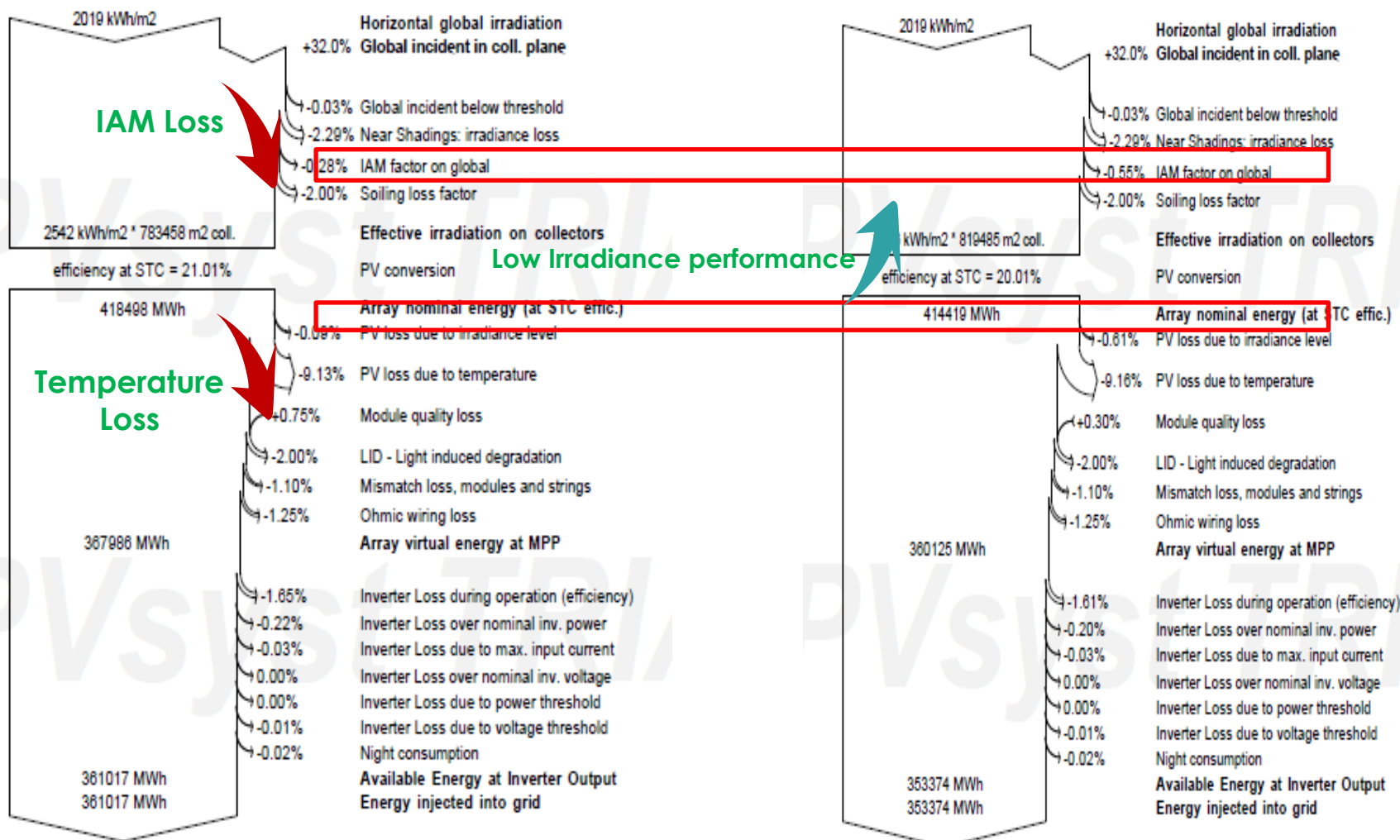
- Excellent data to support high Performance Ratio(PR).
- IAM Data is better than default value in PC Syst.
- Temperature Coefficient is below 0.35%;



# Pan-file Simulation Results

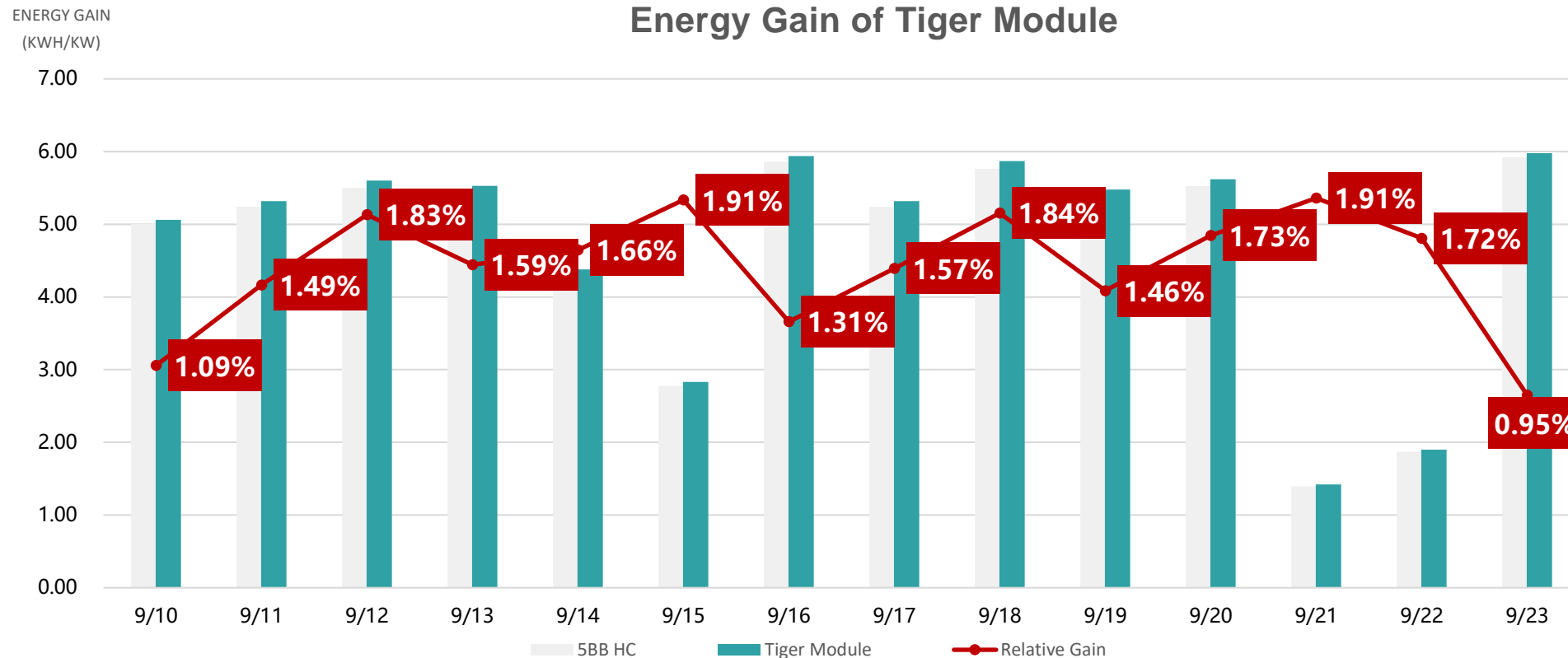
## Tiger Module

## Traditional 5BB HC Module



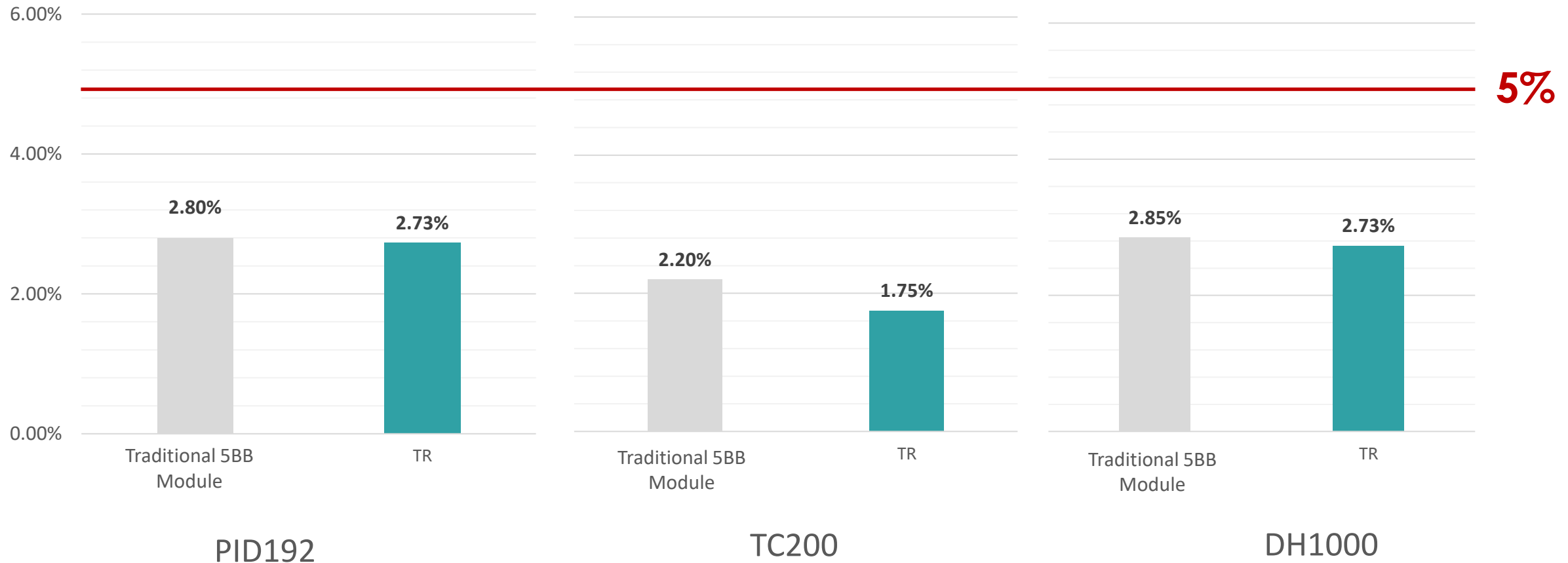
# More Energy Generation

Compared with traditional 5BB HC module, due to the secondary reflection of circular ribbon and higher Rs, energy generation will **increase by approx. 1.57%**  
**9BB also shows excellent performance in low irradiance environment.**

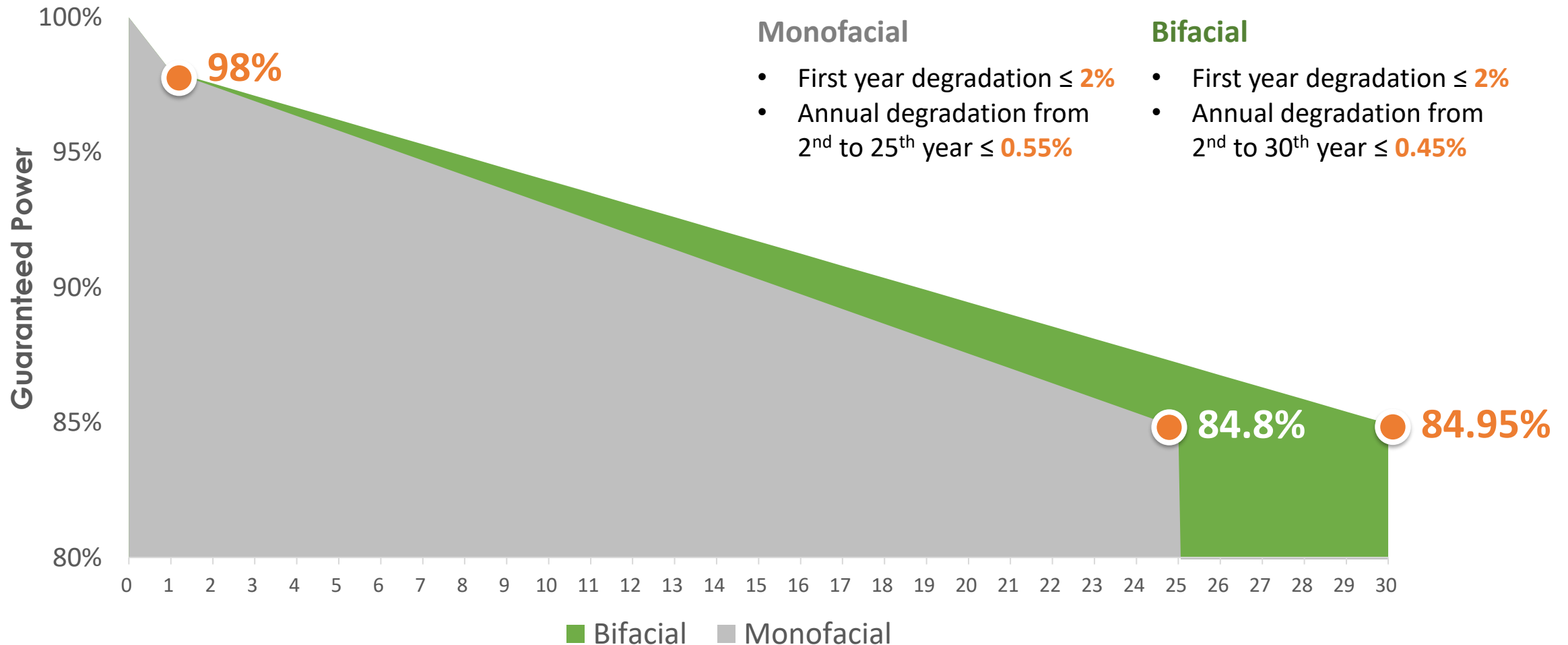


# Increased Reliability: IEC Test

With strict reliability test in IEC61215, such as PID, TC and DH test, TR module has advantages in **reliability performance**.



## Advanced Warranty for Tiger Pro Series



# How Jinko's products can reduce LCOE?

## Module- Optimized Design

### Benchmark

Project	Cheetah	Tiger		Tiger Pro	
Power Class (W)	405	470		530	
Nos. of module	404939	348937		309434	
Number Module in one String ( The lowest Temperature is -3°C )	28	27		28	
Voc at STC (V)	49.4	52.14		49.34	
Quantity of strings	14,463	12,924	-10.64%	11,052	-23.58%
Tracker- Single Axis Tracker (USD/W)	0.0900	0.0883	1.89%	0.0833	-7.44%

Remark: 1. Equipment & civil work cost related to the quantity of strings are decreased parallel

2. V\_OC calculated under -3°C at 1000 W/m<sup>2</sup>, Considering both Irradiance (G) and Cell temperature). The higher quantity of string is considered with EPC's tolerance.

**Example: Australia 164MW inland project, located 270km far away from the northwestern part of Brisbane, Australia.**

# How Jinko's products can reduce LCOE?

## Land – Land Lease Saving

**Mark:** In Australia, the land lease is super cheap at 16,435 USD per year for 164MW land. And the result is not remarkable to IRR & LCOE float

Project (MW)	Cheetah-405	Tiger Pro 530	
Efficiency(%)	20.13%	20.96%	
Land Area (m2)	3,286,923	3,156,753	
Discounted Land Cost total 25 year (USD)	362,013	347,678	<b>-3.96%</b>

## Power Generation – Power Enhancement

Project	Cheetah-405	Tiger 470		Tiger Pro 530	
Discounted Energy Production (MWh) Total 25 years	5,915,319	5,986,303	<b>+1.2%</b>	5,992,289	<b>+1.3%</b>

The result of 405 & 570 is calculated by the PV System optimized the third party pan-file by SGS

**Example: Australia 164MW inland project, located 270km far away from the northwestern part of Brisbane, Australia.**



# How Jinko's products can reduce LCOE?

$$LCOE = \frac{\text{NPV of Total Cost over Lifetime}}{\text{NPV of Total Electricity Generation}} = \frac{\text{Initial Cost (EPC Cost included)} + \sum_{n=1}^{25} \frac{L_n + M_n + IS_n - TS_n}{(1+r)^n} + \frac{\sum_{n=1}^{25} I_n}{(1+r)^n} - \frac{RV}{(1+r)^n}}{\sum_{n=1}^{25} \frac{E_n}{(1+r)^n}}$$

Project (MW)	Cheetah-405	Tiger-470		Tiger Pro -530	
Total Investment	\$107,955,481.42	\$105,385,598.98	-2.38%	\$101,889,500.57	-5.62%
Total Equity Infusion	\$26,988,870.36	\$26,346,399.74	-2.38%	\$25,472,375.14	-5.62%
<b>LCOE (US cent/kWh)</b>	<b>\$2.45</b>	<b>\$2.38</b>	<b>-2.78%</b>	<b>\$2.32</b>	<b>-5.06%</b>
Equity IRR	12.31%	12.74%	3.55%	13.14%	6.79%
Equity Investment Payback Period	12.85	12.56	-2.27%	12.30	-4.27%
Project Investment Payback Period	11.79	11.53	-2.22%	11.30	-4.18%

No.	Item	Weight
1	Initial Cost(Except EPC cost)	4.5%
2	EPC	60.42%
3	Discounted O&M	25.26%
4	Discounted Land Cost	0.20%
5	Interest	9.62%
	Sum	100%

**Example:** Australia 164MW inland project, located 270km far away from the northwestern part of Brisbane, Australia.

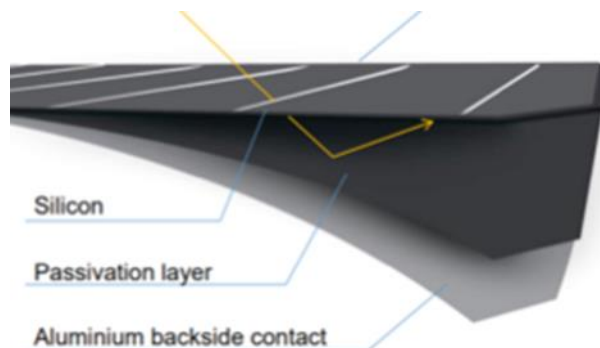
**Mark:** considering the module prices are the same, 22.5US cent/W.

# Technology Components Impacting LCOE

## High Efficiency Mono

- Increases the power by 5% compared to standard mono
- Better low light performance

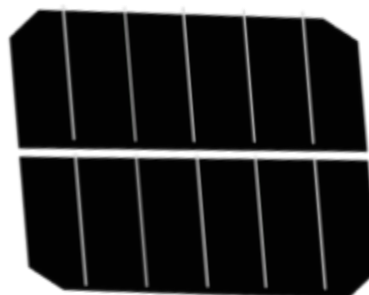
**-2% LCOE**



## Half Cut Cell

- Reduces the internal losses inside the cell
- Better high temp performance due to lower module temp

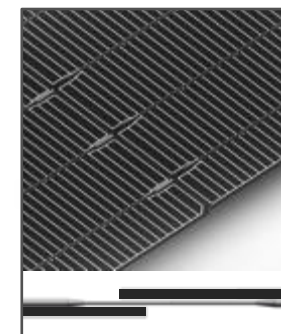
**-1.5% LCOE**



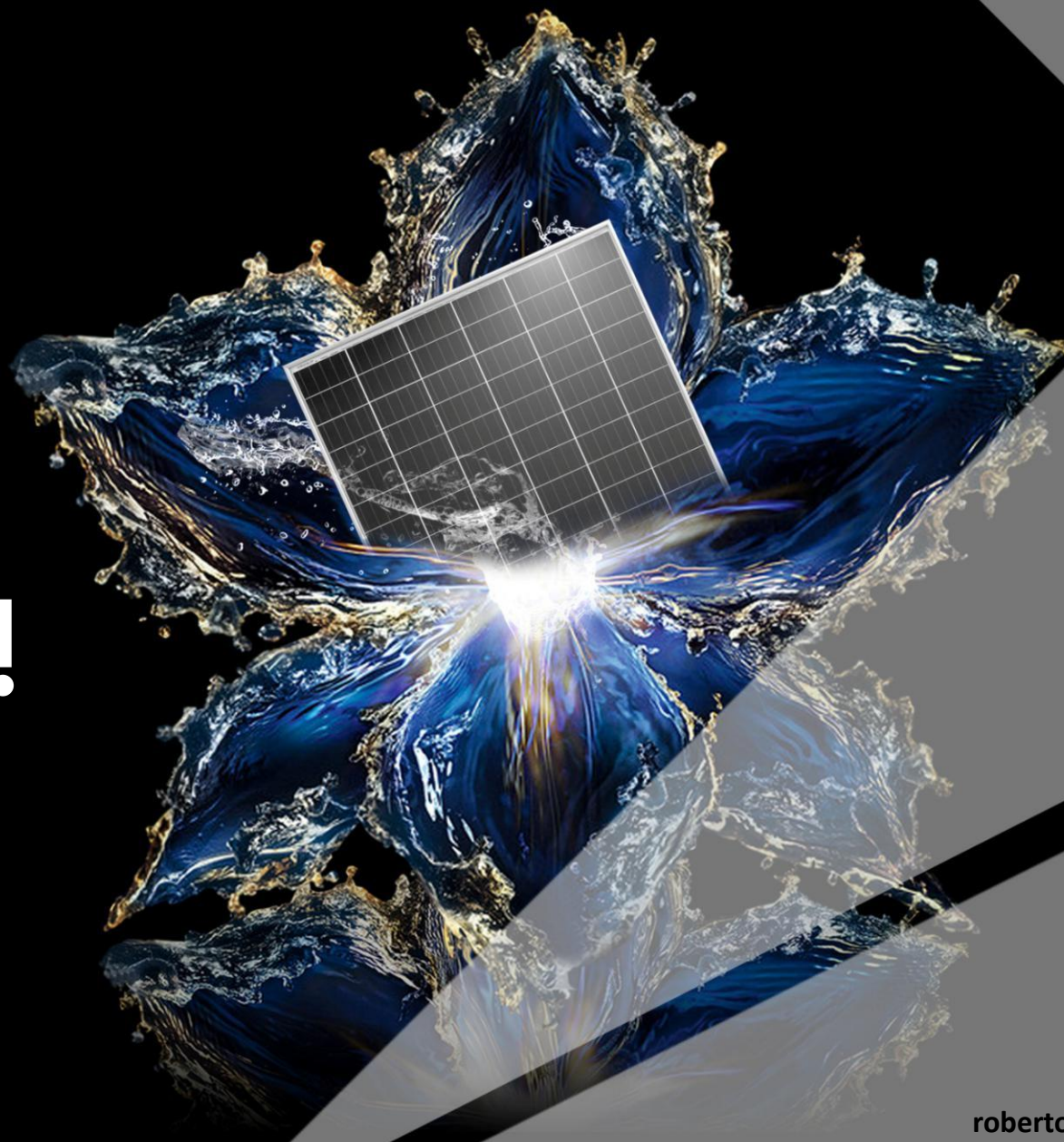
## Tiling Ribbon

- Eliminate the cell gap to increase module efficiency
- More light reflectivity due to round ribbon instead of rectangle ribbon

**-1.2% LCOE**



# Thank you !



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**Soltec**

**Making Tracks,  
Building Trust**



# Soltec SF7 Tracker + Jinko Tiger Pro

## Boosting LCOE

### Soltec

16 years experience in Solar PV Trackers (since 2004)

+1,600 staff

15 international subsidiaries

+10GWp accumulated sales

+3GWp bifacial trackers

#1 LATAM

#1 world 2P tracker manufacturer



### Summary

We will talk about the integration of the **Jinko Tiger Pro** module in **Soltec SF7** tracker, and why the robust **Soltec SF7** 2P tracker is the best choice to decrease the LCOE in projects with big size modules.

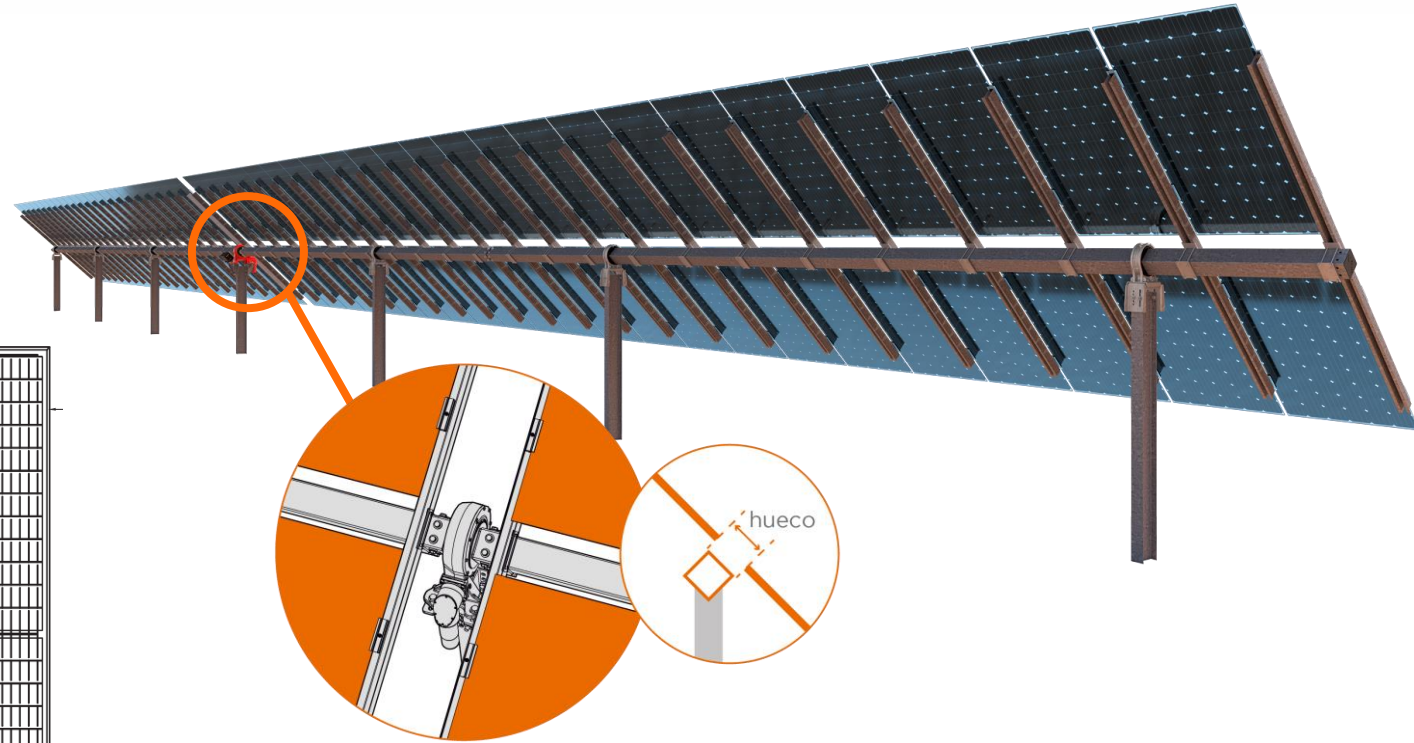
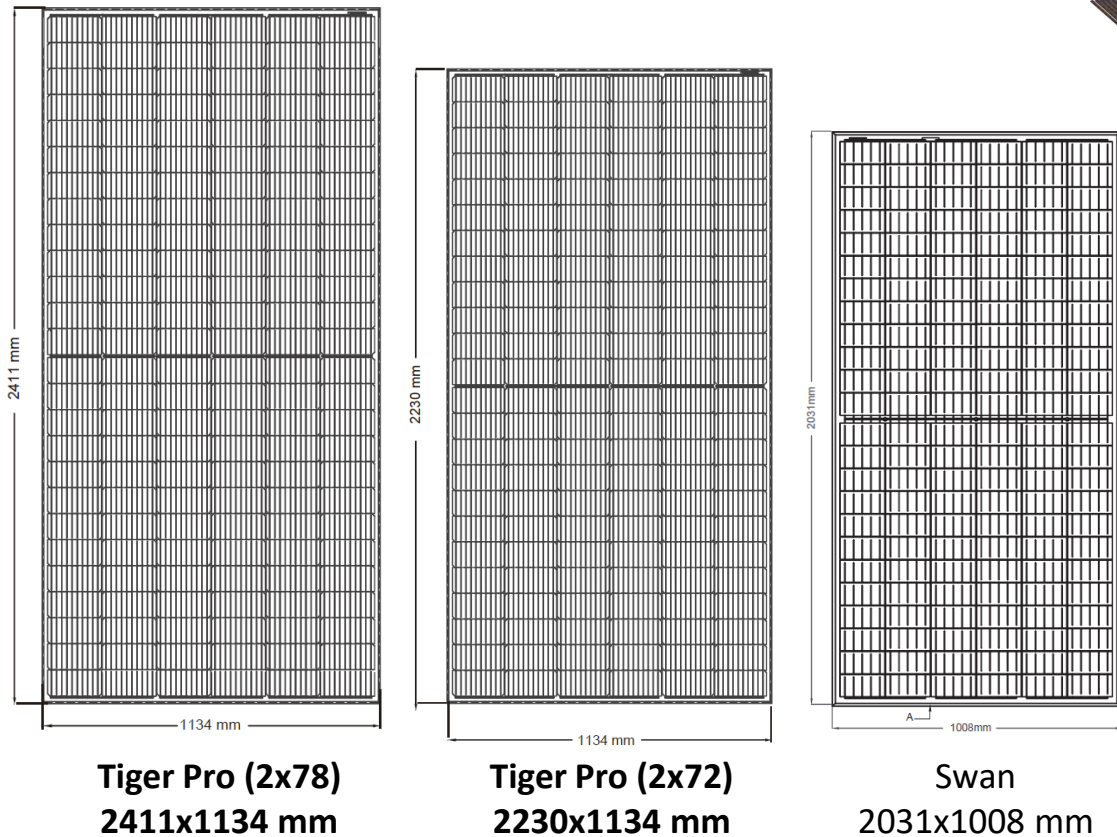
- **Dy-WIND** → Dynamic Wind Analysis in Tracker Array Design.
- **Bifacial** → Energy Production comparison 2P vs 1P.



# Soltec SF7 Tracker + Jinko Tiger Pro

## Boosting LCOE

### 2P Bifacial Tracker width



Module	Module length	Bifacial Tracker width
Swan	2031 mm	4212 mm
<b>Tiger Pro (2x72)</b>	<b>2230 mm</b>	<b>4610 mm (+9.45%)</b>
<b>Tiger Pro (2x78)</b>	<b>2411 mm</b>	<b>4972 mm (+18.04%)</b>

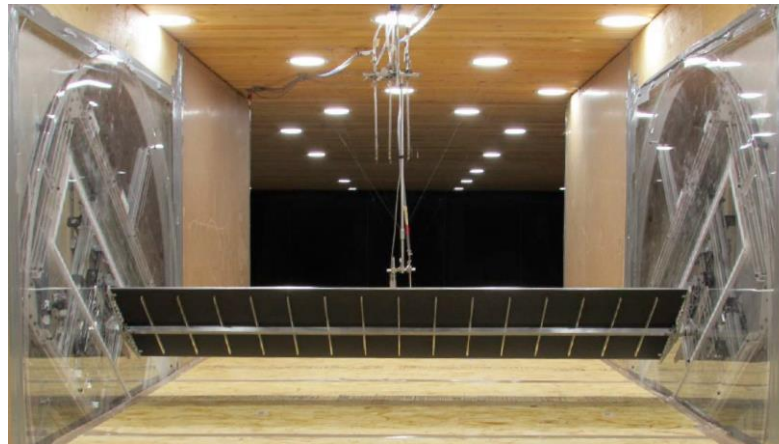
## Dy-WIND – Dynamic effects and wind tunnels

Pressure Wind Tunnel Test – Rigid Model



2013/2014

Sectional Model Wind Tunnel



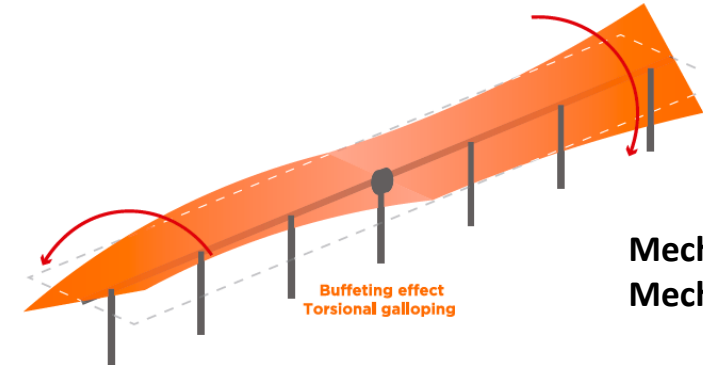
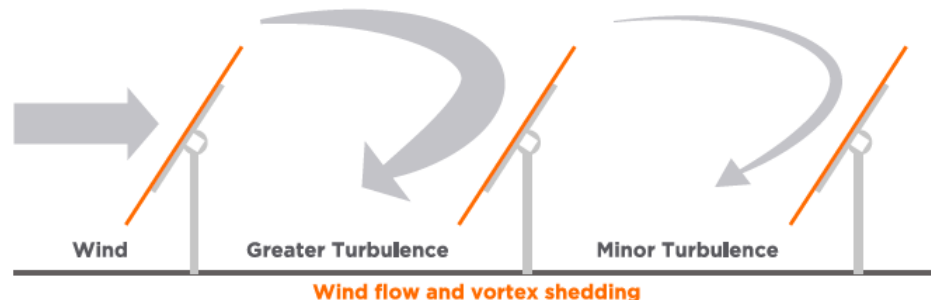
2017/2019

Full Aeroelastic Wind Tunnel



2019/2020

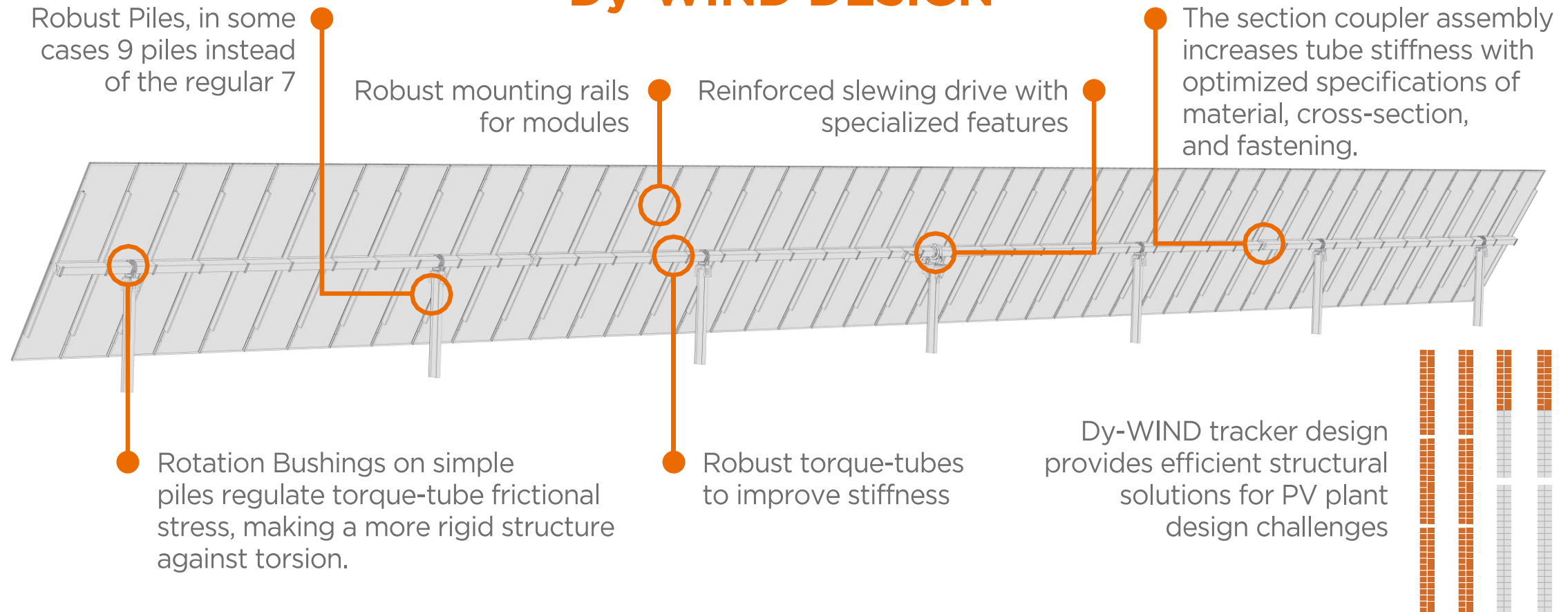
Mechanism 1: Resonant Vibration



Mechanism 2: Torsional Flutter  
Mechanism 3: Torsional Galloping

## DESIGN CONCLUSION: SF7

### Dy-WIND DESIGN



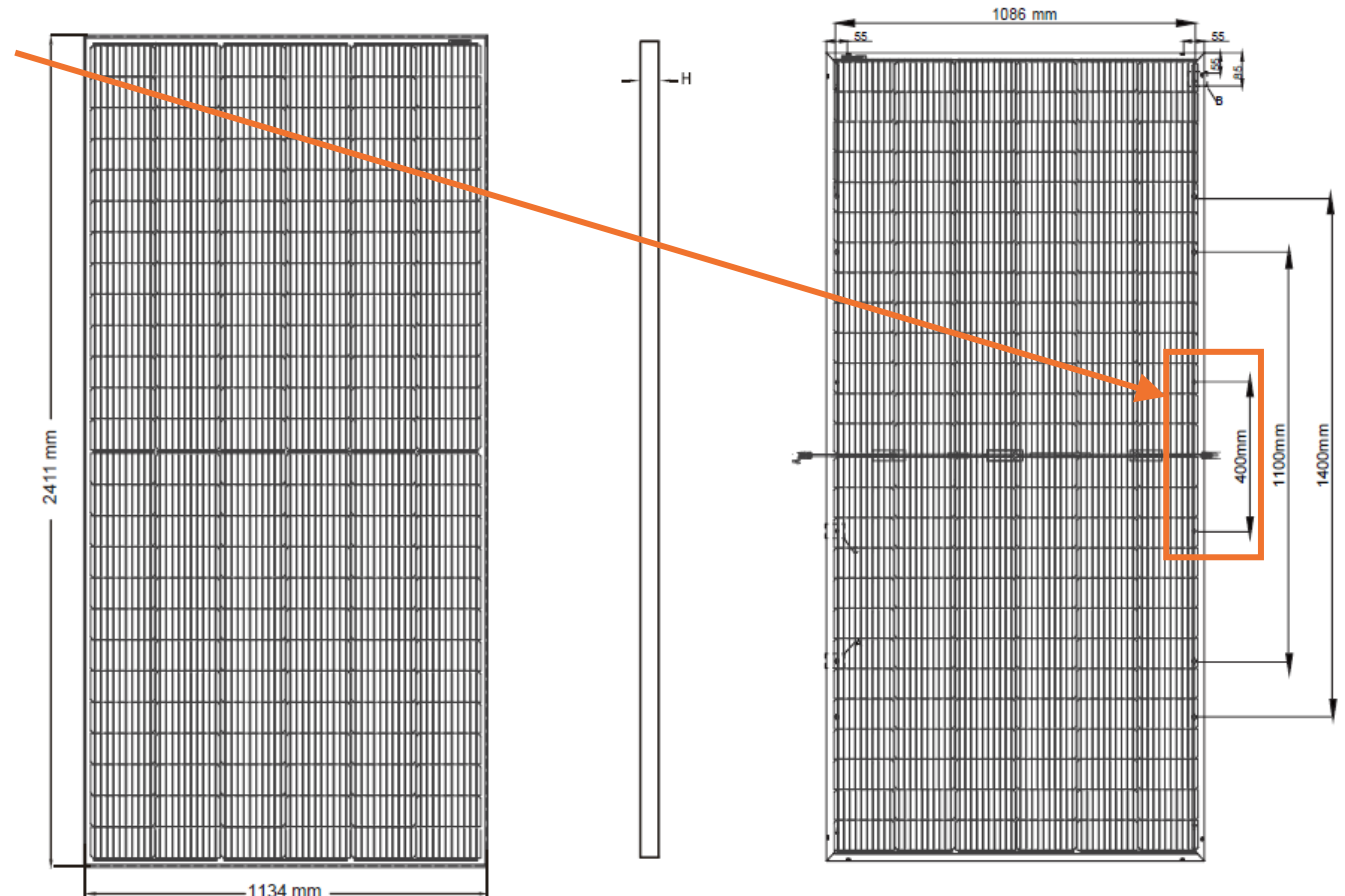


### Challenge → Module Mounting Holes Distance

Keeping mounting holes at 400mm augments the module cantilever, increasing bending and with it, the risk of module micro-cracks.

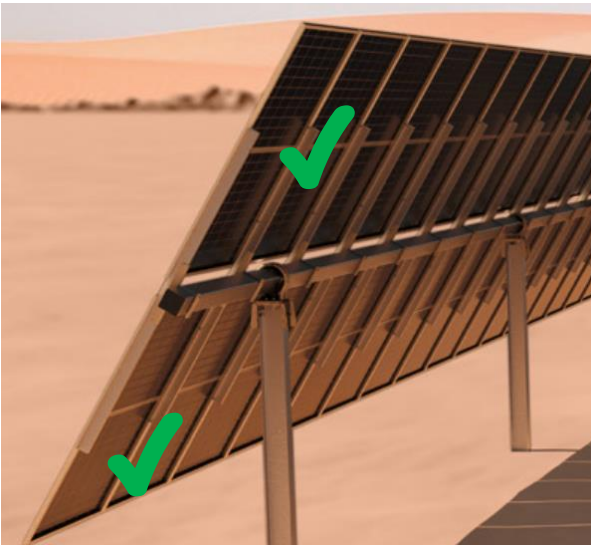
This potential problem affects more the 1P tracker configuration than the 2P, as the cantilever is greater for 1P.

Depending on the wind specifications the mounting hole distance might need to be increased, greatly affecting the module rails length, specially on the 1P trackers.

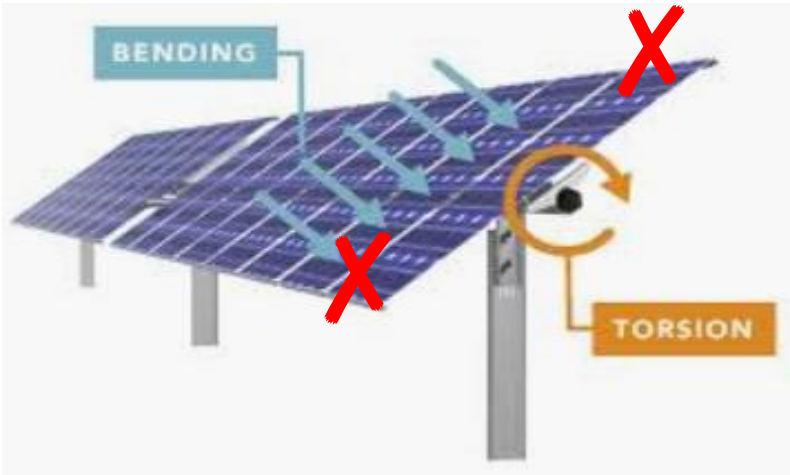


### Challenge → Module Mounting Holes Distance

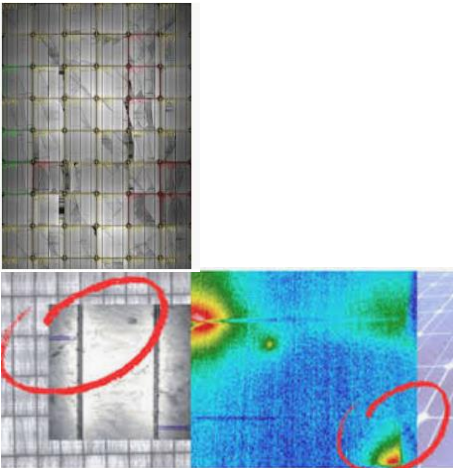
Soltec SF7 – 2P Configuration



1P Configuration



Micro-cracks



Tiger Pro (2411x1134 mm)			400mm		1100 mm			
Tracker	Config.	Num rails per tracker	Module Rail Length (m)	Total Module Rails length per tracker (m)	Module Rail Length (m)	Total Module Rails length per tracker (m)	Increase per tracker (m)	Increase per tracker (%)
2P	2x42	44	2.847	125.2	3.547	156.0	30.8	24.6%
1P	1x84	86	0.44	37.8	1.140	98.0	60.2	159%

# Soltec SF7 Tracker + Jinko Tiger Pro

## Boosting LCOE

### LCOE ANALYSIS

- 93.6 km/h Eurocode (83.0 mph ASCE 7-05)
- 28 modules per string
- 2Px42 tracker configuration
- Pitch 12m
- Mounting holes distance: 400mm



Module	Power (Wp)	Length (mm)	Width (mm)	Weight (kg)	Power per tracker (Wp)	Δ%Module surface	Δ%Power per tracker	Δ%Cost per tracker	Δ% Cost Efficiency
<b>Tiger Pro</b>	535	2230	1134	28.9	44,940	+4.93%	+9.18%	+5.82%	<b>+3.36%</b>
<b>Market Standard</b>	490	2187	1102	30.1	41,160	-	-	-	-



# Soltec SF7 Tracker + Jinko Tiger Pro

## Boosting LCOE

### BOOSTING LCOE

### Balance of Parts

Module	Modeules per MWdc	Trackers per MWdc	Piles per MWdc	Δ%Motors & Electronics per MWp	Δ%Piles per MWp	Δ%Occupied Area
<b>TIGER Pro</b>	1870	23,2	178	-	-	-
<b>Market Standard</b>	2041	25,3	196	+9%	+9%	+9%



The diagram illustrates the combination of two solar components to achieve a goal. On the left, the SF7 logo (a red circle with 'SF7' in white) is followed by the text 'Single-Axis Tracker'. This is followed by a plus sign '+'. To the right of the plus sign is the Jinko Solar logo (the word 'Jinko' in green with 'Solar' in a script font above it) and below it, 'TIGER Pro' in green text on a grey rectangular background. This is followed by an equals sign '='. To the right of the equals sign is a large red downward-pointing arrow, and finally, the text 'LCOE' in bold black letters.

# Soltec SF7 Tracker + Jinko Tiger Pro

## Boosting LCOE



Single-Axis  
Tracker



## #1 Bifacial Leader

**BiTEC: Bifacial Tracker Evaluation Center** in  
California – USA.



Further info – whitepapers available at:  
[soltec.com/soltec-lab/](https://soltec.com/soltec-lab/)



## Bifacial Gain Comparison 1P vs 2P

### Black & Veatch Validated

Parameters	Calculated Bifacial Gain
Lower average module temperature (better cooling)	+1.3%
No torque tube shading	+0.7%
Higher module height and pitch, and other design details.	+0.1%
<b>Total</b>	<b>+2.1%</b>

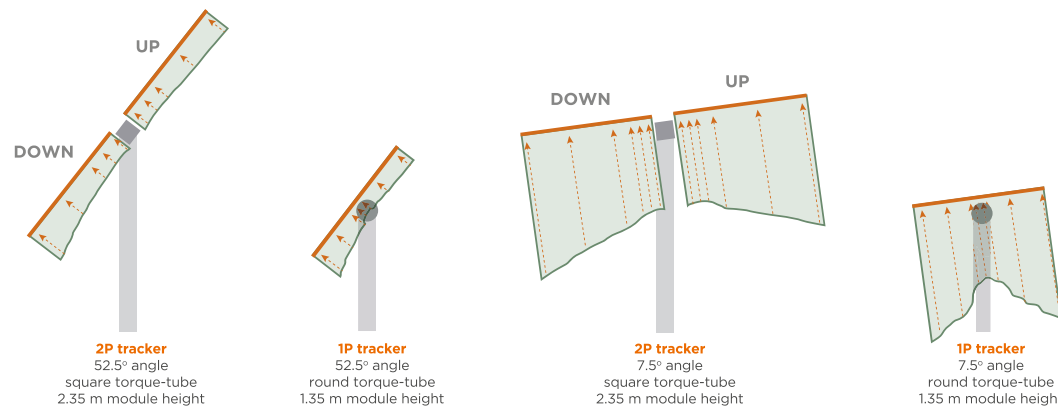
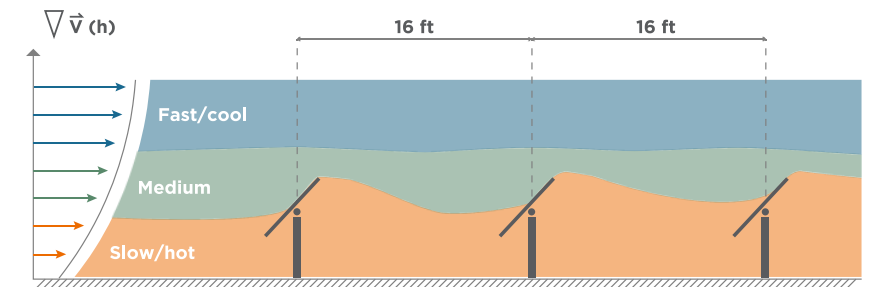
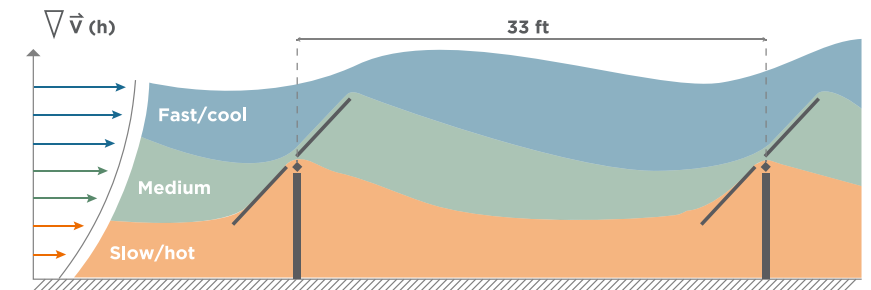
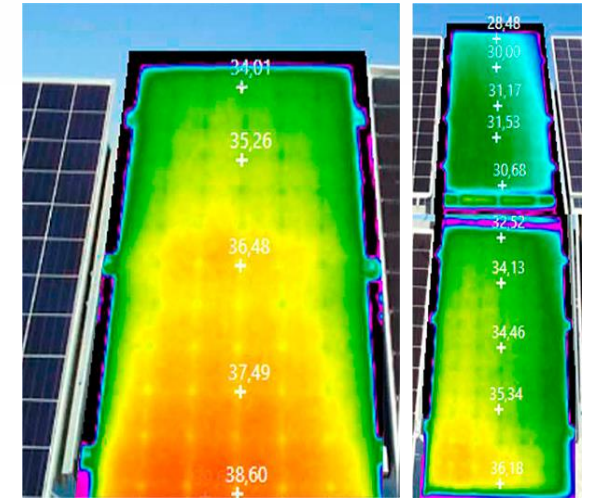


Figure 8. Module rear side irradiation distribution with trackers in 2P Vs. 1P in different angles and heights, with square and round torque tubes. Source: BITEC





# Thanks!

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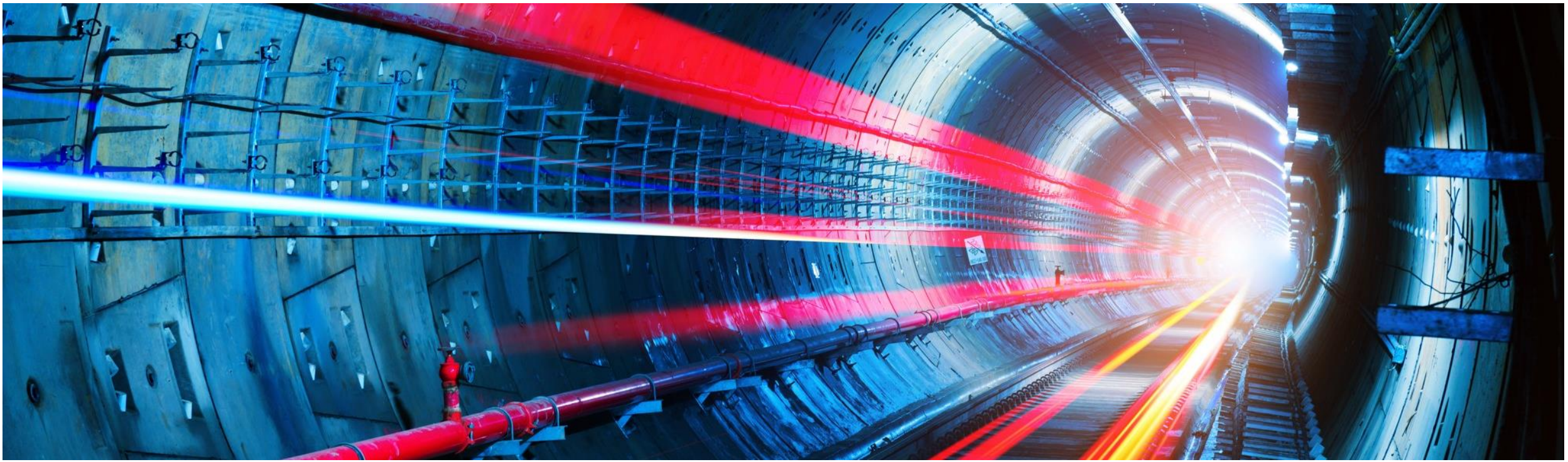
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# Low LCOE promotes a successful PV project

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OE Service Introduction



# Condition 1 : Site Hypothesis



Location	Golmud, Qinghai
Capacity	120MW
GPS	94.55°E 36.26°N
Annual Irradiation	2195 hours
Altitude	2800 meter
Ambient Temperature	6.69°C/year

## Condition 2 : Module Selection

	Plan 1 : Jinko 530W	Plan 2 : XX-500	Plan 3 : XX-450
Rated Power	530W	500W	450W
Module Efficiency	21.4%	20.9%	20.7%
Required Module Amounts	227,006	240,625	267,362
Required String Amounts	8,731	9,625	10,284

- The module amounts of plan 1, **5.7%** less than plan 2, **15.1%** less than plan 3.
- The corresponding BOS costs of plan1 is also lower, which means EPC procurement and development costs can be saved.
- Plan 1's string distance can be designed larger, reducing the shadow risk.
- Plan 1 can use less area of land, cutting down its lease and purchase costs.

## Condition 3 : Cash Flow Factors + Discount Rate (7%)

- ❑ Total Investment
- ❑ Land Rent
- ❑ Bank Loans
- ❑ OM Costs
- ❑ Tax

Expense



Revenue

- ❑ Generation Simulation (PV Syst)
- ❑ Grid Purchase Price
- ❑ Residual Asset (5%)

# Power Generation Estimation

Ge er mu -QingHai  
Balances and main results

	GlobHor kWh/m <sup>2</sup>	DiffHor kWh/m <sup>2</sup>	T_Amb ° C	GlobInc kWh/m <sup>2</sup>	GlobEff kWh/m <sup>2</sup>	EArray MWh	E_Grid MWh	PR
January	97.9	29.57	-7.10	145.4	137.7	16725	16081	0.919
February	115.3	29.61	-3.20	169.5	160.6	18885	18096	0.887
March	158.8	48.62	2.44	220.6	208.9	23875	22833	0.860
April	198.7	55.21	8.14	279.2	264.4	29066	27748	0.826
May	219.0	71.01	12.87	296.5	280.7	30385	29045	0.814
June	215.3	76.46	16.63	281.2	266.2	28262	19887	0.588
July	209.9	77.69	19.37	283.0	267.8	28352	27153	0.798
August	204.3	63.51	18.06	278.5	263.7	28044	26848	0.801
September	175.0	47.18	13.26	246.3	233.3	25271	22587	0.762
October	146.1	39.11	6.53	213.3	202.1	22876	21149	0.824
November	108.7	31.49	-1.10	160.4	151.9	17913	17209	0.892
December	90.1	25.65	-6.24	138.9	131.5	16062	15478	0.926
Year	1939.2	595.10	6.69	2712.8	2568.8	285717	264114	0.809



Year	Generation
1	by PV Syst
2	-0.55% of year0
3	-1.10% of year0
4	-1.65% of year0
5	-2.20% of year0
.....	.....
25	-13.20% of year0

Legends: GlobHor      Horizontal global irradiation      GlobEff      Effective Global, corr. for IAM and shadings  
 DiffHor      Horizontal diffuse irradiation      EArray      Effective energy at the output of the array  
 T\_Amb      Ambient Temperature      E\_Grid      Energy injected into grid  
 GlobInc      Global incident in coll. plane      PR      Performance Ratio

# LCOE Evaluation

C: Total investment capital

n: 25 years life-cycle

$L_t$ : No.t year's land fee

$M_t$ : No.t year's OM fee

$T_t$ : No.t year's tax

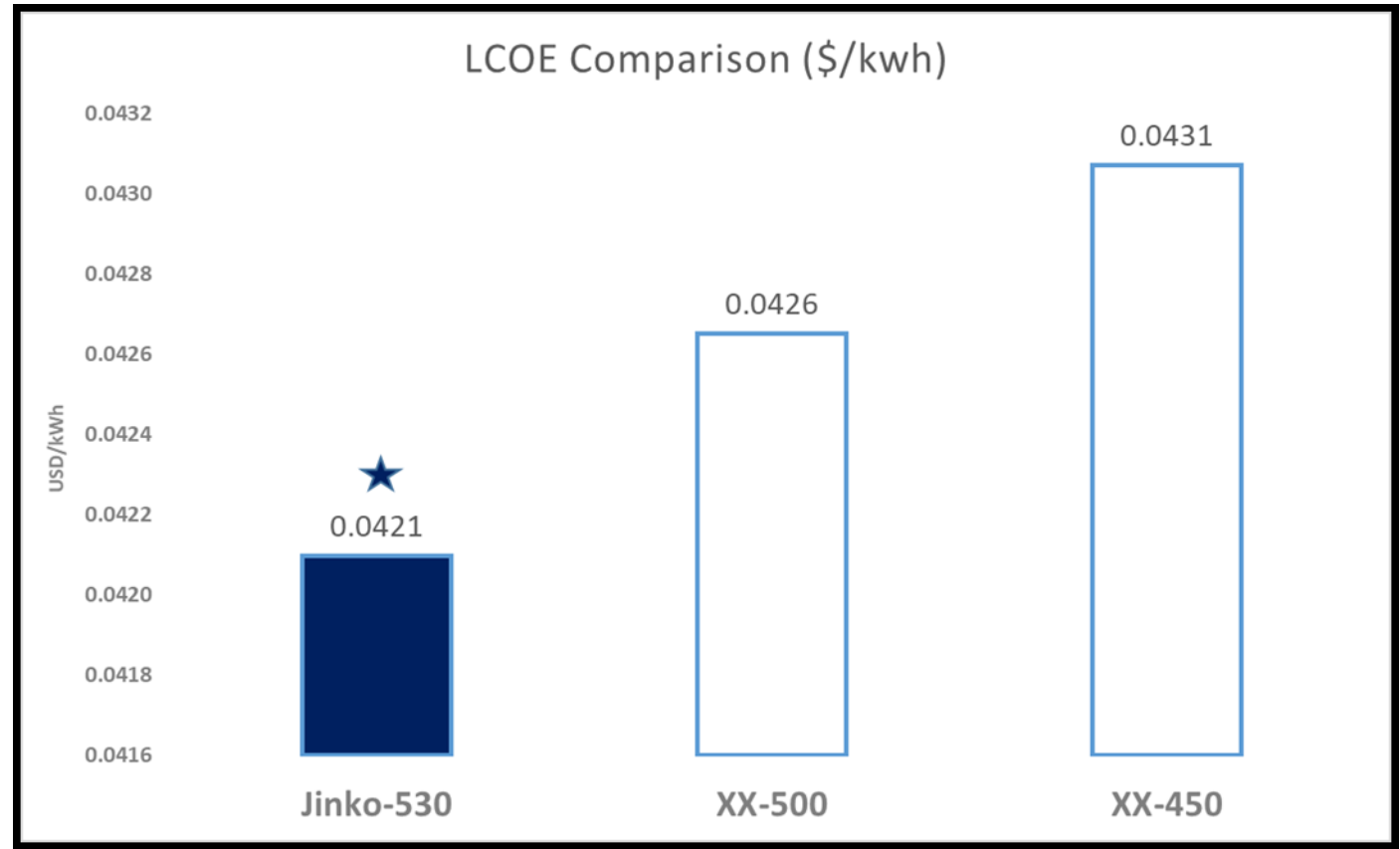
R: PV plant's residual value

$I_t$ : No.t year's loan interest

$E_t$ : No.t year's generated energy

r: Discount rate

$$\text{LCOE} = \frac{C + \sum_{t=1}^n \frac{(L_t + M_t + T_t)}{(1+r)^t} - \frac{R}{(1+r)^n} + \sum_{t=1}^n I_t}{\sum_{t=1}^n \frac{E_t}{(1+r)^t}}$$



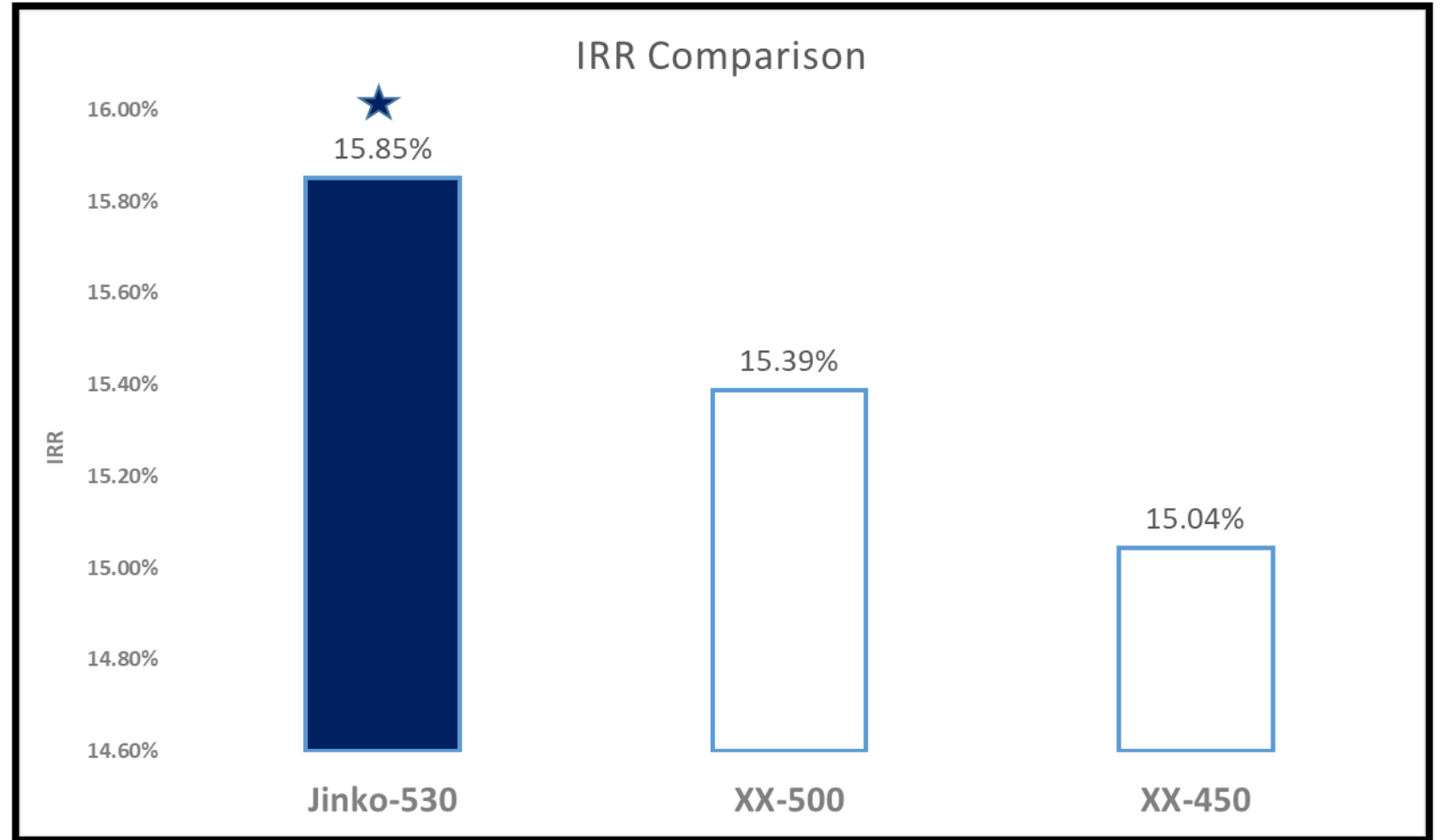
# IRR Evaluation

$$\sum_{t=1}^n \frac{CF_t}{(1 + IRR)^t} - I_0 = 0$$

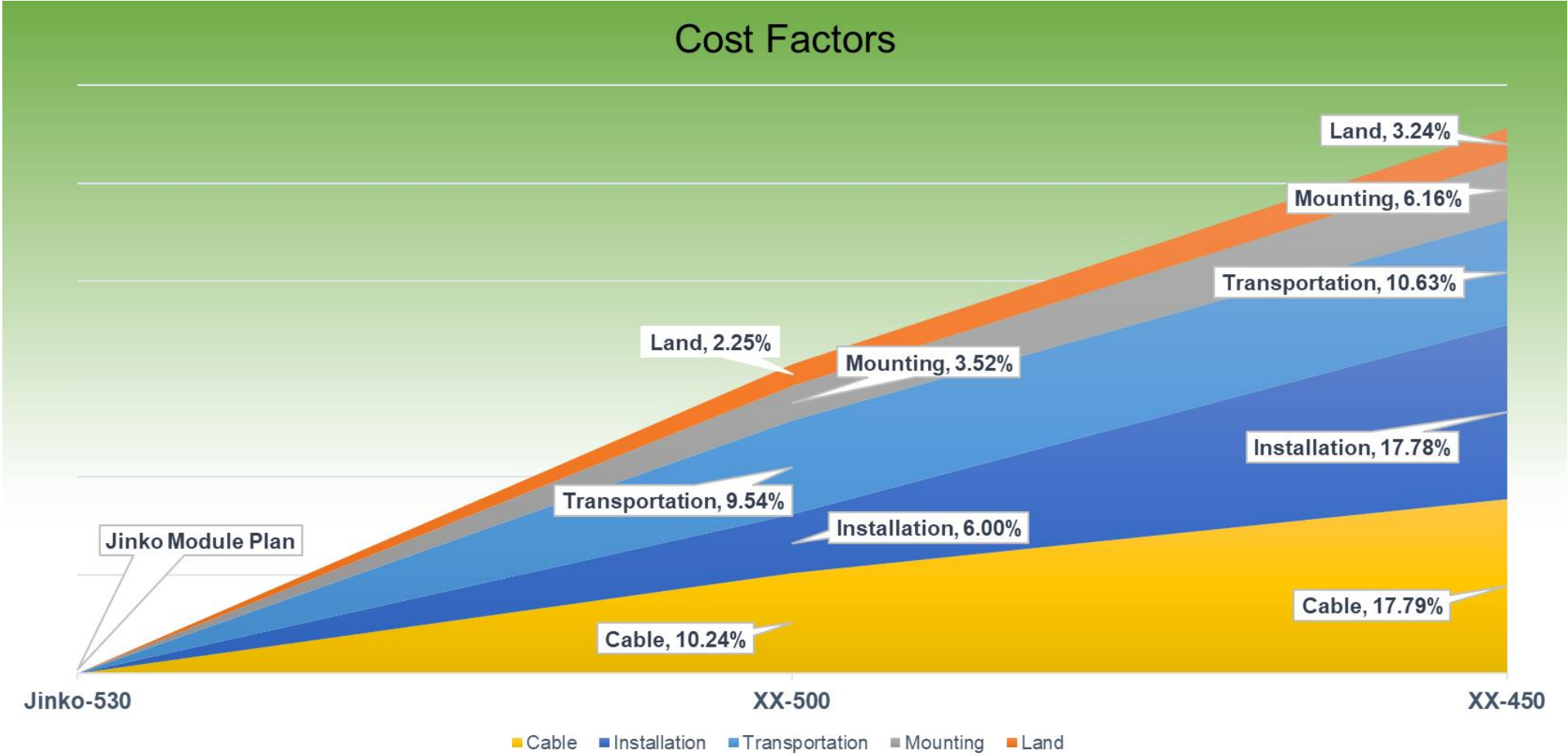
$CF_t$ : No.t year's cash flow

$n$ : 25 years life-cycle

$I_0$ : Initial self investment

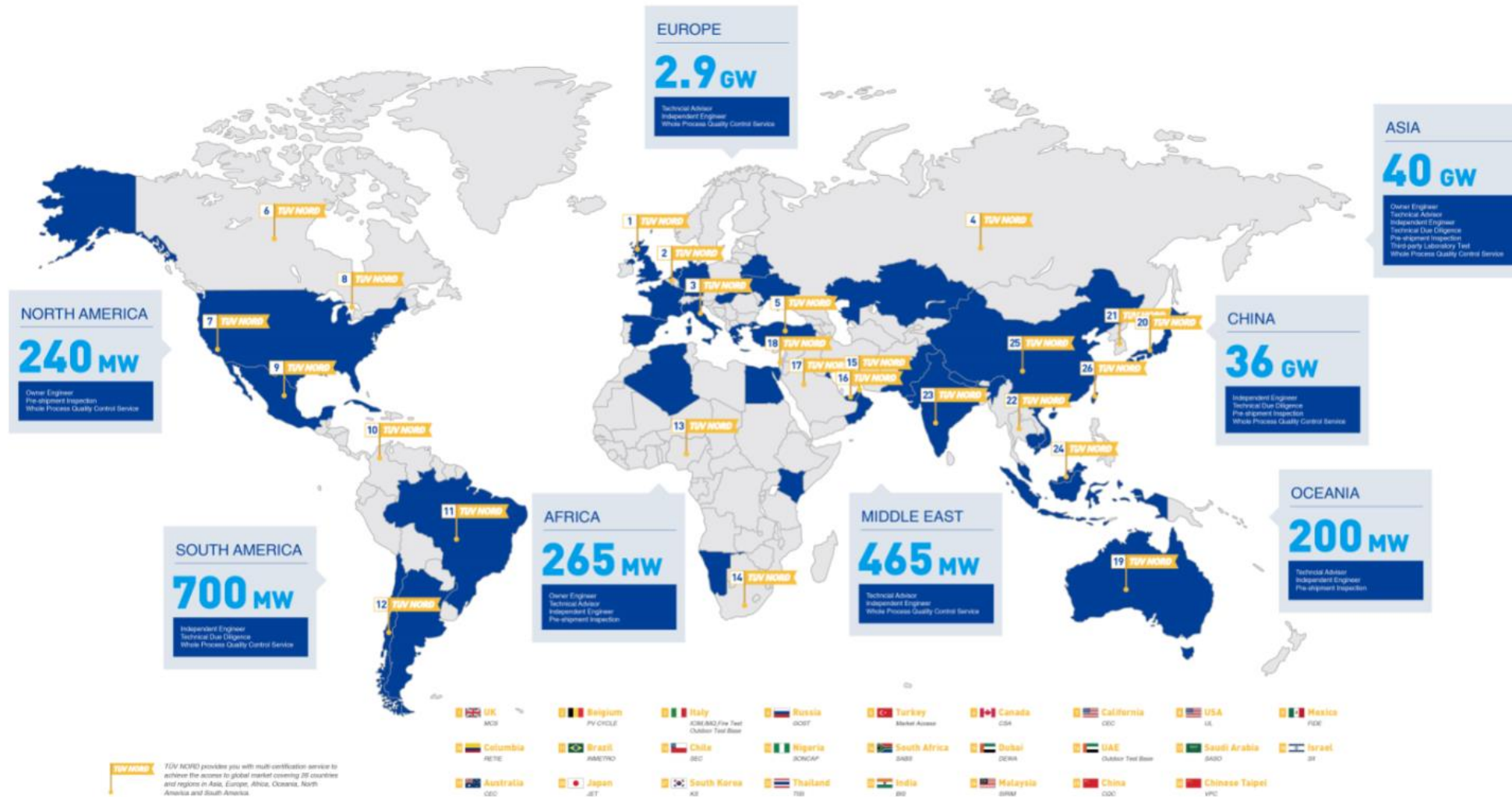


# Cost Factor Comparison





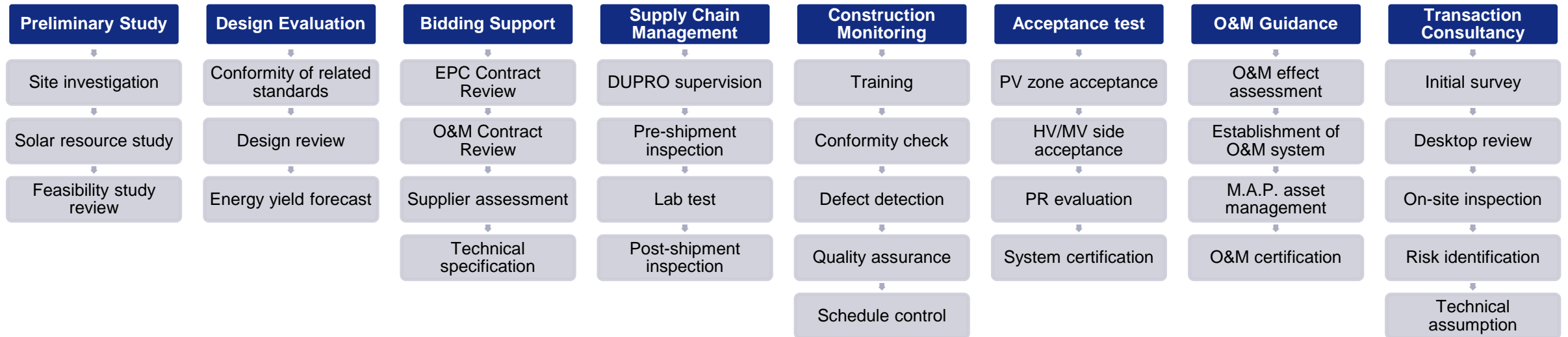
# Global PV Projects' Overview



- Top 10 certificate company
- More than 150 years' history
- Branches cover 70 countries
- Services include testing, inspection, certification and consulting

# Owner Engineer's Duty

## Entire process of solar project



# OE Service will focus on.....



PLEASE CONTACT US FOR MORE INFORMATION.

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