Technological advances in PV and their role in the viability of PV projects

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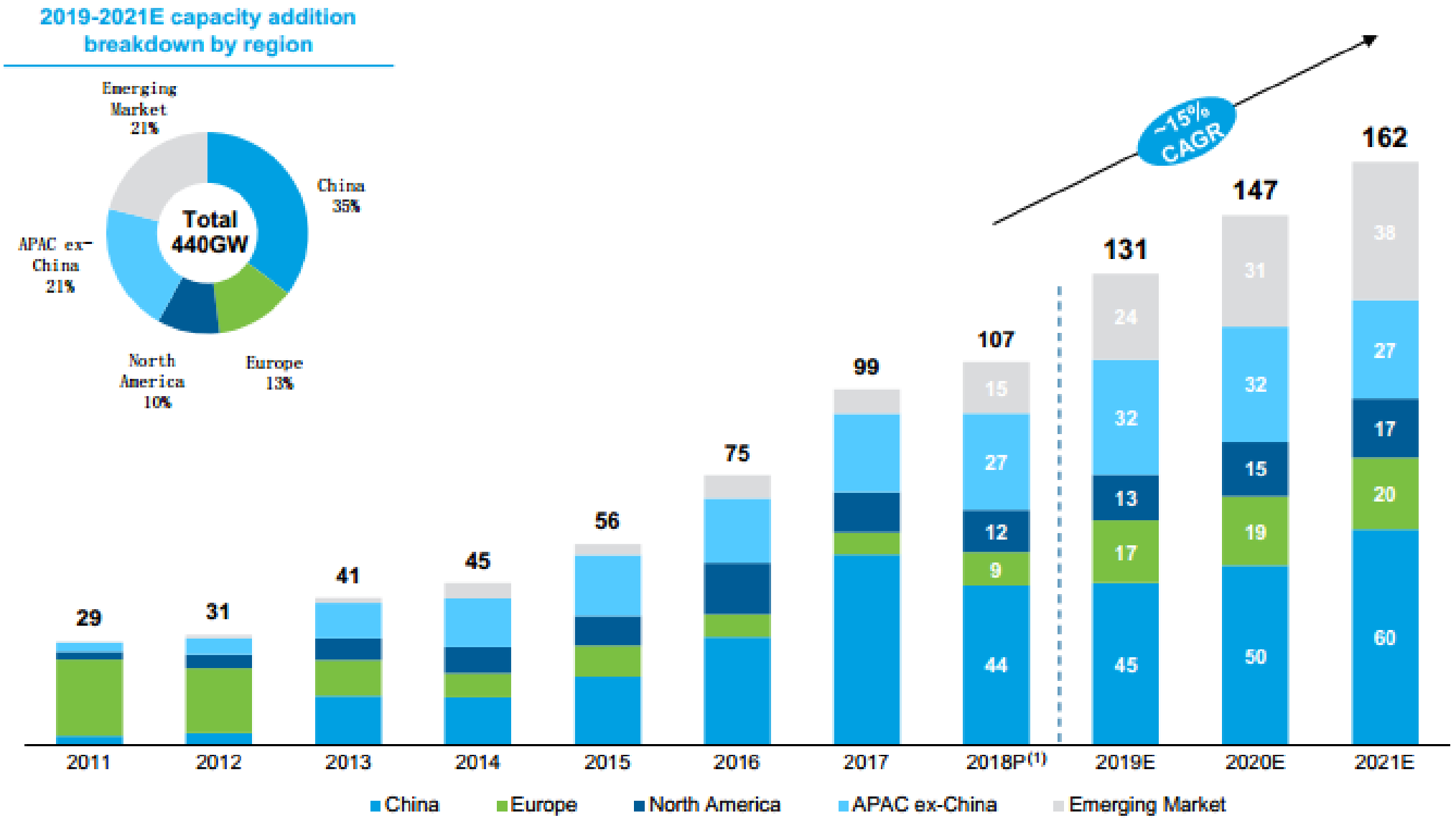
Robust Global Solar Demand



Source: Bloomberg New Energy Finance Q1 2019 Global PV Market Outlook and broker reports.

Market Trend: Mono vs. Poly

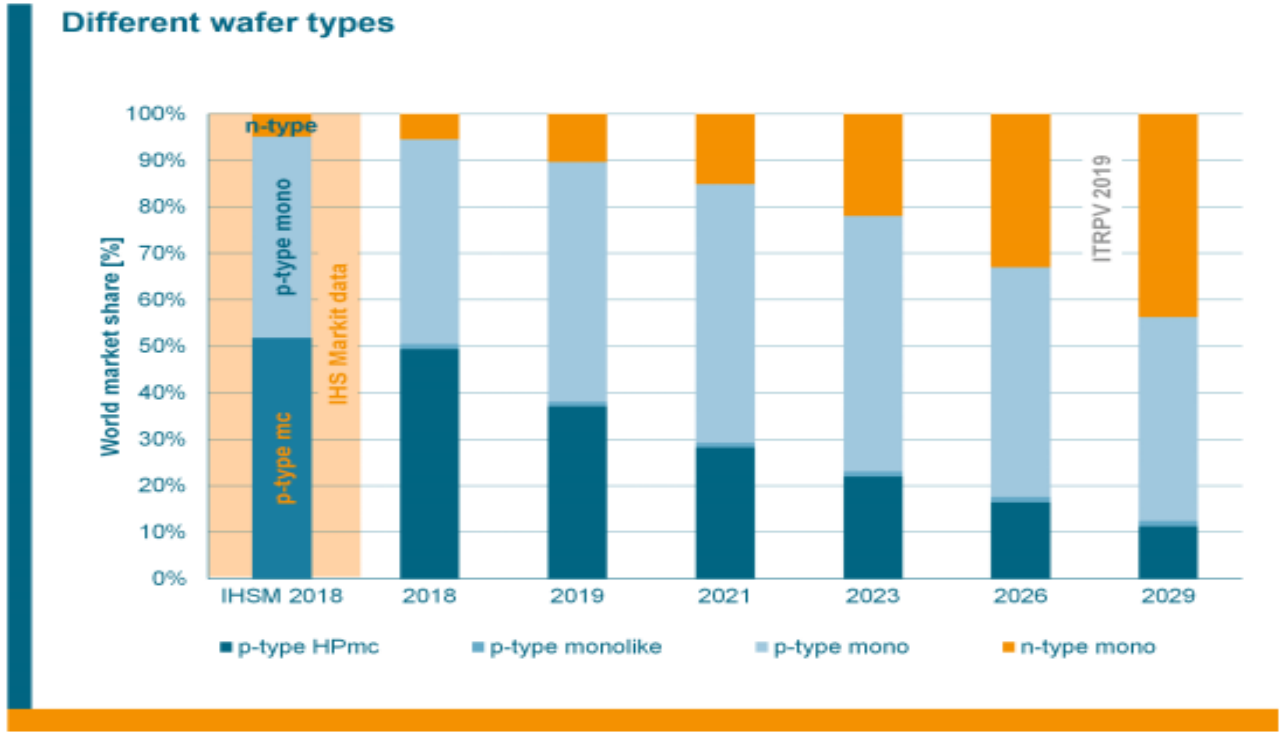


Fig. 38: World market shares for different wafer types. IHS Markit data are indicated for 2018 as reference, not distiguishing between HPmc and mc material [19].

- **Poly still cost-effective, mature option in many regions to sustain market growth**
- **Wafer cutting technique as key factor in production cost reduction and tech. develop.**
- **Mono driving capacity expansion, both P/N-type technologies**

Market Trend: Bifacial technology

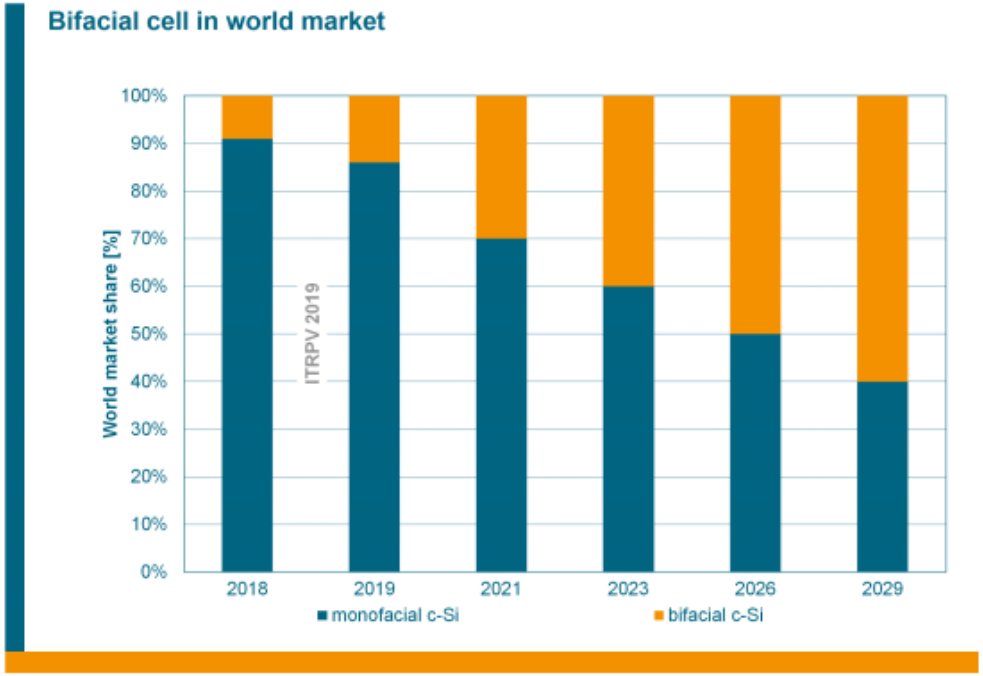
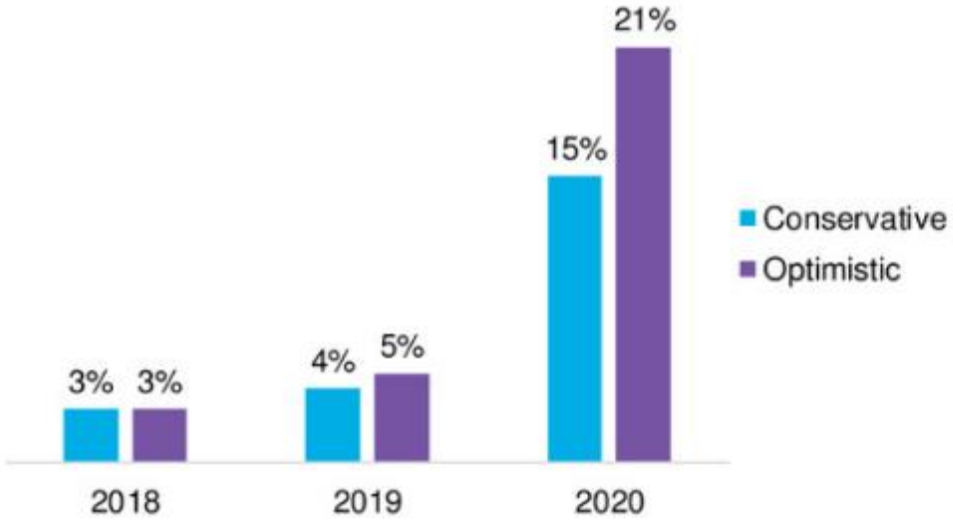


Fig. 42: Worldwide market shares for bifacial cell technology.

Source: ITRPV

Market Share Forecast of Bifacial Modules



Source: BloombergNEF Note: The middle scenario of global market size forecast is used to calculate the share.

The market share of bifacial modules rises sharply from 2018 and will reach 15% in 2020.

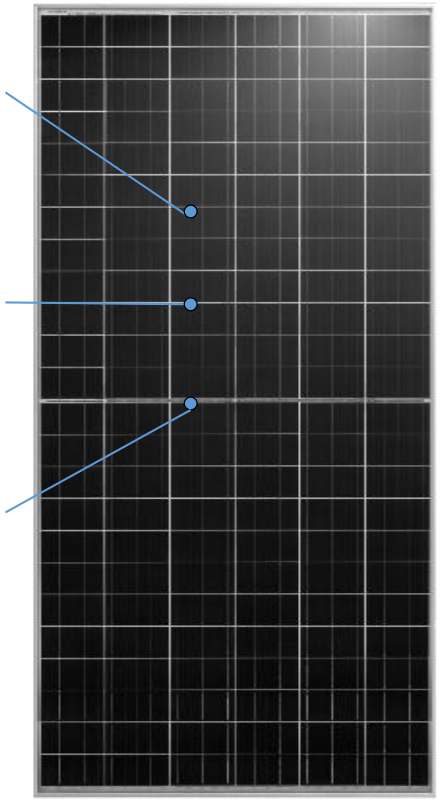
Bifacial Technology Benefits

Industry-leading right-angle large-cell technology brings about higher conversion efficiency and power output

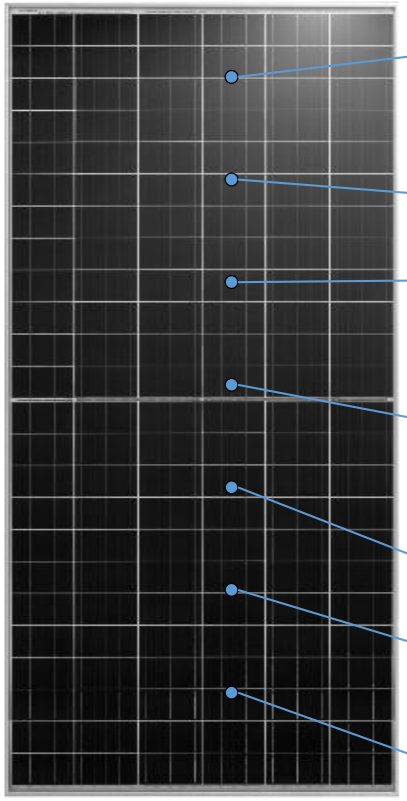
Half-cell technology reduces the risk of hot spot caused by high current

Higher IRR given that electricity generation can increase by 5-25% depending on terrestrial surface types

Bifacial Double-Glass



Bifacial Transparent Sheet



inter solar award 2019 WINNER

Electricity generation can increase by 5-25%

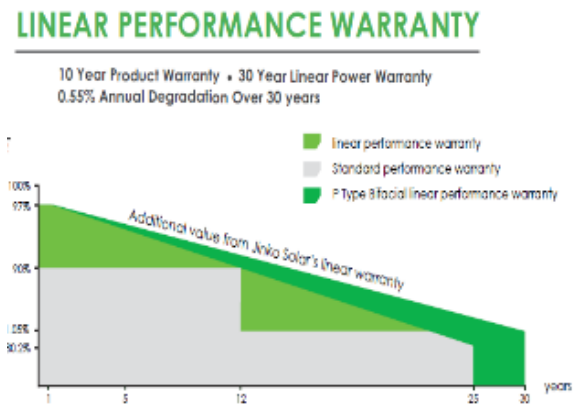
Weight reduction by 25%

BOS cost can decrease by 3% and O&M cost can decrease by 5% compared to that of monofacial mono modules

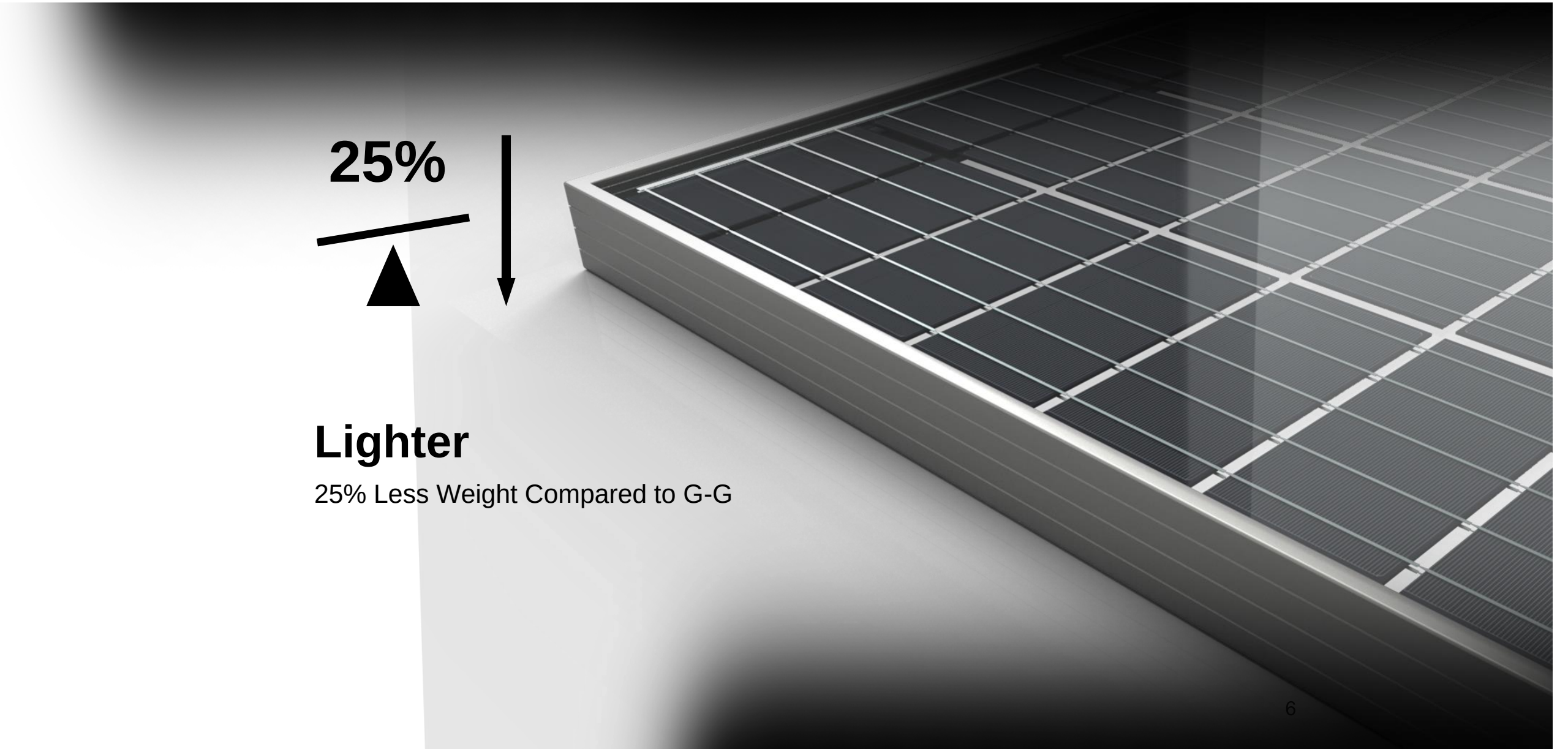
Max power output of 500W

Easy-to-clean Tedlar transparent film

30-yr linear power warranty



Bifacial Technology Benefits: 25% lighter



Lighter

25% Less Weight Compared to G-G

Bifacial Technology Benefits: Stain resistance

The hydrophobic surface offers excellent **anti-staining features,** making **cleaning of the modules easier**

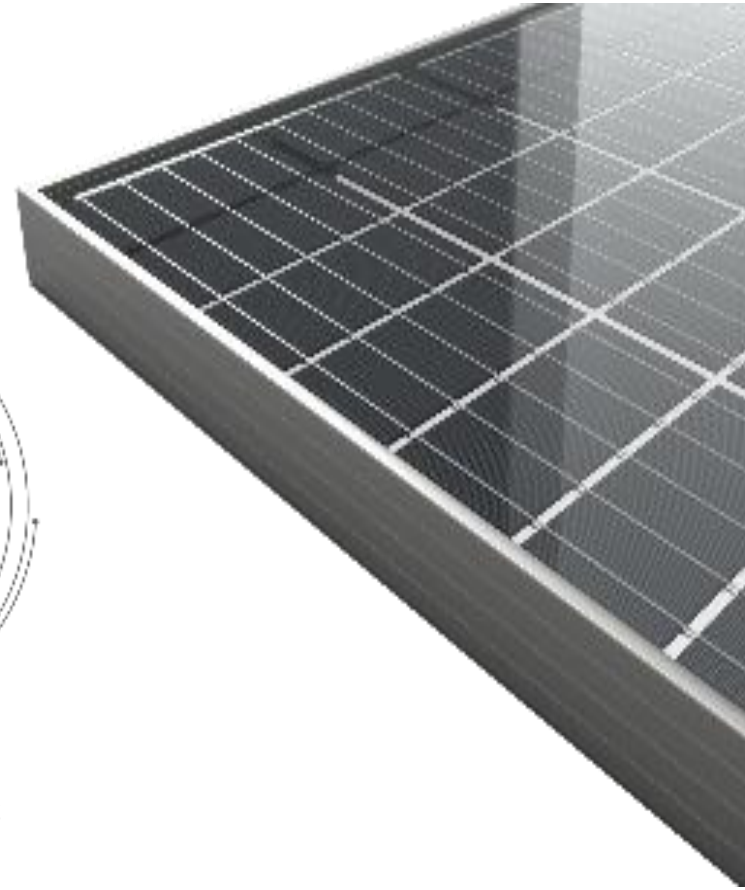
5%

O&M

Tedlar PVF Films

Easy-to-clean Surface Finish

Bifacial with Transparent Backsheet Business Case



100MW

Project Size

72,000,000 $

TOTEX

CAPEX
70,000,000$

OPEX
2,000,000$
during 25 years

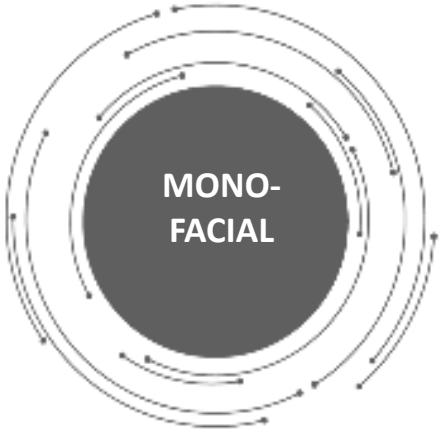
2,850,000 MWh

Energy yield
during 25 years

1,500 kWh/m2
Annual Irradiance

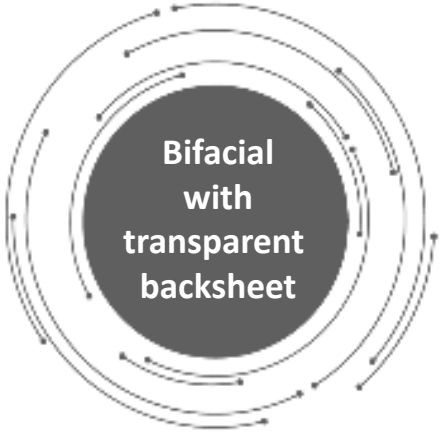
PR 85%

Bifacial with Transparent Backsheet Business Case



Option 1:
Monofacial 400Wp modules

- TOTEX 72m$
- LCOE 72m$/2,850,000MWh = 25.3$/MWh



Option 2:
Bifacial module with transparent backsheet 400Wp modules

- +10% energy yield
- Lower annual degradation

- TOTEX 75m$
- LCOE 75m$/3,157,000MWh = 23.7$/MWh
- 1.6$/MWh lower or 6.3% reduction of the LCOE by using the Jinko bifacial modules with transparent backsheet (compared with Monofacial modules)
- Additional benefit: with Jinko modules the lifetime of the PV park increases to 30 years

Assumption: Rest of the costs (loan interest, development costs, installation costs, etc.) remains the same in two different options.

Market Trend: Multi-Busbar technology

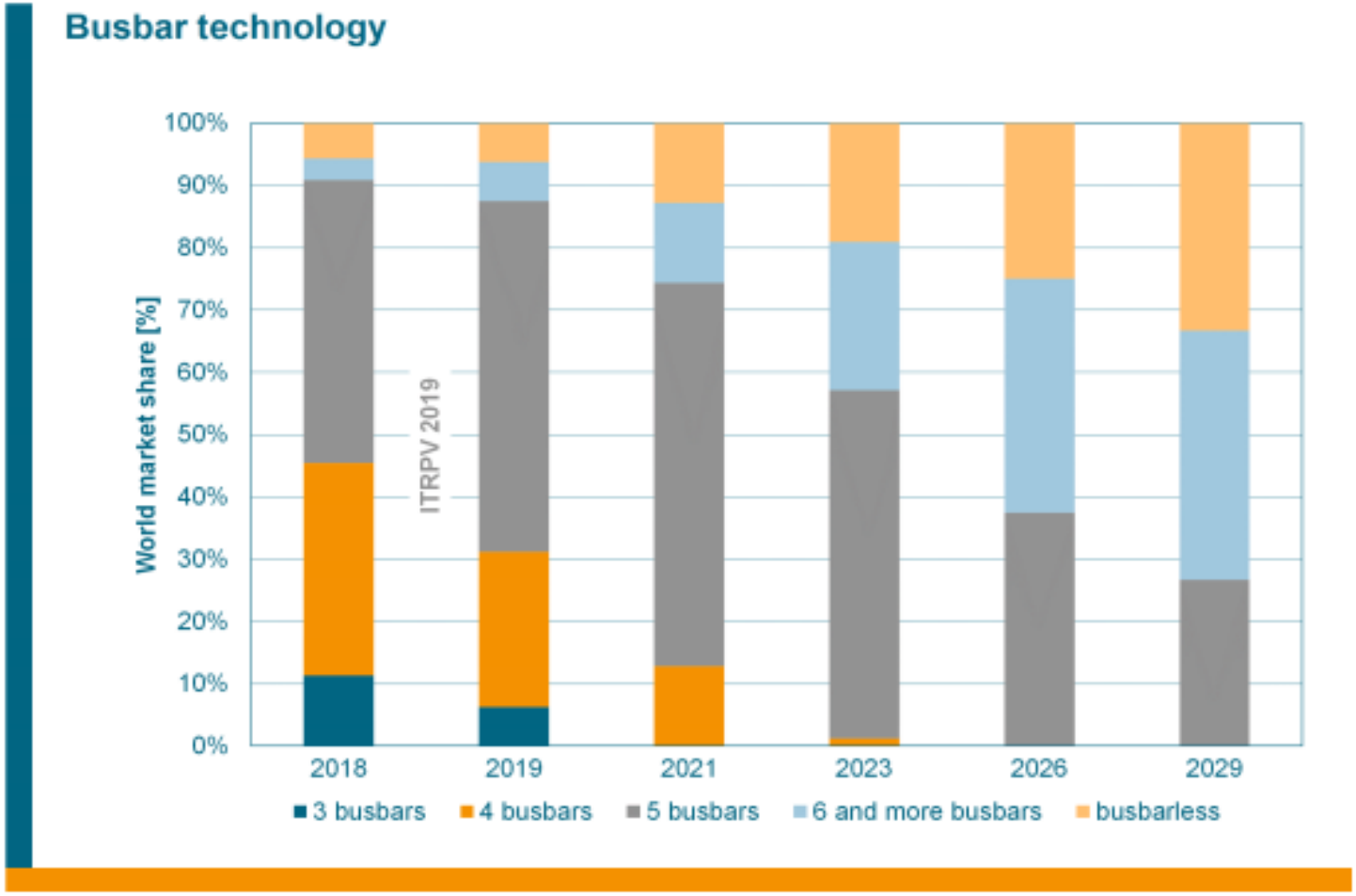
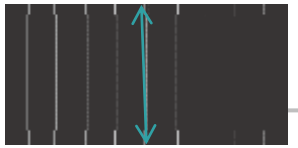


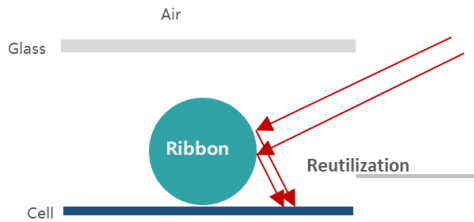
Fig. 34: Worldwide market share for different busbar technologies.

Source: ITRPV

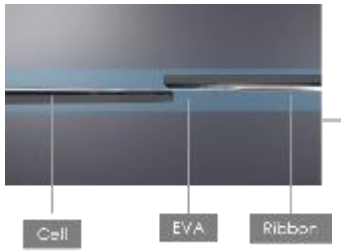
TR 9 Busbar technology Benefits



Half Cell Technology

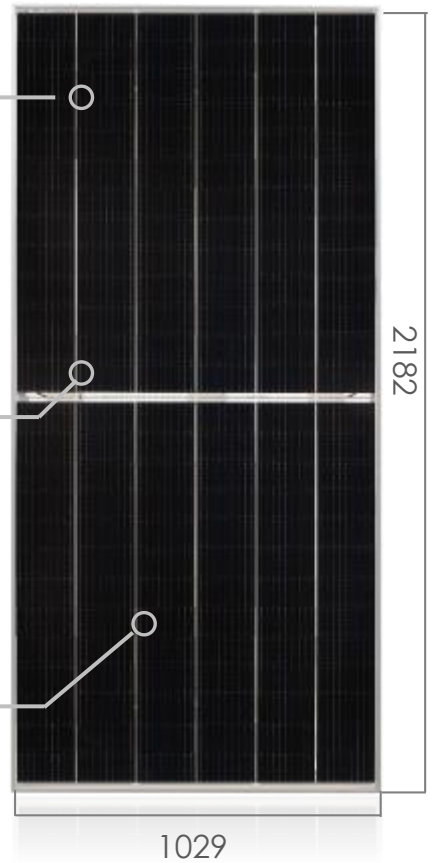


9BB with circular ribbon

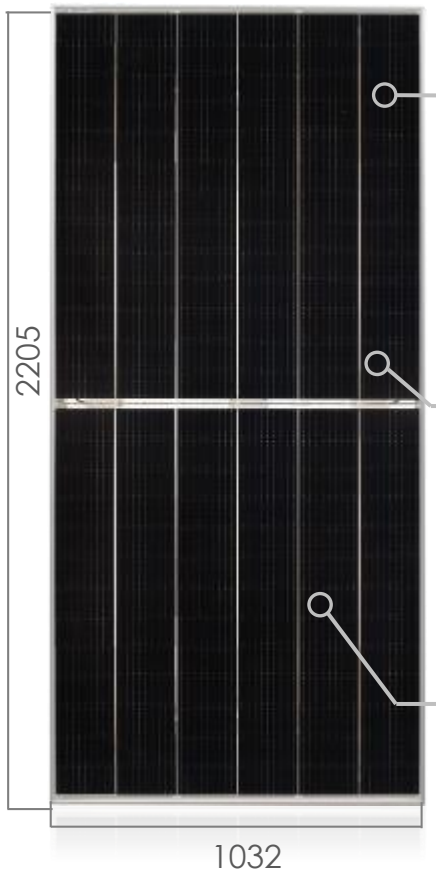


TR technology to eliminate the cell gap

Mono-facial



Bifacial



IRR

Rear side energy gain to increase IRR

Less Weight

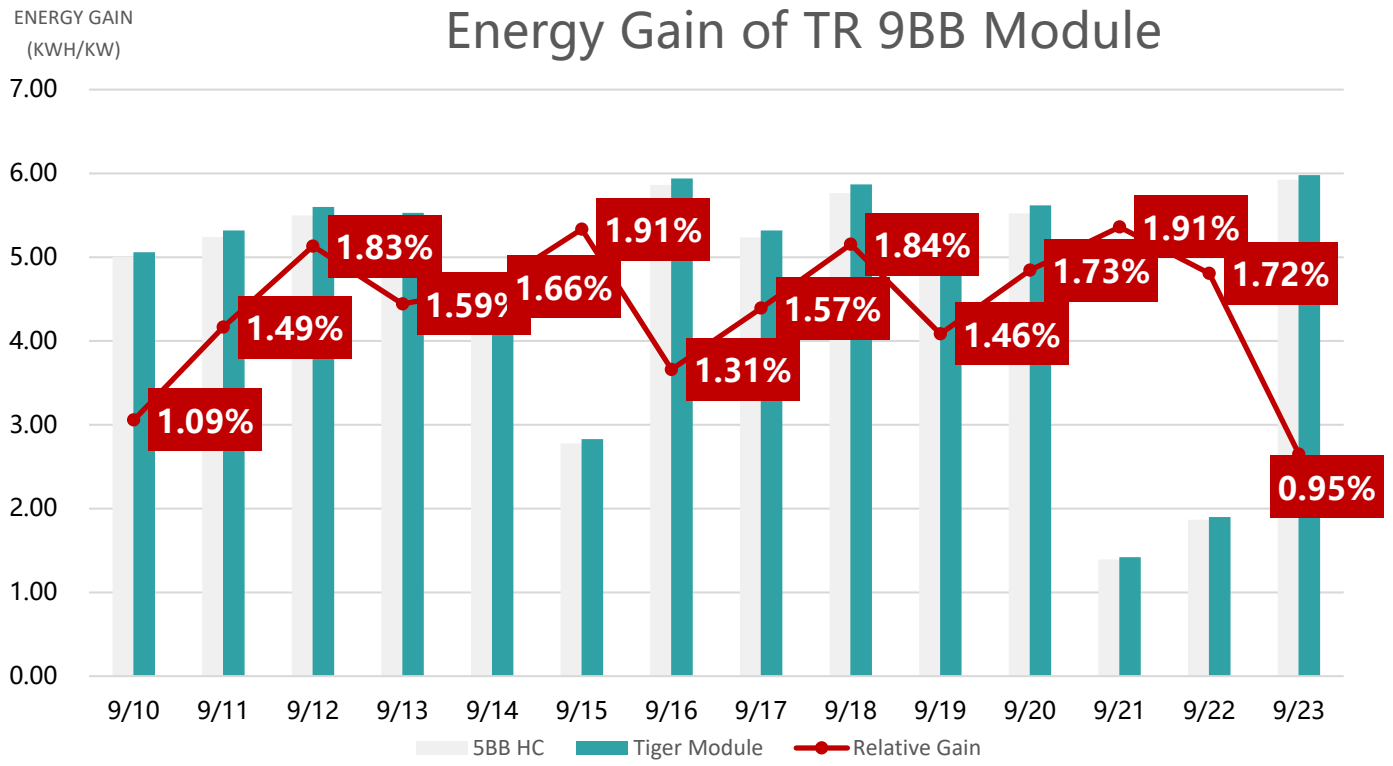
Perfectly compatible with transparent backsheet, same weight with monofacial module

Use DuPont Tedlar film with high reliability and self-cleaning features

CONVERSION | BOS | LOW LIGHT | PID-RESISTANT | 2400 Pa 5400 Pa

TR 9 Busbar technology Benefits: More Energy Generation

Comparing with traditional 5BB HC module, due to the secondary reflection of circular ribbon, energy generation will increase by approx. 1.57%.



Because of higher Rs and second reflection, 9BB shows excellent performance especially in low irradiance environment.

Financial Benefits of TR 9 Busbar Technology

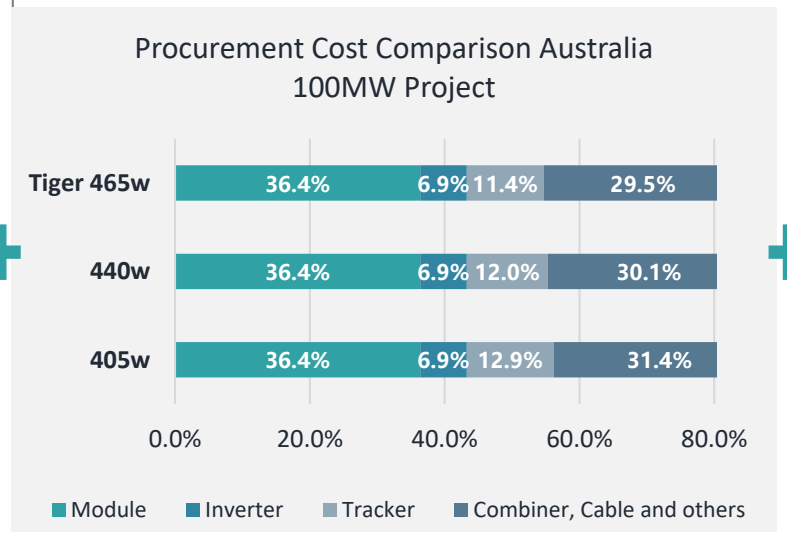
Engineering | **P**rocurement | **C**onstruction → **L**and

Power output per string ↑

String number ↓

- 1.66%

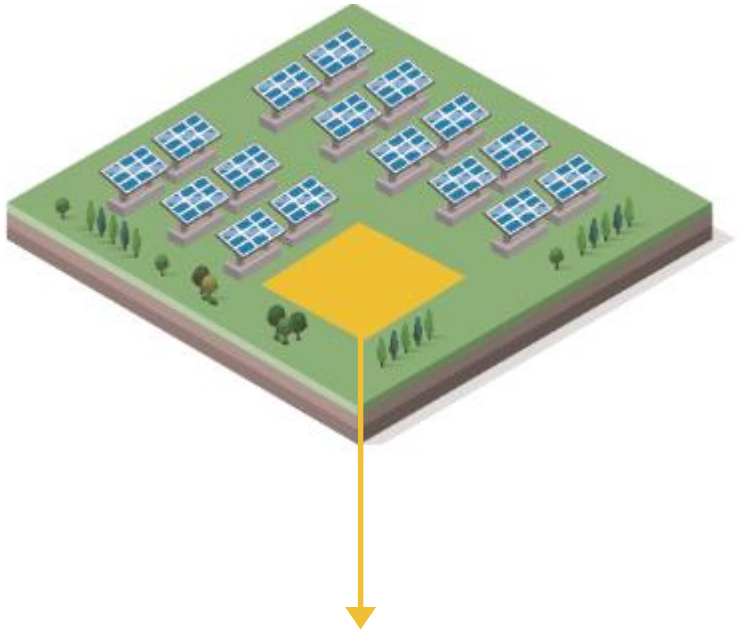
+



+

Construction cost ↓

- 1.84%



Saving > 1.2% EPC cost

-4% Land Area

Example : Australia – 164 MW Project

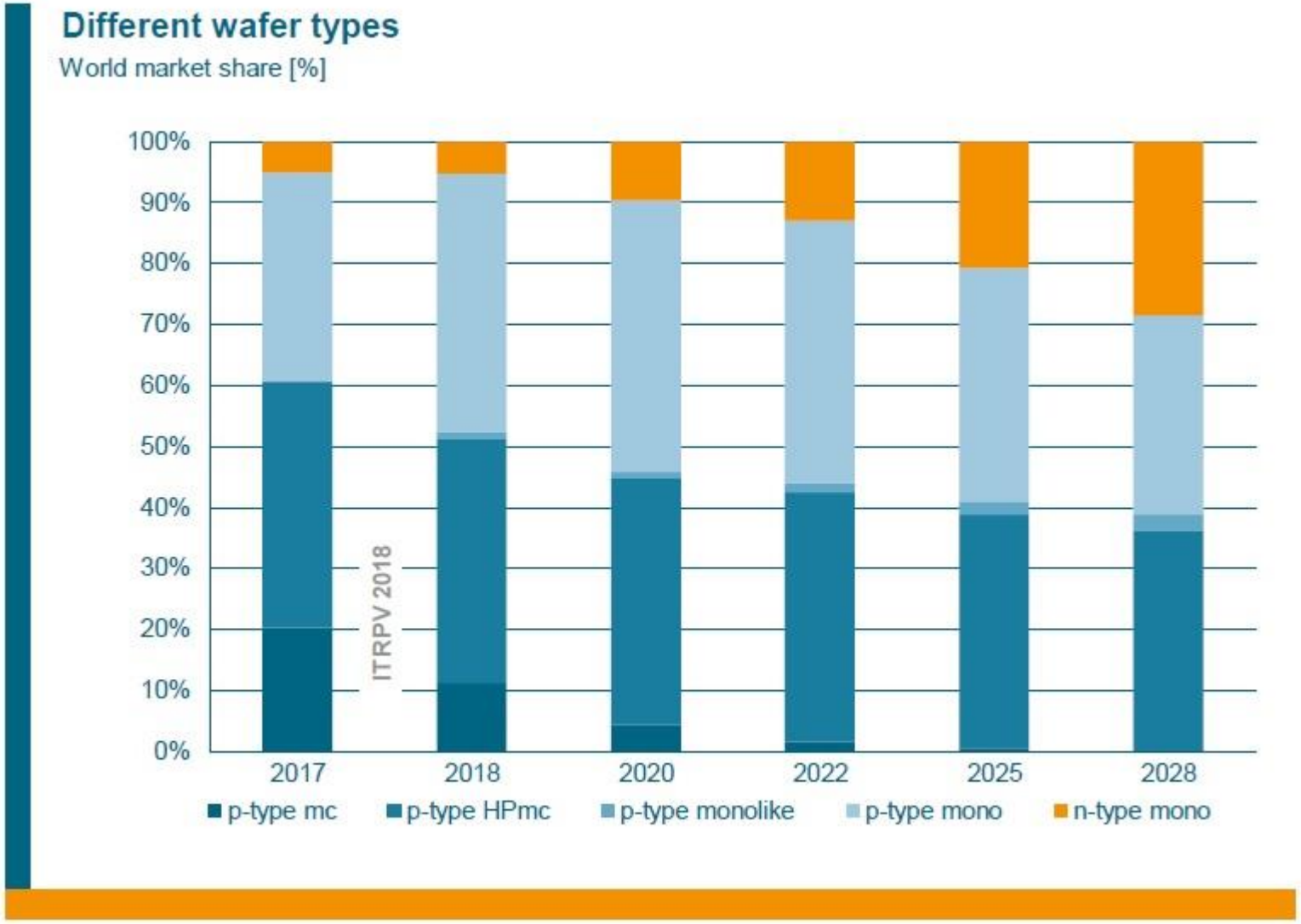
LCOE Analysis TR 9 Busbar technology

***Example** : Australia - 164MW Project

LCOE Analysis			
Module	*Normal Perc Module*	*Bigger size Perc Module*	**9BB TR Module**
Power	405	440	465
Efficiency	20.13%	19.8%	20.71%
EPC cost	100%	97%	96%
Land	100%	101%	97%
Opex	100%	94%	88%
1st Year Generation	352085(MWh/year)	353374(MWh/year)	**360351(MWh/year)**
Result			
LCOE(US cents/kWh)	2.67	2.64	**2.59**
IRR	11.06%	11.23%	**11.52%**

As a next generation product, **TR 9BB** brings not only **advanced technology** but also **lower LCOE and higher IRR**

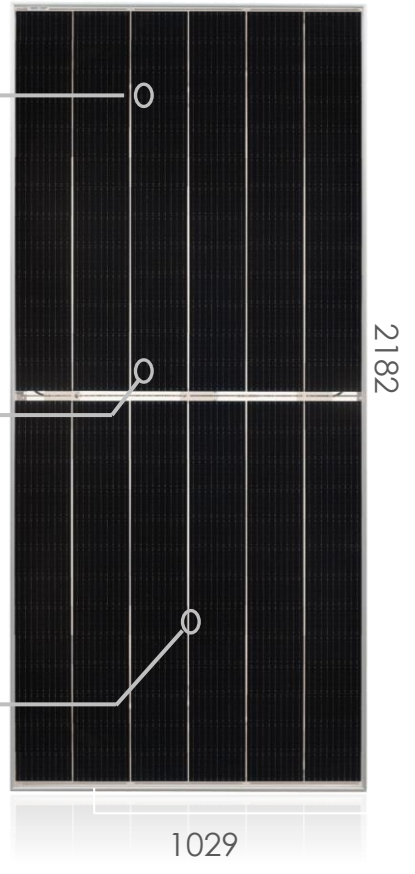
Market Trend: N-type technology

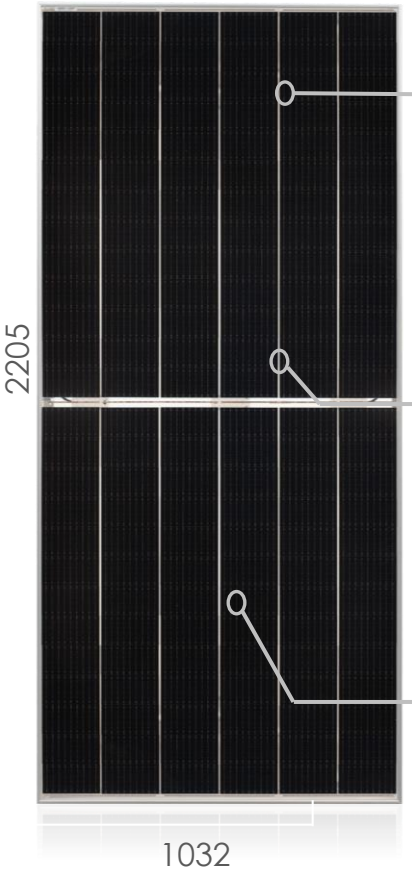


N-type technology Benefits

9 BB TR N-type Mono-facial

9 BB TR N-type Bifacial





475W
21.16%
N-type Cell Technology

1st year: **1%**
2-30 years: **0.4%**
Better warranty

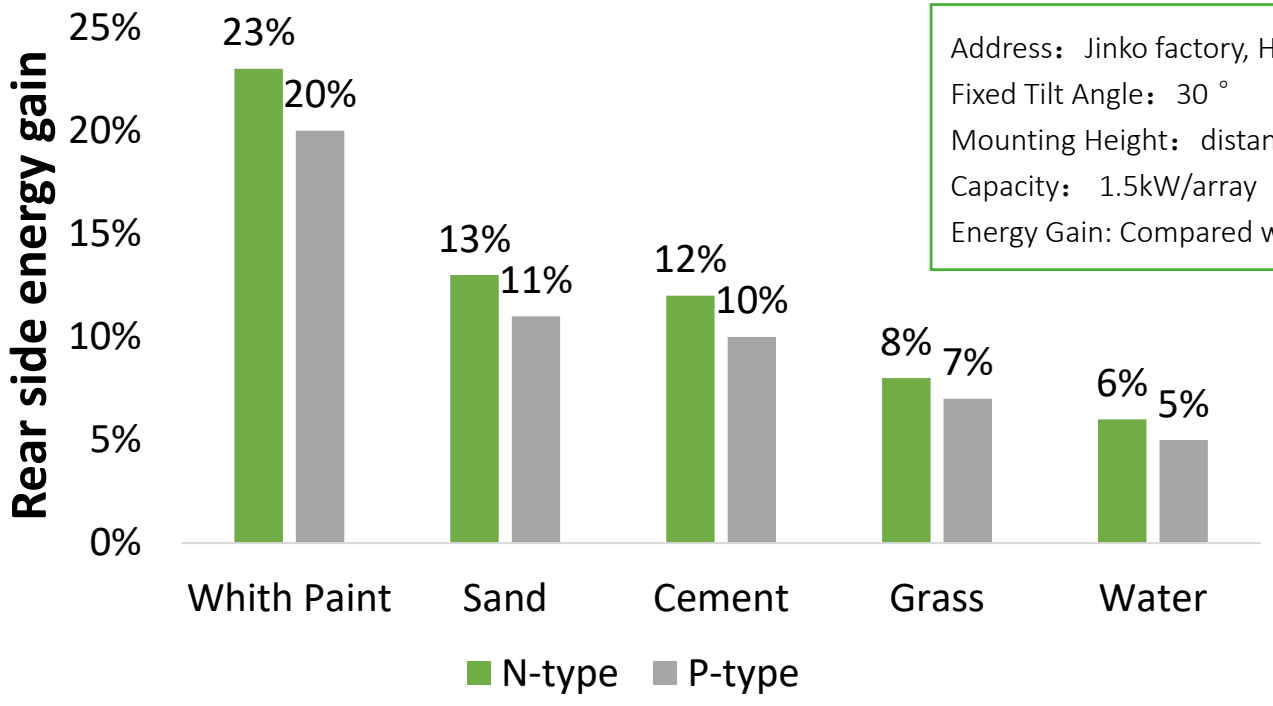
Eliminate the cell gap

85±5%
Higher bifacial factor

-0.34%
Better Temp. coefficient

+2.52%
More Energy Generation

Haining Energy Generation Performance



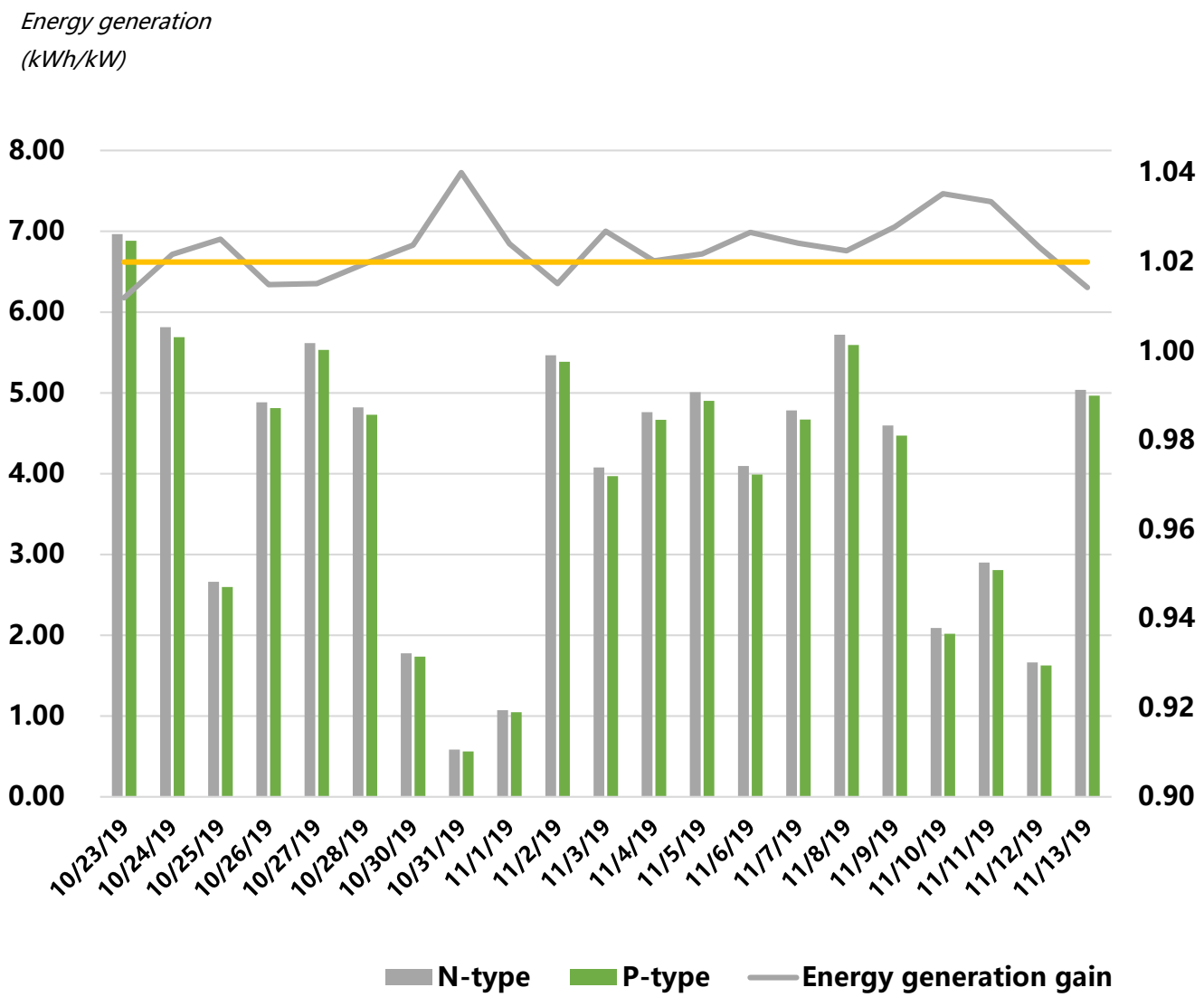
Address：Jinko factory, Haining，30.3° N/ 120.4° E
Fixed Tilt Angle：30 °
Mounting Height：distance from lower edge to ground is 1.2m
Capacity： 1.5kW/array
Energy Gain: Compared with mono-facial module in same condition

Albedo	80%-85%	22%-25%	30%-33%	10%-20%	2%-5%

✓N-type module has better rear side performance than P-type

✓Testing module is using Transparent backsheet

3rd Party Testing Result



Location：Qionghai, China
Tilt：+/-60°
Installation height：1.5m
Ground type：Sand
Albedo: 20.41%
Test period：
2019.10.23~2019.11.13

Source: Testing result from CQC

LCOE Analysis N-type module

***Example** : Australia - 164MW Project

LCOE Analysis		
Module	**P-type module**	**N-type module**
Power	**455**	**470**
Efficiency	**20.19%**	**20.65%**
1st Degradation	**2.5%**	**1%**
Linear Degradation	**0.55%**	**0.4%**
Bifacial Energy gain	**9%**	**10.9%**
1st Year Generation	**392783(MWh)**	**406530(MWh)**
Result		
LCOE(US cents/kWh)	**2.42**	**2.28**
IRR	**12.34%**	**13.15%**

Thank you!

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