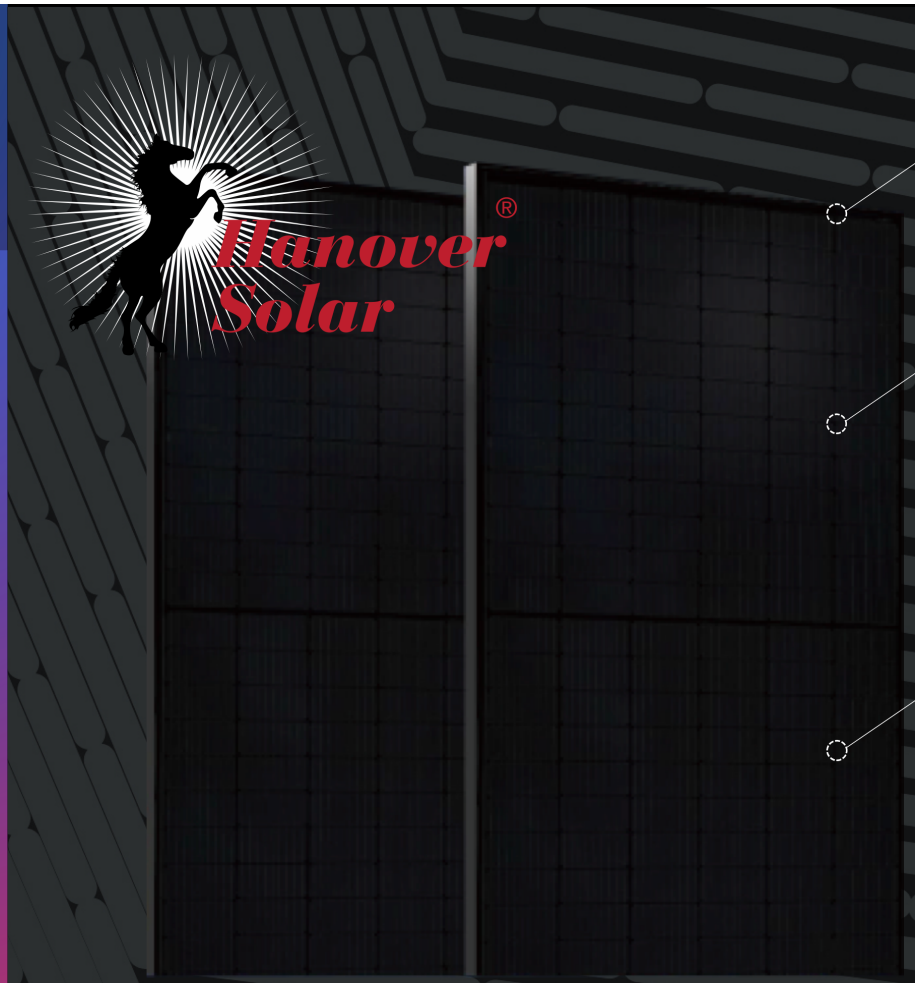
HJT

Hanover Solar®

HIGH EFFICIENCY HIJ TECH
Glass Glass MODULE **2022**



High Efficiency

Over 22% module efficiency

High Reliability

No PID/LID

Low hot spot temperature

Low NOCT

High Energy Yield

Excellent low irradiance performance

Low temperature co-efficient

High bifaciality

Low degradation

HJT Technical Advantage

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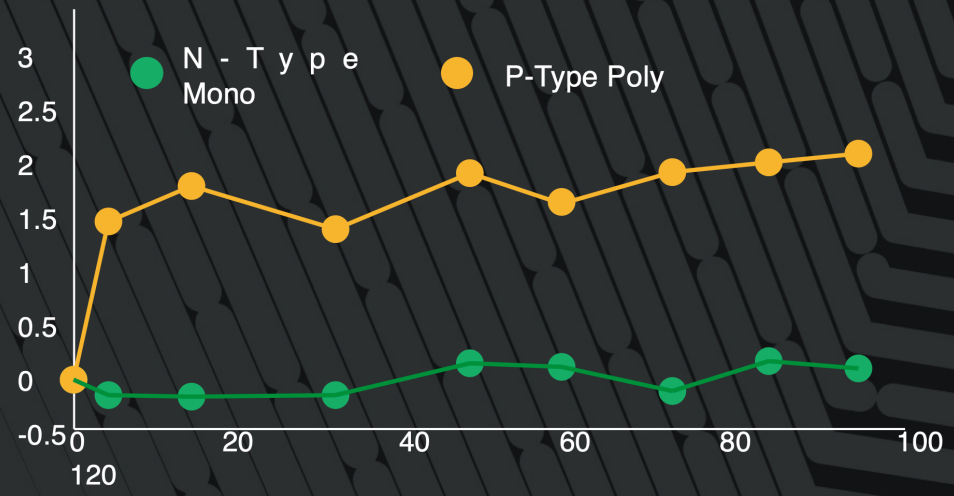
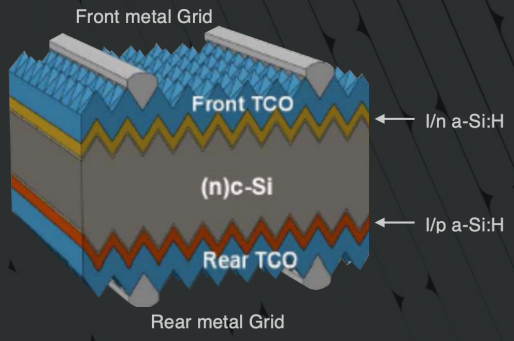
- NO PID LID effect
- Lowest Degradation
- High Bifaciality
- Higher Reliability
- Framed Glass Glass
- Mounting Compatible
- Technical Characteristics of Shingled Module
- Excellent Low Irradiance Response
- Non-Destructive Cutting Technology
- Low Temperature Welding Technology
- Low Temperature Coefficient
- Higher Energy Production

NOLID/ PID Effect

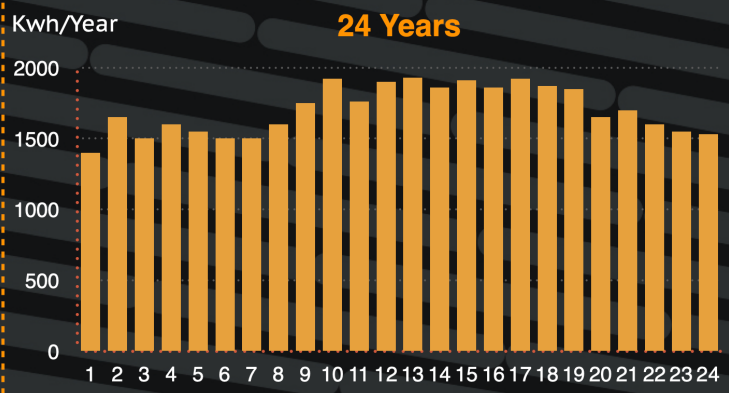




LID:

P-type cells doped with boron and oxygen and metal impurities light irradiation to form compounds, resulting in the cell's efficiency decay;

N-type silicon wafers are mainly doped with phosphorus, which is not easy to form compounds in sunlight.

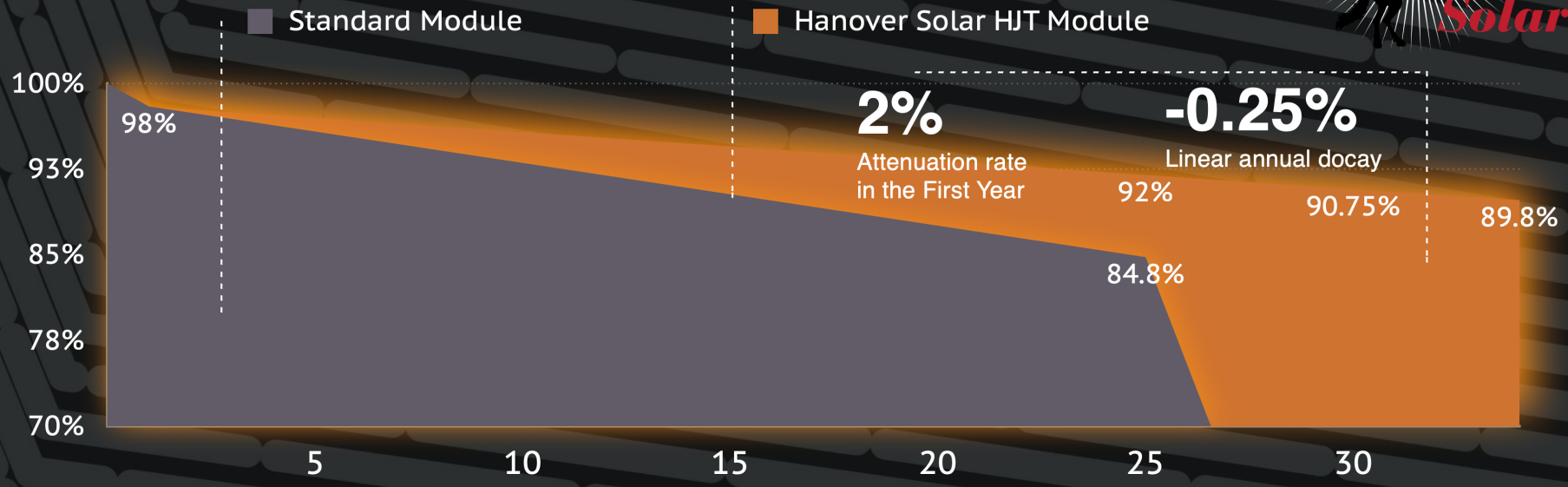


1. The HJT cell is designed with conductive TCO surface and insulation-free layer, so there is no build-up surface layer charge.

2. 25 years of HJT module application with no customer feedback of PID occurrences.

3. No PID occurrences after in-house and third party reliability testing.

Lowest Degradation



Low temperature coefficient and high bifaciality performance allows HJT module to bring more energy yield. According to the existing power warranty curve, HJT module has higher power retention rate than that of Mono PERC. Higher power retention rate brings more energy yields.

Hanover Solar Glass Glass module products use HJT cells, which have better attenuation resistance, high efficiency, stable and long-lasting power generation, while Hi-chaser promises to provide the best quality assurance to ensure maximum customer value.

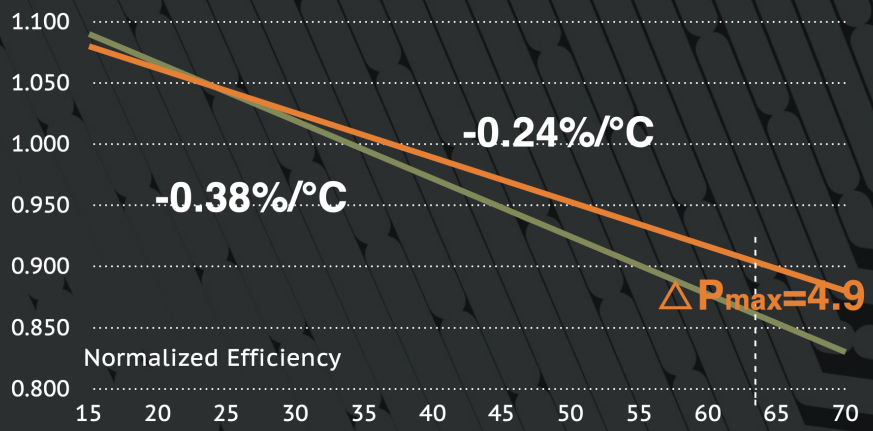
TCO film in HJT module prevents charge accumulation on the surface, resulting high resistance to PID.

LID (light-induced degradation) is mainly formed by B-O complex in silicon wafer. Because of the absence of B-O complex in n-type silicons, the LID effect is less.

Lower Temperature Coefficients

HJT vs PERC module output power
under varied operating temperatures

— Hanover Solar HJT Module
— Standard Perc Module



Compared to standard PERC module, Hanover Solar HJT module features lower power temperature coefficient and higher output power. It's about 4.9% more efficient in power output than PERC module under 60°C operation temperature.

Hanover Solar HJT demonstrates unique advantages in high temperature / high irradiance area.

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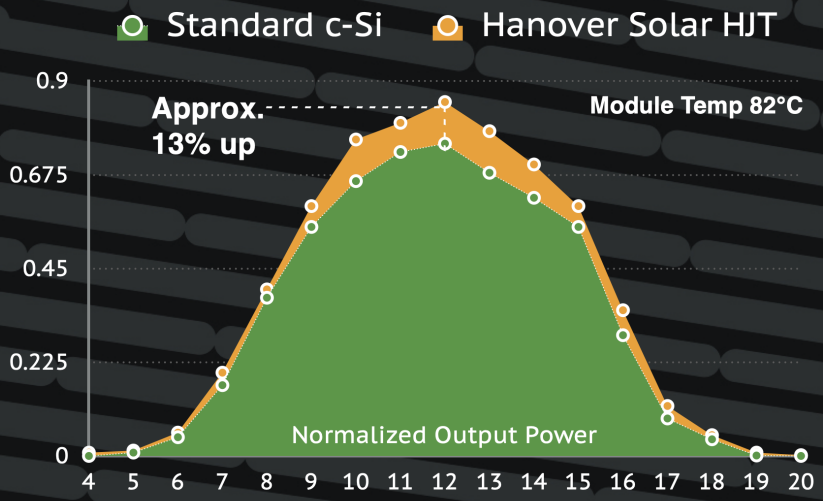
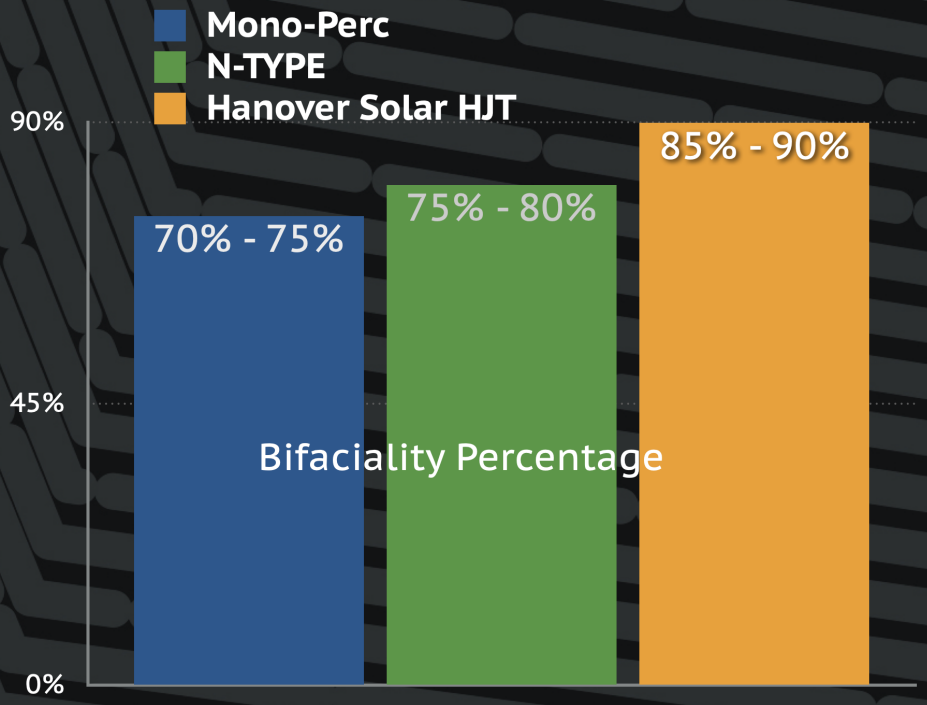


Power generation gain of up to 10% or more can be achieved in summer when the module temperature is above 75 °C.

Highest Bifaciality

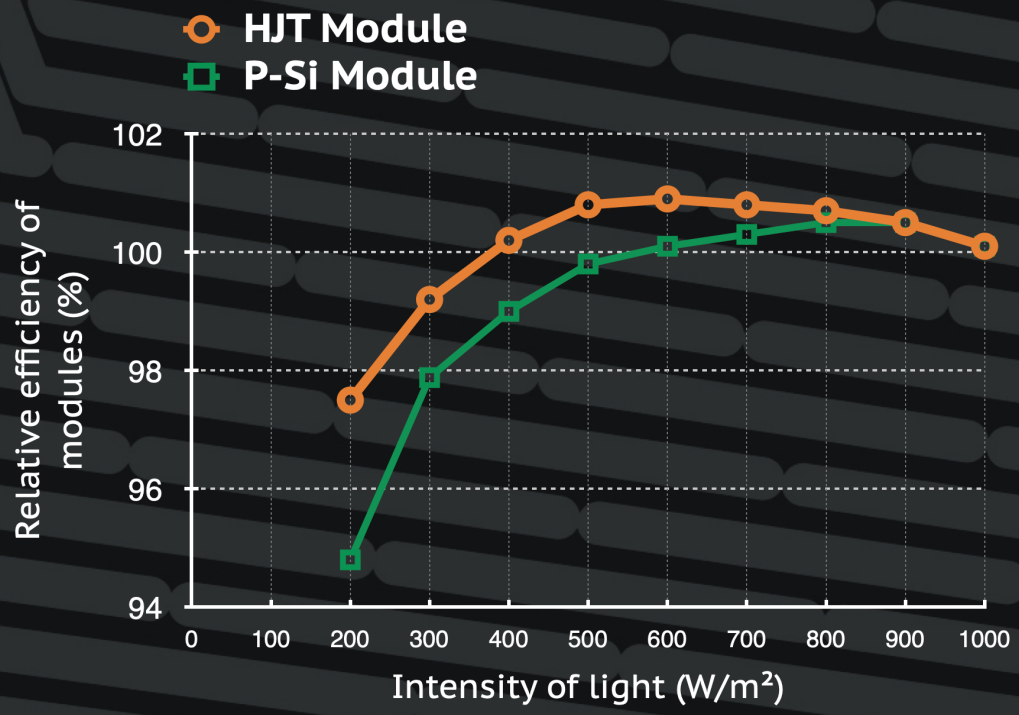


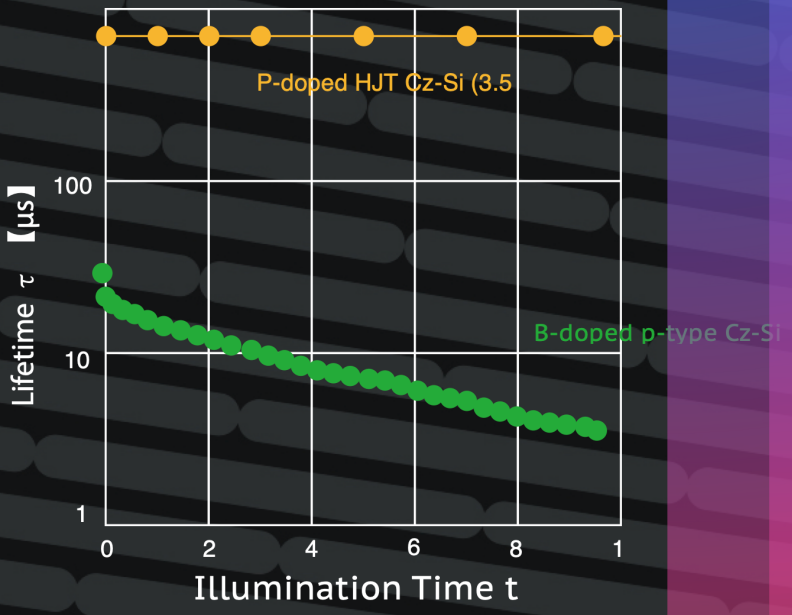
Note: Bifaciality will be affected by grid width of the back panel, bifaciality of the cell itself and test method etc, which shall be subject to Hanover Solar design and test.

HJT is considered one of the top cell technologies with highest bifaciality. Higher bifaciality allows more energy yield on the back.

Generally, it enables extra 5% - 30% energy gain on back, depending the factors such ground reflection, region type etc.

Excellent Low Irradiace Response





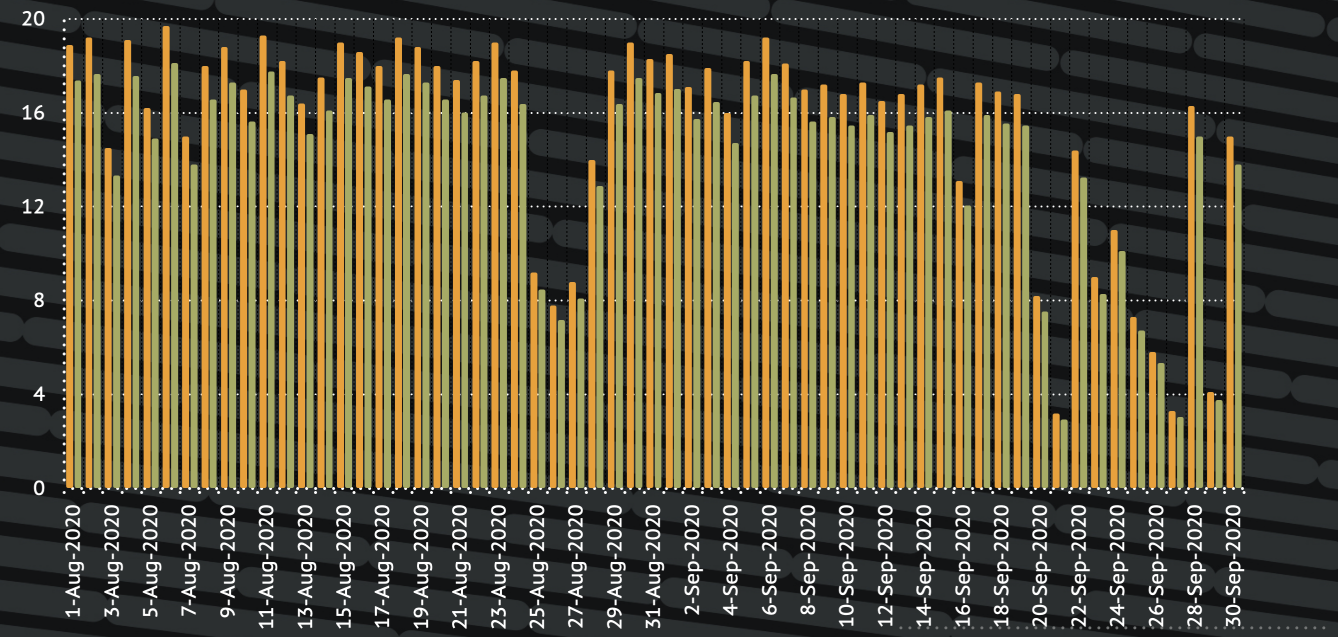
Due to the high Minority carriers life time of HJT substrate materials, HJT crystalline silicon modules demonstrate better power generation characteristics than conventional P-type crystalline silicon modules under low light.

Higher Energy Production

The effective power generation time of HJT is 11.07% more than the effective power generation time of conventional cells.

HJT gain over mc-Si modules amounts to 4% on average and reaches above 5% on the hottest summer days.

Comparison of a daily production of HJT and mc-Si in MWh
HJT Bifacial – temperature coefficient



Higher Reliability

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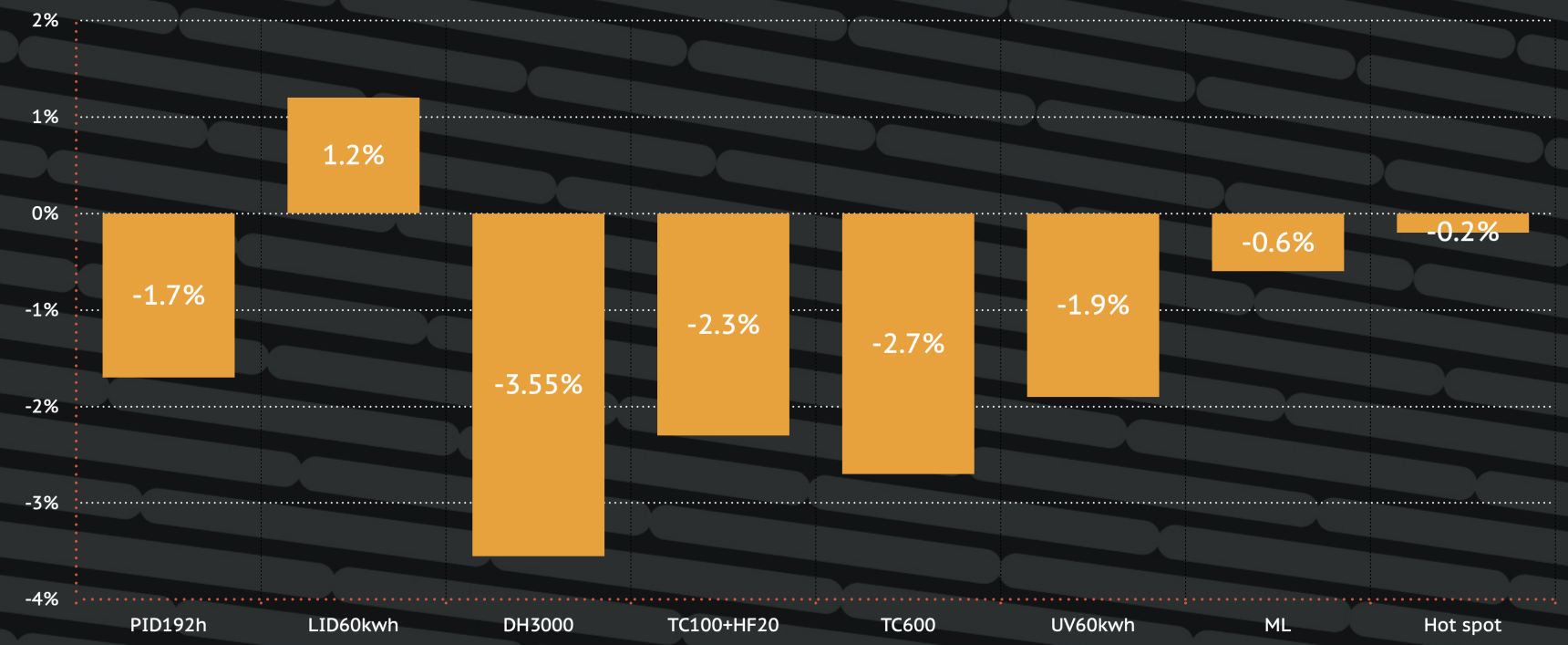
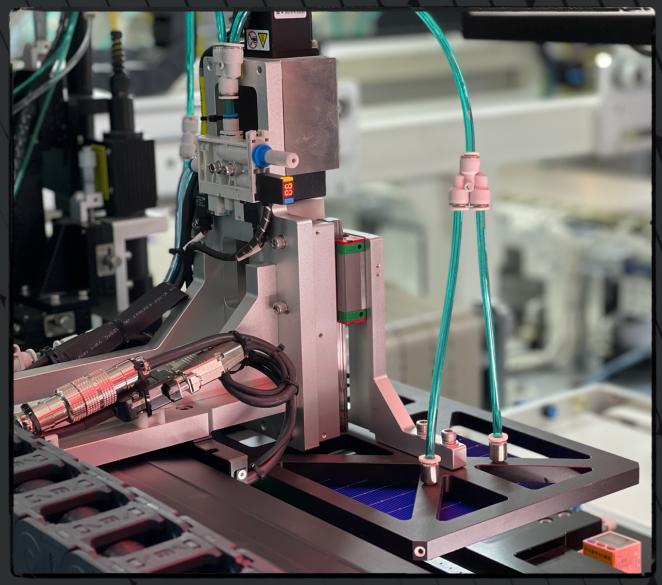
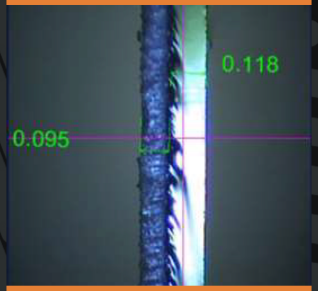


All degradation after test is much lower than IEC standard.

Non Destructive Cutting Technology



Traditional Cutting



Rough surface resulting 80-120μm heat affected area

VS

Non-destructive Cutting Technology

Smooth cutting surface with zero heat-affected area

Non-destructive cutting technology:Laser localized heating and supporting cooling technology are used to form gradient temperature within the material, which formulates the thermal stress to force the material to crack.

166mm Single Glass 9BB Half-Cell (Solar cell: 22.5%)	Traditional Cutting	Non-destructive Cutting
	447.17	**448.59**
Increase	1.4W	

Advantages: Smooth surface by non-destructive cutting; no heat affected area; less cutting effect to cell efficiency.

Comparison of two cutting solutions of 166mm HJT & Mono PERC

Low Temperature Welding

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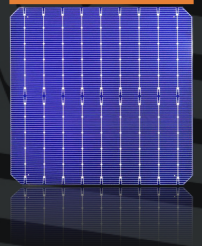
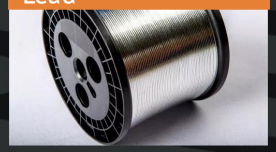
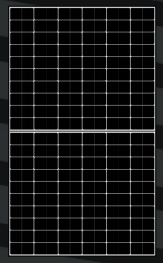


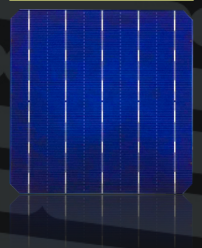
Low Temperature welding Flux
Round wire welding
Bismuth / Tin / Lead



165-190℃
Welding Temp



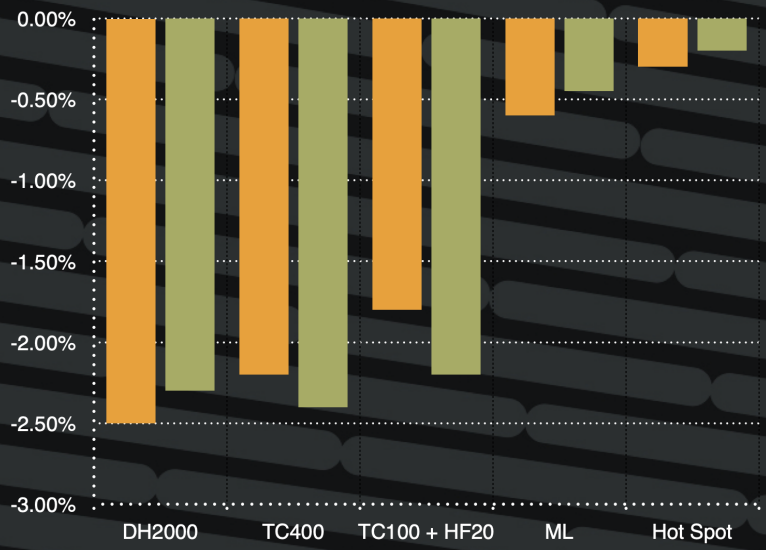
P e r c



MBB welding Flux
+
Round wire welding Strip
Tin / Lead

210-230℃
Welding Temp

Reliability of HJT Low-Temp Welding vs Perc welding



HJT cells are welded with special Bismuth added formula low-temperature welding strip and welding flux. Bring much lower damage for the cells.

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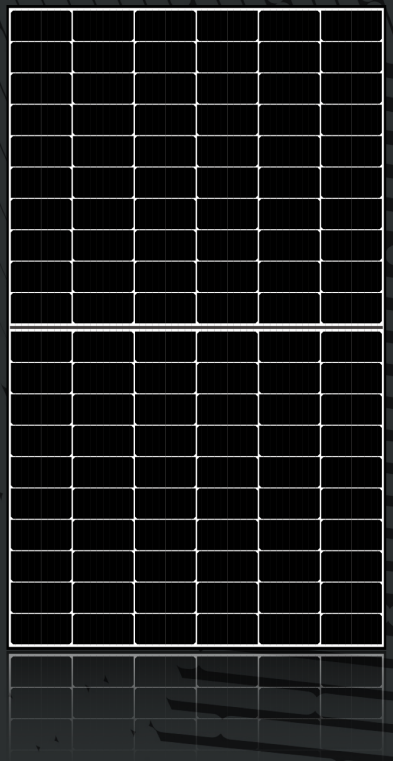
- Higher module efficiency
- Higher generation revenue
- Lower full life cycle cost of electricity
- Compatible with distributed power system on rooftops and large scale ground mounted power plants



Benchmarking Module Details

Cell Size / Layout	HJT 166mm 120 half cut cells		HJT 166mm 144 half cut cells	
Module	Hanover Solar HJT Glass Glass	Hanover Solar Perc Glass Glass	Hanover Solar HJT Glass Glass	Hanover Solar Perc Standard Module
Output (W)	400W	380W	480W	445W
Size L x W x H (mm)	1755 x 1038 x 30	1755 x 1038 x 30	2094 x1038 x 30	2094 x1038 x 30
Module Efficiency (%)	22%	20,9%	22,1%	20,5%
Bifaciality Factor (%)	85% - 90%	75% - 80%	85% - 90%	No Bifaciality
Degradation Rate (%)	2% for the first year, and 0,25% annually since the 2nd year	2% for the first year, and 0,55% annually since the 2nd year	2% for the first year, and 0,25% annually since the 2nd year	2% for the first year, and 0,55% annually since the 2nd year
Temperature Coefficients (% / ℃)	- 0,24%	- 0,35%	- 0,24%	- 0,35%