

# Solar Photovoltaic Products The New Generation

*Trina Solar Europe  
V5  
Aug 2019*

- **Trina Solar at a Glance**
- Reliable Partner
- Industry Leader
- Premium Quality
- PV Modules

# Trina Solar at a Glance



1997

Providing high quality  
solar products, solutions  
and services  
since 1997



15,000+

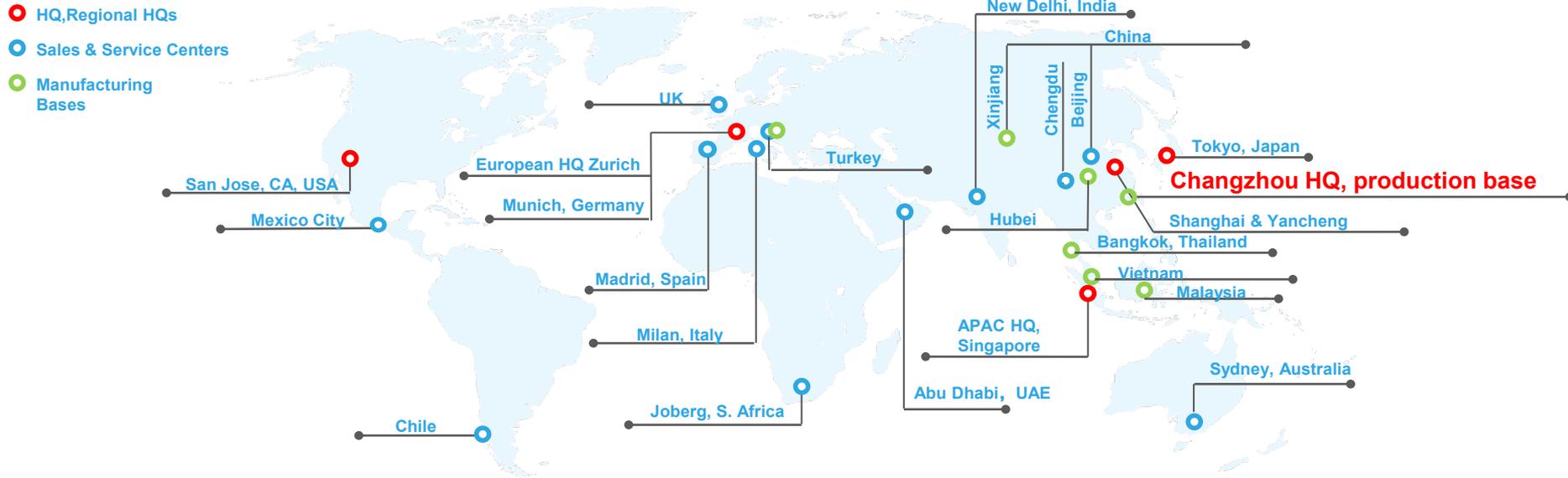
More than 15,000  
employees in  
over 20 offices globally



40GW+

Global cumulative  
shipment over 32 GW  
to date

# Global Presence & Local Support



**Module shipments**

**40+ GW**



**Employees**

**15000+**



**Grid-tied Power Plants**

**3.0+ GW**



**Customers**

**500+**  
in 70+ countries

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# Long-term Partner

● Mr. Jifan Gao founded Trina Solar

1997

● IPO in NYSE; Stock No. TSL

2006

● Started the construction of Trina PV Industrial Park, one of the biggest integrated PV Industrial Park in the world

2008

● Module shipment ranked world No. 1

2014

- Global leading PV total solutions provider
- Vietnam factory in operation

2017

2002

Started the construction of 39 PV plants in Tibet, China



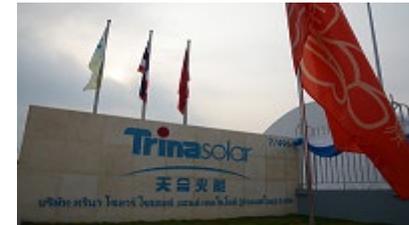
2011

Started the construction of State PV Science & Technology Key Lab



2016

- World's most bankable PV module manufacturer
- Thailand factory in operation



2018

Pioneer of Energy IoT

# Trustworthy Partner



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Trina Solar State Key Laboratory  
of PV Science and Technology



## Industry Leading R&D Team

- First CTD (Client Data Test Program Certificate) laboratory from **UL**
- World's first TMP (Testing at Manufacturer Premises) laboratory for **TÜV Rheinland**
- First PV WMT (Witnessed Manufacturer's Testing) laboratory by **CQC**

## Achievements

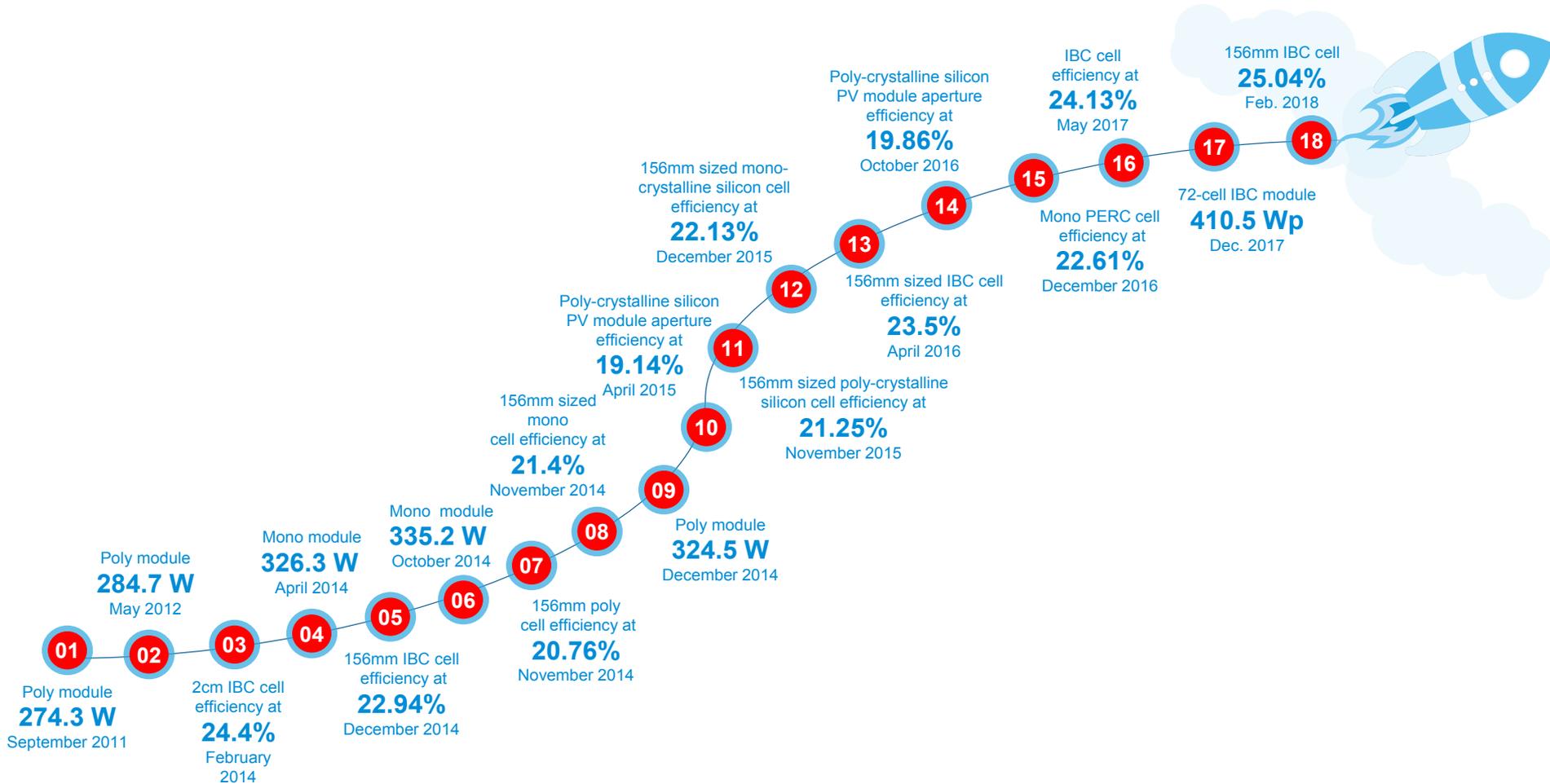
- 1376 patents applied
- 795 patents authorized
- IBC cell broke world record: 25.04% in 2018

## Projects

- 50+ scientific research projects:
- 2 National 973 Programs
  - 5 National 863 Programs



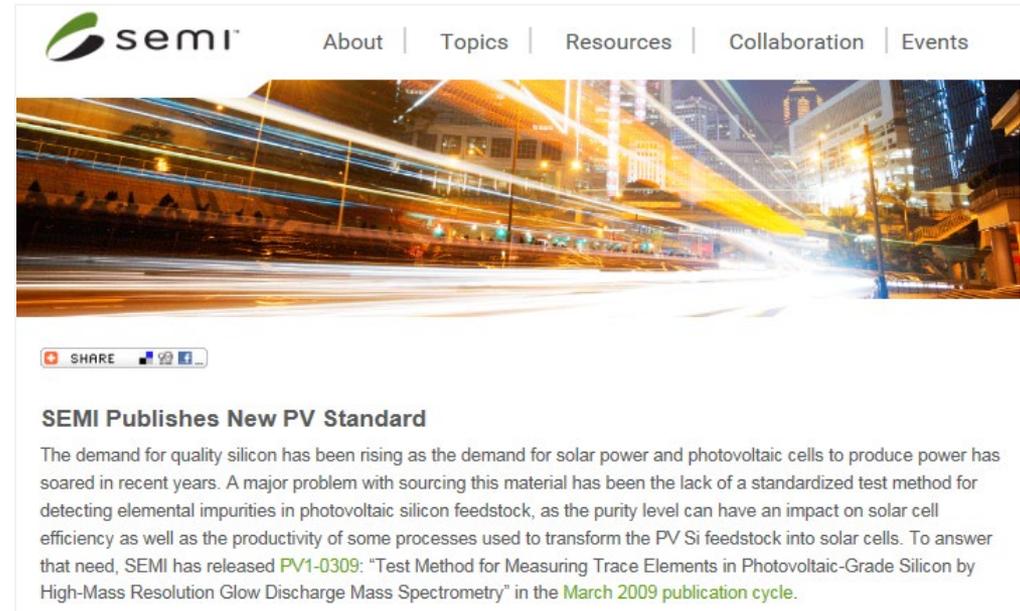
## 18 world records on cell or module efficiency



Lead or participation in **74** international PV standards



The screenshot shows the IEC TC 82 website. At the top left is the IEC logo and the text "International Electrotechnical Commission". Below this is a navigation menu with items: "You & the IEC", "About the IEC", "News & views", "Standards development", "Conformity assessment", "Members & experts", and "Developing countries". A breadcrumb trail reads: "Standards development > How we work > Technical Committees & Subcommittees > TC 82 Dashboard". The main heading is "TC 82 Solar photovoltaic energy systems". Below the heading are tabs for "Scope", "Structure", "Projects / Publications", "Documents", "Votes", "Meetings", and "Collaboration Tools". The "Scope" tab is active. The content area has a blue header "TC 82 Scope" and text: "To prepare international standards for systems of photovoltaic conversion of solar energy into electrical energy and for all the elements in the entire photovoltaic energy system. In this context, the concept 'photovoltaic energy system' includes the entire field from light input to a photovoltaic cell to and including the interface with the electrical system(s) to which energy is supplied. NOTE: It is recognized that there is some common interest between TC 47 and TC 82, therefore these two Committees shall maintain liaison." To the right of the text is a small image of a solar cell with "TC 82" overlaid.

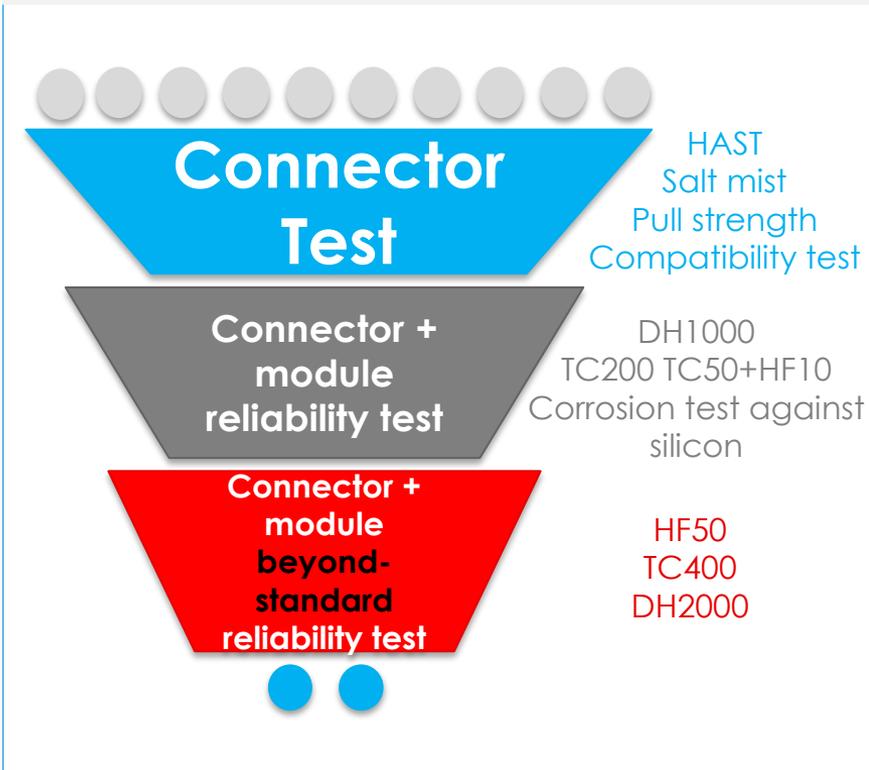


The screenshot shows the SEMI website. At the top left is the SEMI logo. To the right is a navigation menu with items: "About", "Topics", "Resources", "Collaboration", and "Events". Below the menu is a large image of a city street at night with light trails. Below the image is a "SHARE" button with social media icons. The main heading is "SEMI Publishes New PV Standard". The text below reads: "The demand for quality silicon has been rising as the demand for solar power and photovoltaic cells to produce power has soared in recent years. A major problem with sourcing this material has been the lack of a standardized test method for detecting elemental impurities in photovoltaic silicon feedstock, as the purity level can have an impact on solar cell efficiency as well as the productivity of some processes used to transform the PV Si feedstock into solar cells. To answer that need, SEMI has released PV1-0309: 'Test Method for Measuring Trace Elements in Photovoltaic-Grade Silicon by High-Mass Resolution Glow Discharge Mass Spectrometry' in the March 2009 publication cycle."

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- PV Modules

# Material Selection

## Strict Selection Process of TS4 connector designs & OEM suppliers



## Comprehensive Evaluation of connector



- Visual inspection
- Leakage
- Reliability
- compatibility
- Pull strength
- Contact resistance

## Design meeting customer needs

### Universal Connection Solution

- 1500V, 1000V, 600V
- IEC & UL certified for international markets
- Compatible with MC4, H4, UTX

### High Reliability & Safety

- Strict Trina Solar internal qualification process
- IEC 62852, UL 6703
- The highest International Protection rating at IP68

**Only materials, which pass Trina Solar strict selection process and evaluation, can be used on Trina Solar modules, including Trina TS4 connector**

# Internal Product Reliability Tests

- Long-term Strategic Partnerships to perform in-house certification testing



## Environmental Reliability Testing

Extreme environmental testing ensures reliability and performance in the most unforgiving environments

Wet Leakage Test

Damp Heat Test

Mechanical load Test

Highly Accelerated Stress Test

Humidity Freeze Test

Outdoor Exposure Test

UV Preconditioning Test

Impact Testing

Corrosive Atmosphere Test

Hot-spot Endurance Test

Insulation Test (Dry & Wet)

Thermal Cycling Test

## Component Testing

Testing of module components maximizes electrical output and minimizes module degradation

Bypass Diode Test

Materials & components testing

QC throughout Manufacturing Process

Micro-crack Testing

Measurement of NOCT

Electrical Component Testing

Flash Testing



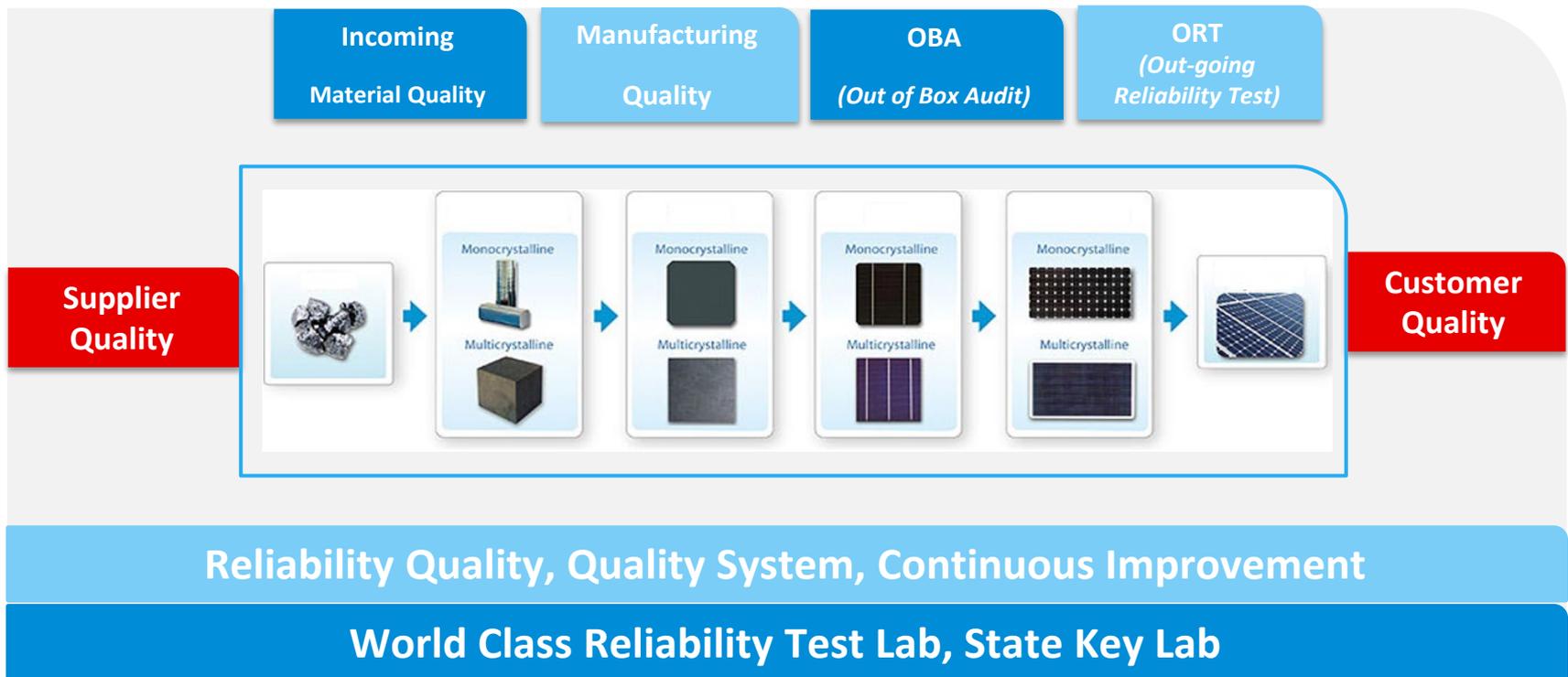
Trina Solar State Key Lab

# Internal Product Reliability Tests

Trina Solar		Other Brands	
Material	Module	Material	Module
	<div style="display: flex; flex-direction: column; align-items: center;"> <div style="background-color: #00a0e3; color: white; padding: 5px; margin-bottom: 5px;">UV</div> <div style="background-color: #00a0e3; color: white; padding: 5px; margin-bottom: 5px;">HAST</div> </div>		
<div style="background-color: #333; color: white; padding: 10px; border-radius: 5px;">                     Thermal Cycle 200, Damp Heat 1000 (IEC 61215)                 </div>	<div style="background-color: #333; color: white; padding: 10px; border-radius: 5px;">                     IEC 61215 (<b>beyond</b>) IEC 61730 UL 1703                 </div>	<div style="background-color: #ccc; padding: 10px; border-radius: 5px;">                     (No Test)                 </div>	<div style="background-color: #ccc; padding: 10px; border-radius: 5px;">                     IEC 61215, IEC 61730, UL 1703                 </div>

Trina Solar Tests both **Material** and **Module**

# Quality Management System



**47** inspection points in module production process alone!

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# PV Module Overview

## Residential



## C&I

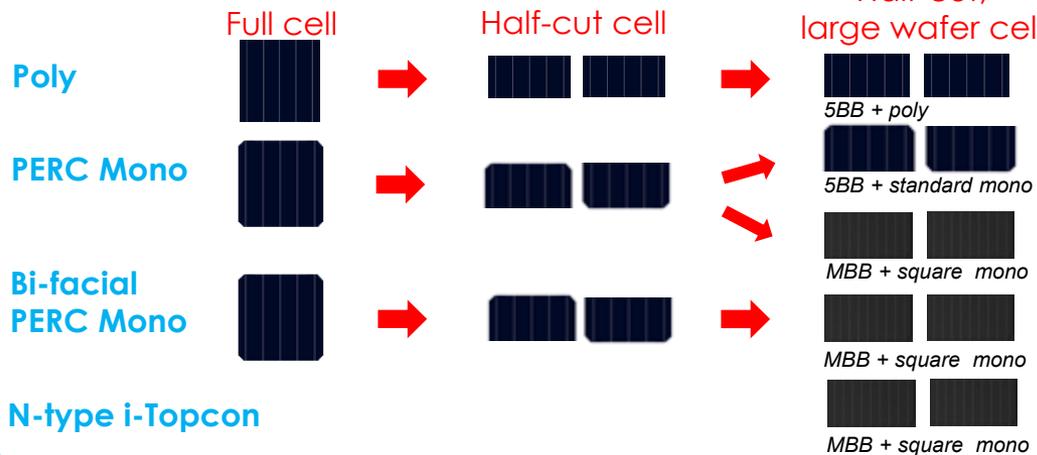


## Utility



### PV Module Features

### Cell Technology



### Frame

**35mm Frame**  
(backsheet module)



**30mm Frame**  
(double glass)



**Partial Frame**  
(bifacial module in Trinapro)

### Cell Configuration

6X10X2: 120 half-cut cell  
6X12X2: 144 half-cut cell

### Max. System Voltage

1500 Vdc  
1000 Vdc (only for HoneyBlack M)

### Color

Black/White    Black/Black    Silver/White



# High Efficiency half-cut cell modules

- **79 independent IPs of PERC technology, including 56 inventions**
- **Leading MBB (Multi-Busbar) technology**
  - Available on Honey M and Tallmax M
  - More strength uniformity; less power loss caused by crack
  - 24 authorized patents, including 15 inventions, published 3 international papers
  - Trina received the first MBB certificate from TUV Rheinland in China, March 2018
  - Market share among tier 1 manufacturers > 40%
  - Capacity: 7.6 GW in 2019
  - Track record >1GW
- **Half Cut Cell design leads to higher efficiency and lower power loss**
  - lower working temperature and hot resistance
  - Less shading resistance
- **10~15 Wp above industry average, lowering 1~2% BOS and 0.7% to 1.3% LCOE (according to case study in Shandong China)**
- **Highest efficiency 20.67% achieved and delivered in Top Runner projects in China**
- **BOM management according to climate at project location**



Honey<sup>M</sup>

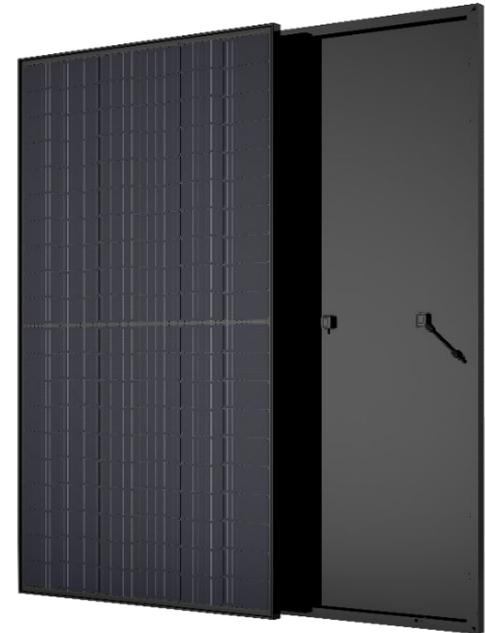
Honey

TALLMAX<sup>M</sup>

TALLMAX

# Pure Black module for homes

- **Aesthetics**
  - **Black cell**
    - Dedicated cell blackening treatment & Machine selection for color accurate control
    - 1GW black cell capacity
  - **Black backsheet, frame, main busbar, label and adhesive**
  - **MBB**: nearly invisible
- **High Power Density**
  - **340Wp** maximum
  - **Square cell** to maximize sunlight capture
  - Over 13% extra power can be installed on roof
- **24 authorized patents** including 15 inventions, and **3 international papers**
- **High Reliability**
  - **Half cut cell**: lower working temperature, hot resistance and shading resistance
  - **MBB**: More strength uniformity; less power loss caused by crack



HoneyBlack™

# Premium N-type module for homes

- **Aesthetics**
  - **Dark cell**
  - **Black frame**
  - **MBB**: nearly invisible
- **High Power Density**
  - **350Wp** maximum
  - Latest **N-type i-Topcon** cell technology
  - **Square cell** to maximize sunlight capture
  - Over 15% extra power can be installed on roof
- **30 Year** performance warranty
- **Best protection:**
  - Fire class A rating according to IEC 61730
- **High Reliability**
  - **Half cut cell**: lower working temperature, hot resistance and shading resistance
  - **MBB**: More strength uniformity; less power loss caused by crack



**DUOMAX** twin

# Double Glass module

- **No. 1 Tracker record**
  - > 3GW accumulative shipment
  - > 20% global market share
- **10GW capacity**
  - Fully automated workshops
  - 99.5% industry leading yield
- **68 authorized patents including 18 inventions, and 3 international standards**
- 20% more power and 20% longer lifetime are **GARANTEED**
  - 30 year performance warranty
  - Annual degradation 0.5% (from the 2<sup>nd</sup> year)
- **Fire class rating A** according to IEC 61730
- Robust glass-glass structure provides cell protection in **heavy snow or high wind environments**
- Double glass design **minimizes PID risk in high humidity & high temperature environments**
- **Professional logistics services and on-site installation instruction** to minimize breakage rate (<0.01%)



**DUOMAX**

**DUOMAX<sup>TM</sup>**

# Bi-facial module harvests up to 30% more energy

- **Up to 30% of additional energy production** from the rear side of solar modules
- Robust **glass-glass structure** provides cell protection in **all conditions**
- Bifacial system solution available: module, tracker, inverter
- **High Reliability**
  - **Half cut cell:** lower working temperature, hot resistance and shading resistance
  - **MBB:** More strength uniformity; less power loss caused by crack



**DUOMAX** twin

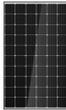
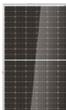
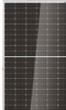
# PV Module Roadmap

Application: **Residential Rooftop** | Channel: **Distributor, Installer** | Delivery from: **Rotterdam Warehouse**

	Product Line	2018 Q4	2019			
			Q1	Q2	Q3	Q4
N-type i-TOPCON	<p>N-type i-TOPCON, black frame, white backsheet, glass-glass</p> <p><b>DUOMAX<sup>TM</sup> twin</b> TSM-NEG6MC.28(II)</p> 					<p><b>340-350 W</b> (120 half-cut cell, large wafer, <b>MBB+square mono</b>)</p>
PERC MONO	<p>PERC mono, black frame, white backsheet</p> <p><b>Honey<sup>TM</sup></b> TSM-DD05A.08(II)</p> 	<p><b>300-315 W (60 cell, 5BB)</b></p>				<p><b>325-340 W</b> (120 half-cut cell, large wafer, <b>MBB+square mono</b>)</p>
	<p>PERC mono, black frame, white backsheet</p> <p><b>Honey<sup>TM</sup></b> TSM-DE06M.08(II)</p> 					
	<p>PERC mono, black frame, black backsheet</p> <p><b>Honey<sup>TM</sup></b> TSM-DD05A.05(II)</p>  <p><b>HoneyBlack<sup>TM</sup></b> TSM-DD06M.05(II)</p> 	<p><b>295-310 W (60 cell, 5BB)</b></p>				<p><b>320-335 W</b> (120 half-cut cell, large wafer, <b>MBB+square mono</b>)</p>

# PV Module Roadmap

Application: **C&I Rooftop** | Channel: **Distributor, Installer** | Delivery from: **Rotterdam Warehouse**

	Product Line	2018 Q4	2019			
			Q1	Q2	Q3	Q4
POLY	Poly, silver frame, white backsheet	 Honey TSM-PD05	270-280 W (60 cell, 5BB)			
		 SPLITMAX TSM-PE05H	280-290 W (120 half-cut cell, 5BB)			
		 Honey TSM-PE06H	<div style="border: 2px solid red; padding: 5px; display: inline-block;">                     285-295 W (120 half-cut cell, large wafer, <b>5BB</b>)                 </div>			
PERC MONO	PERC mono, silver frame, white backsheet	 Honey™ TSM-DD05A(II)	300-315 W (60 cell, 5BB)			
		 SPLITMAX TSM-DE05H(II)	310-325 W (120 half-cut cell, 5BB)			
		 Honey™ TSM-DE06M(II)	<div style="border: 2px solid red; padding: 5px; display: inline-block;">                     325-340 W (120 half-cut cell, large wafer, <b>MBB+square mono</b>)                 </div>			
		<b>New Product</b>				

# PV Module Roadmap

Application: **Large Ground Mount Project** | Channel: **Utilities, PD, EPC** | Delivery from: **Factory to project site**

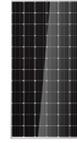
	Product Line		2018 Q4	2019			
				Q1	Q2	Q3	Q4
POLY	Poly, silver frame, white backsheet	 Honey TSM-PD05	270-280 W (60 cell, 5BB)				
		 SPLITMAX TSM-PE05H	280-290 W (120 half-cut cell, 5BB+LRF)				
		 Honey TSM-PE06H				<div style="border: 2px solid red; padding: 5px; color: white;">                     285-295 W (120 half-cut cell, big wafer, 5BB+LRF)                 </div>	
PERC MONO	PERC mono, silver frame, white backsheet	 Honey™ TSM-DD05A(II)	300-315 W (60 cell, 5BB)				
		 SPLITMAX TSM-DE05H(II)	310-325 W (120 half-cut cell, 5BB+LRF)				
		 Honey™ TSM-DE06H(II)				<div style="border: 2px solid red; padding: 5px; color: white;">                     325-340 W (120 half-cut cell, big wafer, 5BB+LRF+standard mono)                 </div>	

Note: double glass versions are also available

**New Product**

# PV Module Roadmap

Application: **Large Ground Mount Project** | Channel: **Utilities, PD, EPC** | Delivery from: **Factory to project site**

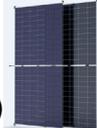
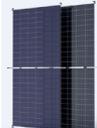
	Product Line	2018 Q4	2019			
			Q1	Q2	Q3	Q4
POLY	Poly, silver frame, white backsheet	<b>TALLMAX</b> TSM-PD14 	320-330 W (72 cell, 5BB)			
		<b>SPLITMAX</b> TSM-PE14H 	335-345 W (144 half-cut cell, 5BB+LRF)			
		<b>TALLMAX</b> TSM-PE15H 	340-350 W (144 half-cut cell, big wafer, 5BB+LRF)			
PERC MONO	PERC mono, silver frame, white backsheet	<b>TALLMAX™</b> TSM-DD14A(II) 	360-375 W (72 cell, 5BB)			
		<b>SPLITMAX</b> TSM-DE14H(II) 	370-390 W (144 half-cut cell, 5BB+LRF)			
		<b>TALLMAX™</b> TSM-DE15H(II) 	380-405 W (144 half-cut cell, big wafer, 5BB+LRF+standard mono)			

Note: double glass versions are also available

**New Product**

# PV Module Roadmap

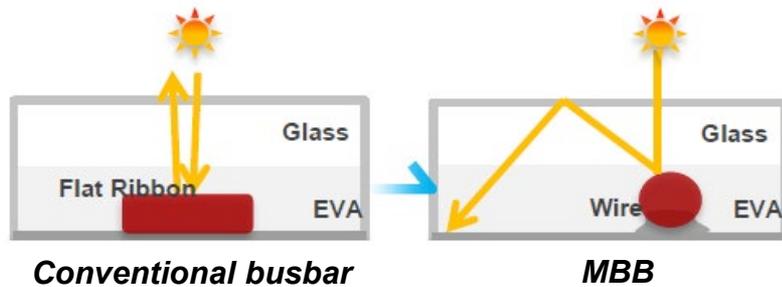
Application: **Large Ground Mount Project** | Channel: **Utilities, PD, EPC** | Delivery from: **Factory to project site**

	Product Line	2018	2019				
		Q4	Q1	Q2	Q3	Q4	
PERC MONO	Bifacial, PERC mono, double glass, frameless or framed	<b>DUOMAX<sup>twin</sup></b> TSM-DE05HC(II) TSM-DE05HC.20(II) 	310-325 W (120 half-cut cell, 5BB+LRF)				
		<b>DUOMAX<sup>twin</sup></b> TSM-DE06MC(II) TSM-DE06MC.20(II) 			320-335 W (120 half-cut cell, big wafer, <b>MBB + square mono</b> )		
		<b>DUOMAX<sup>twin</sup></b> TSM-DE14HC(II) TSM-DE14HC.20(II) 	370-390 W (144 half-cut cell, 5BB+LRF)				
		<b>DUOMAX<sup>twin</sup></b> TSM-DE15MC(II) TSM-DE15MC.20(II) 			385-400 W (144 half-cut cell, big wafer, <b>MBB + square mono</b> )		

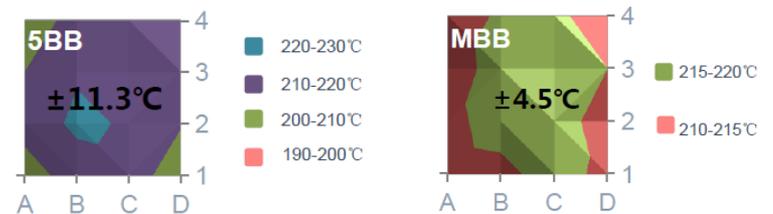
**New Product**

# MBB (Multi-Busbar) offers higher efficiency and better reliability

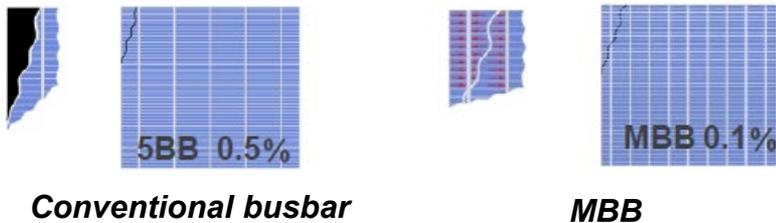
- Higher efficiency



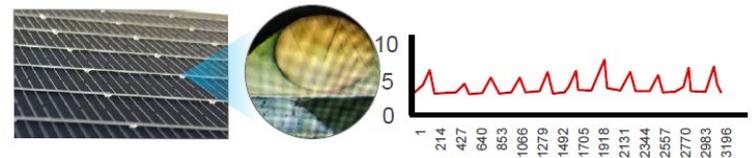
- Better temperature control in soldering process



- Lower power loss caused by cell crack

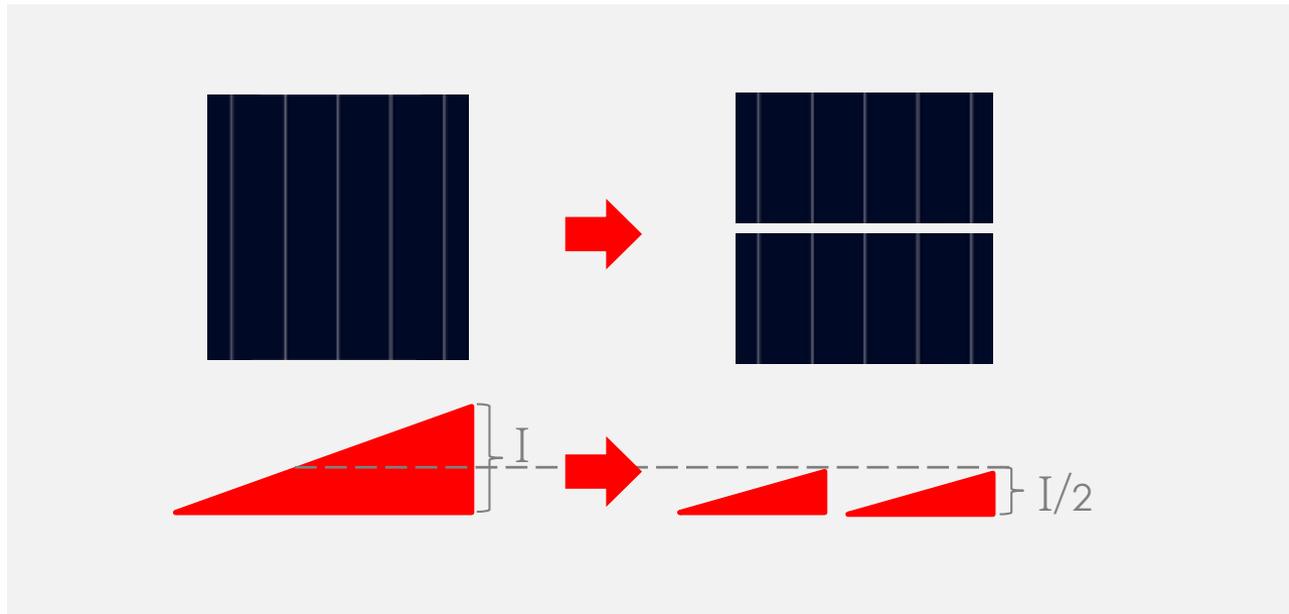


- Peeling strength is twice of the minimum industry standard



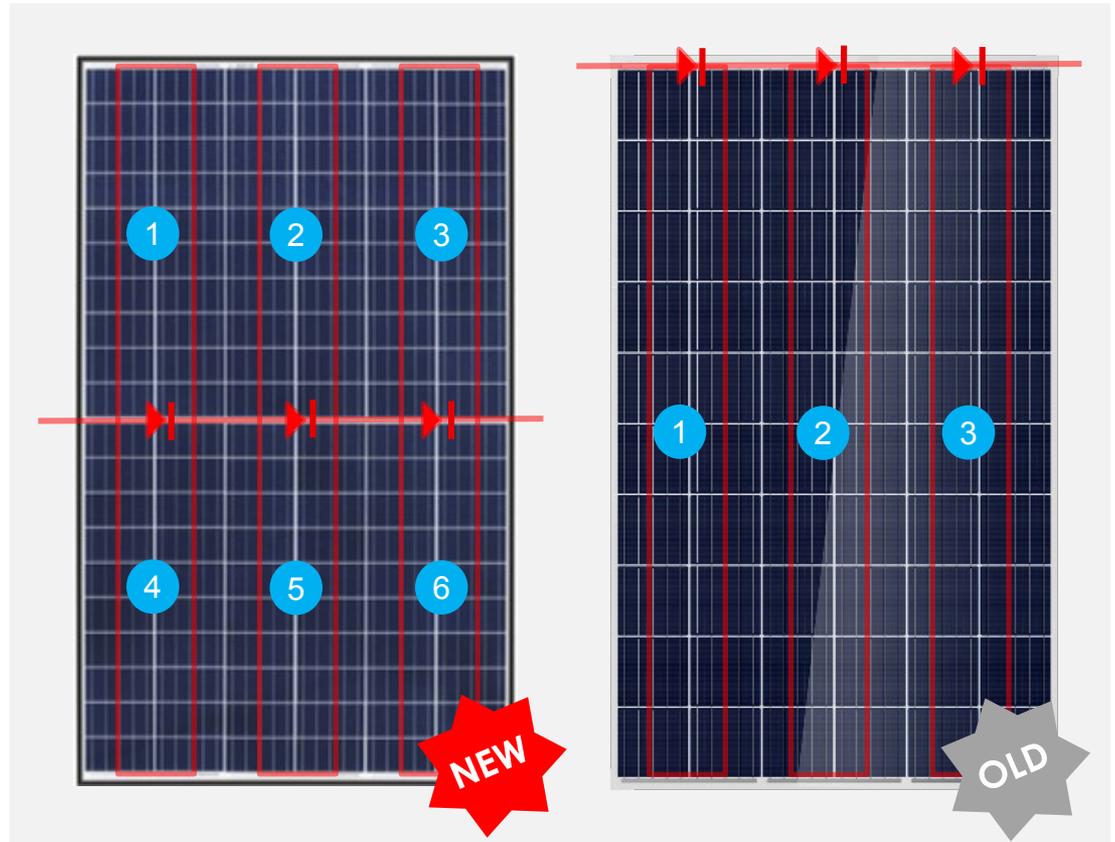
# Half-cut cell design leads to higher cell efficiency

- Reduced current through ribbons
- Power loss from ribbon resistance reduced by 75%



# New cell layout increases energy generation

- 6 cell strings
- Reduced loss from shading

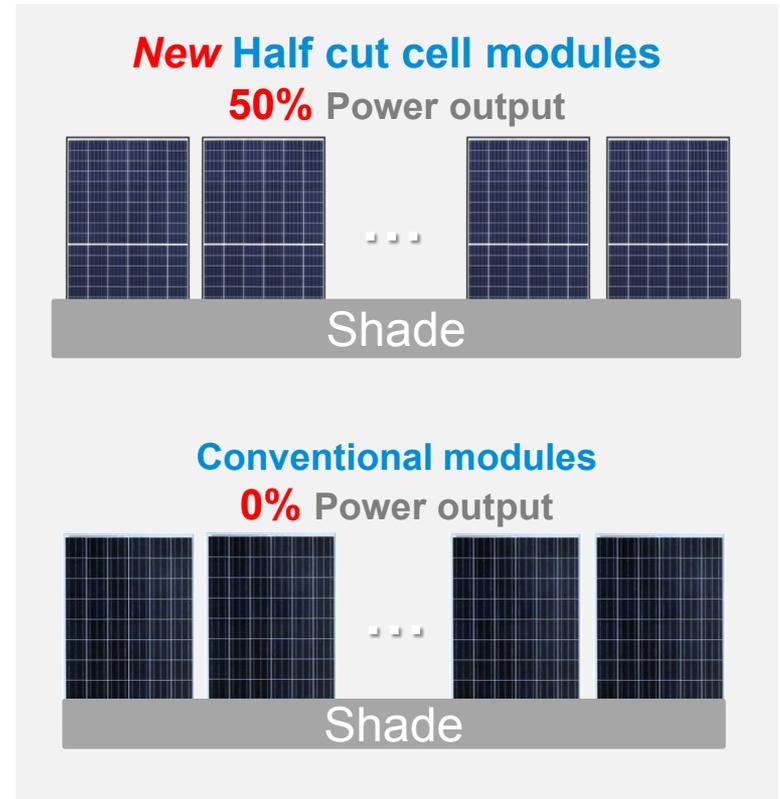


# New cell layout increases energy generation

- Energy gain up to 50% compared with conventional products under shading conditions with portrait installation

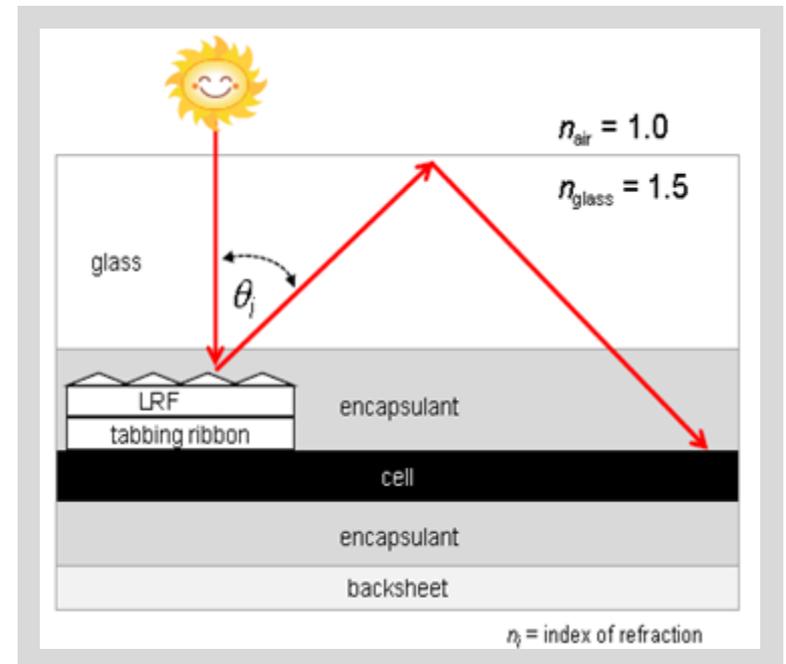
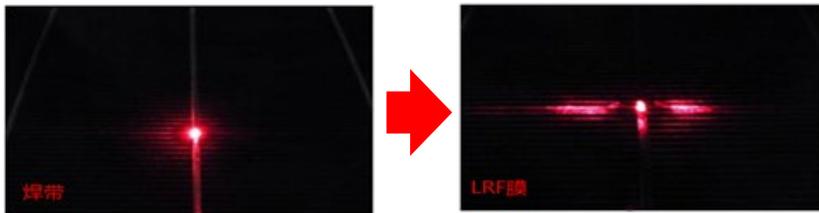


**Example of Shading**  
**(Installation with portrait orientation)**

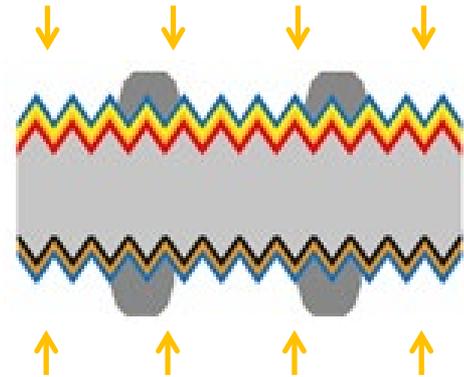


# LRF increases module efficiency

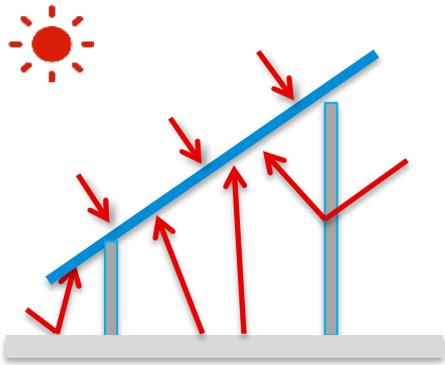
- LRF (Light Redirecting Film) redirects sunlight back to cells



# Bi-facial Cell Technology



Double Sided Cell



Generate energy on **FRONT** and **REAR** sides

# Bi-facial Cell Technology

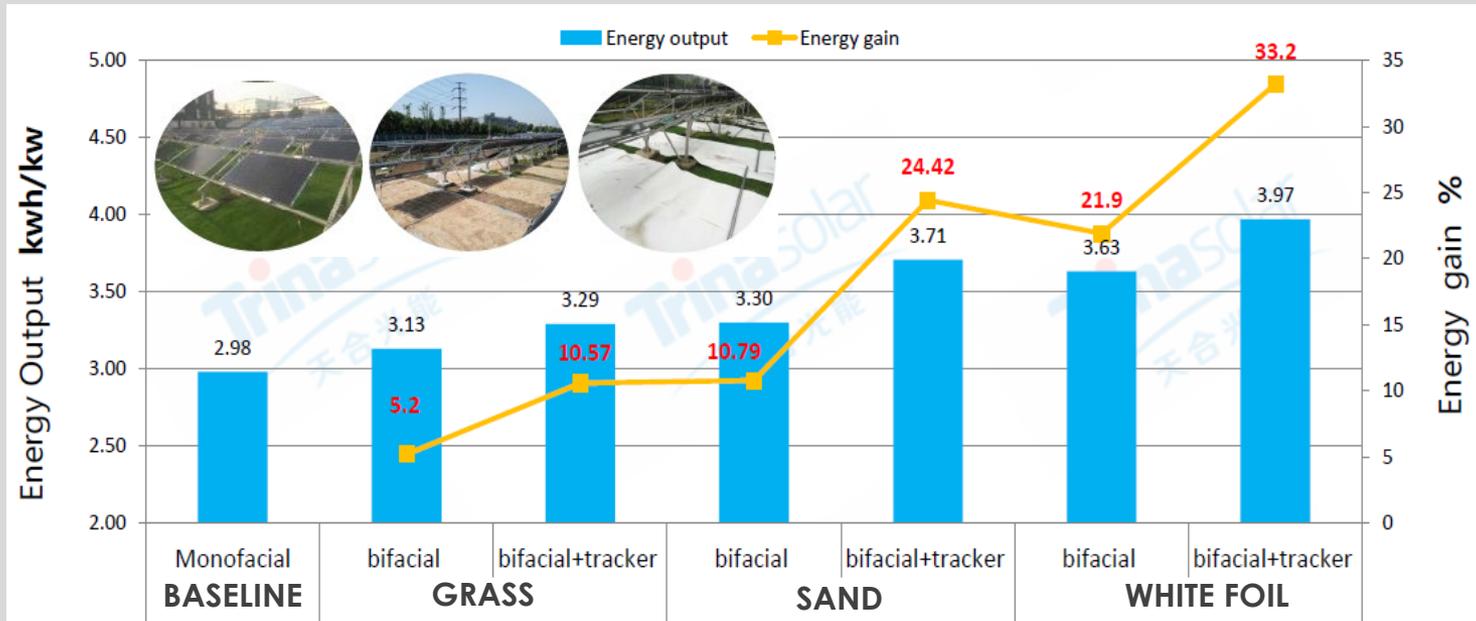
**Albedo** is the fraction of solar energy (the entire spectrum of solar radiation) reflected from the Earth back into space

Measurement of albedo with albedometer on site is highly recommended

Ground Type	Grass	Concrete	New galvanized steel	Fresh snow
				
<b>Albedo*</b>	15% - 25%	25% – 35%	35%	82%

*Data source: PVsyst*

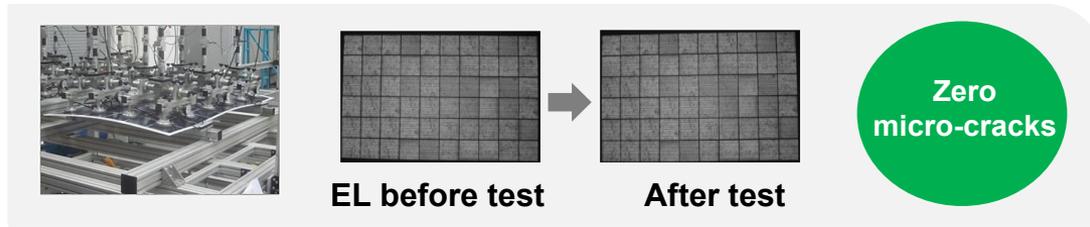
# Bi-facial Cell Technology



- **Location:** Changzhou, China (E119° 58' N31° 48')
- **Ground:** grass, sand, white foil
- **Installation Angle:** 27° for fixed structure; single axis tracker
- **Test period:** February 2017 - April 2017
- **Height:** 0.4m for fixed tilt system

# Robust **glass-glass structure** provides cell protection in heavy snow or high wind environments

- High quality heat strengthened solar glass
- Static load (simulation of snow)
  - Front side tested to 5400Pa (approx. 2m snow height)
  - Back side load test to 2400Pa (approx. 140km/h wind speed)



- Dynamic load (simulation of wind)
  - 1000 times ( +1000Pa,-1000Pa ) , 1 to 3 cycles per minute

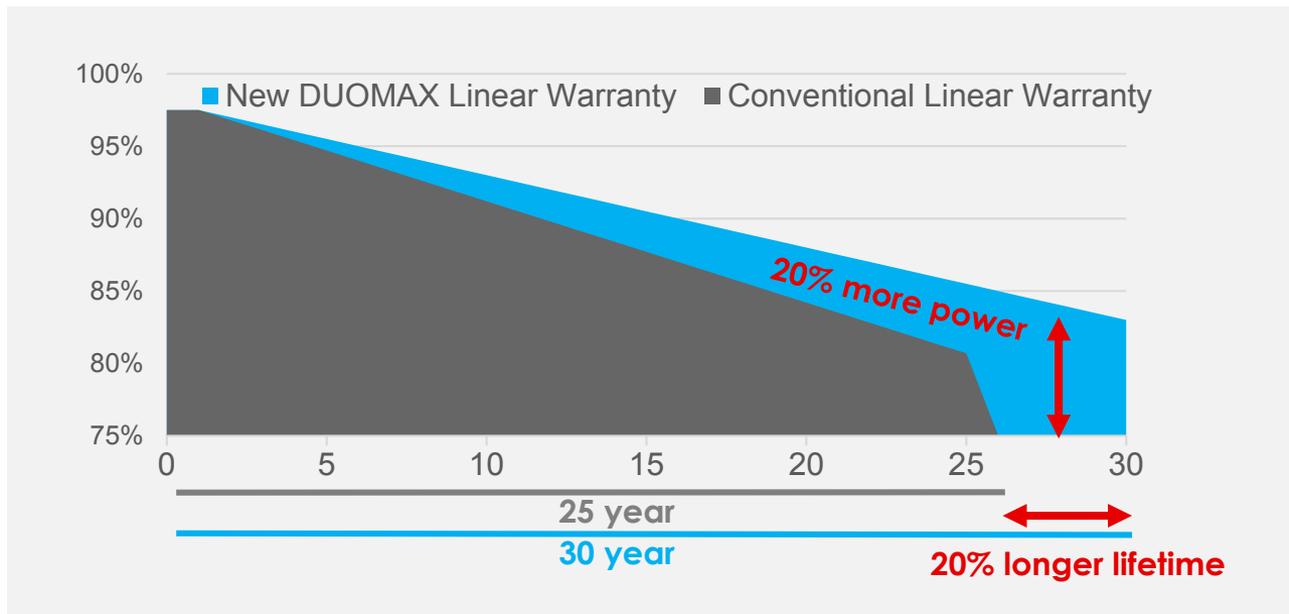
## Heavy Snow or High Wind Regions



# Glass-glass structure allows extended Warranty 20% more power and 20% longer lifetime GUARANTEED

Double Glass module 0.5% annual degradation\*, 30 year warranty

Conventional module 0.7% annual degradation\*, 25 year warranty



\* Annual degradation is yearly degradation from the second year of performance warranty

**THANK YOU**

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