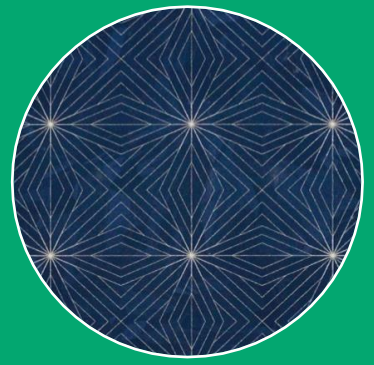
Phono® Solar
SHARE THE SUN, POWER THE FUTURE!

MWT Technology



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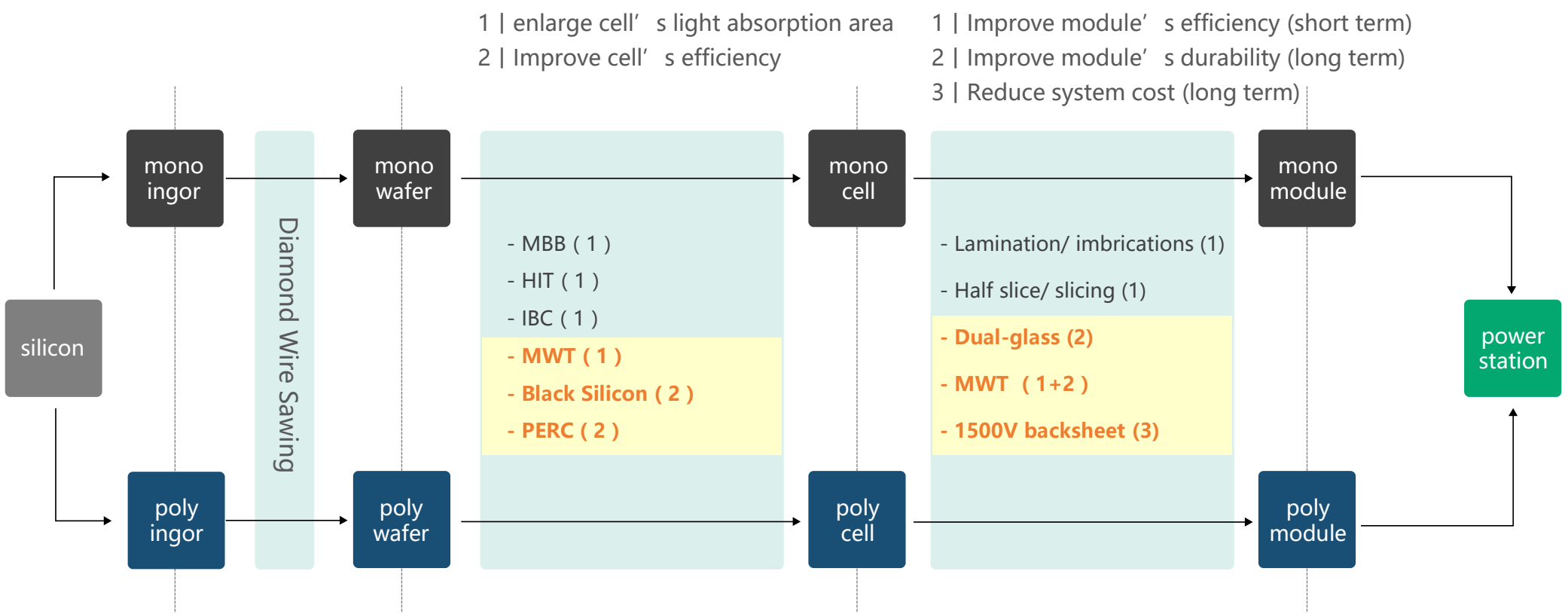
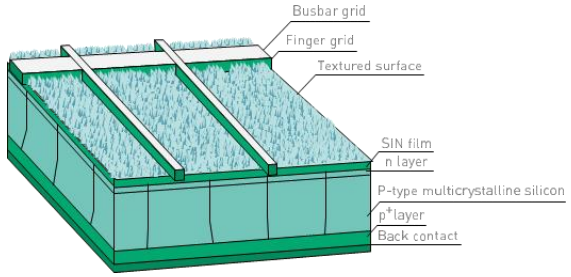
SHARE THE SUN, POWER THE FUTURE!

1 | Key for LCOE in the upstream of crystalline PV industry chain



Phono Solar focus more on your long-term benefits

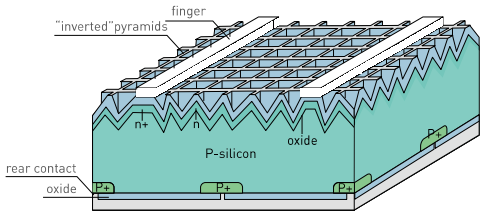
1 | Key for LCOE in the upstream of crystalline PV industry chain



Conventional Al-BSF cell:

Oversupply

LOW technical threshold (mono19.8%, poly18.4%)

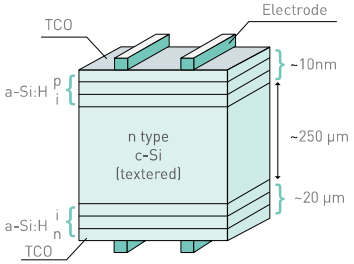


UNSW-25
PERC cell

PERC cell:

Good compatibility with conventional cells equipment

High technical threshold (mono21.6%, poly18.8%)

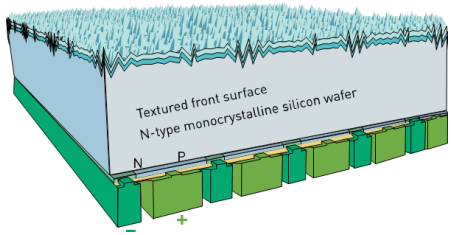


Panasonic-25.6%
HIT cell

HIT cell:

Poor compatibility with conventional cells equipment

High technical threshold and **High** cost (mono22.8%)

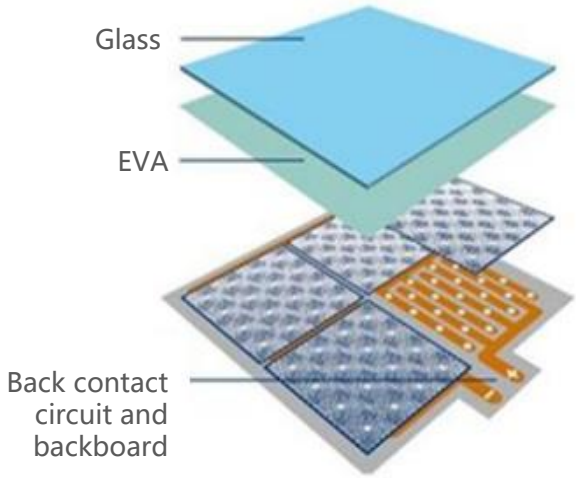


Stanford-25%
rear contact

IBC cell:

Poor compatibility with conventional cells equipment

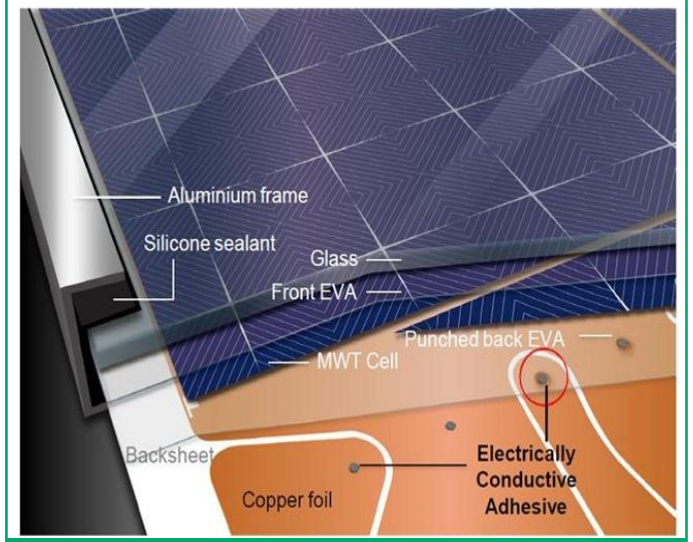
High technical threshold and **High** cost (mono23%)



MWT cell:

Phono Solar is the leader of MWT mass production.

MWT technology has **High** compatibility with conventional cells equipment, **High** technical threshold, complex technical process



MWT technology

- No bus-bar on the cells
- Enlarge module’ s light absorption area
- Improve module’ s efficiency

MWT

MWT (Metal-Wrap-Through) technology allows both positive and negative electrodes distributed on the rear side of solar cells. Unique cell structure and special module packaging process allow MWT module has lower power degradation and operating temperature.

Project using MWT module can generate 3% more, based on the same installation capacity

Higher
efficiency and generation

- The rated power is 20W+ higher than that of conventional module
- Power generation is 3% higher, based on the same installation capacity
- BOS is reduced by 1.2-1.5 USDcent/W

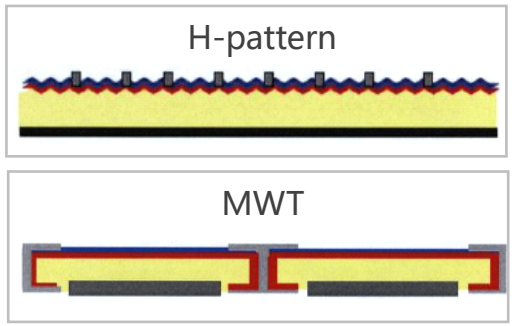
Better
reliability and stability

Lower degradation
higher generating capacity

Wider
technical compatibility

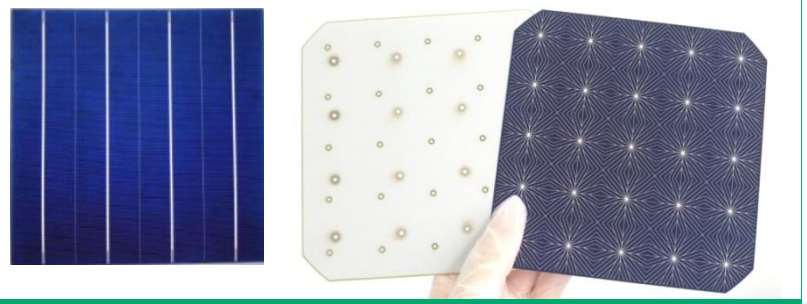
MWT can be combined with most existing manufacturing process and technologies

01-MWT cell



Unlike standard solar cells, Metal Wrap Through (MWT) solar cells are interconnected on the rear side. The front grid is contacted by metallized vias that lead the current onto the rear side. This reduces shading on the front side and ohmic losses due to cell interconnection. The MWT architecture thus achieves higher efficiencies while keeping the manufacturing costs low.

The interconnection in the module can be realized by using either structured cell interconnectors or conductive back sheets.



MWT cell (right) **VS** **Conventional cell** (left)

NO bus-bar

Less shading, higher conversion efficiency (absolutely improved by over 0.4%), reduce consumption of silver paste

No welding belt

Avoid the performance degradation caused by welding stress and microcrack; meanwhile, it is also applicable thinner silicon wafer, which is helpful for reducing cost.

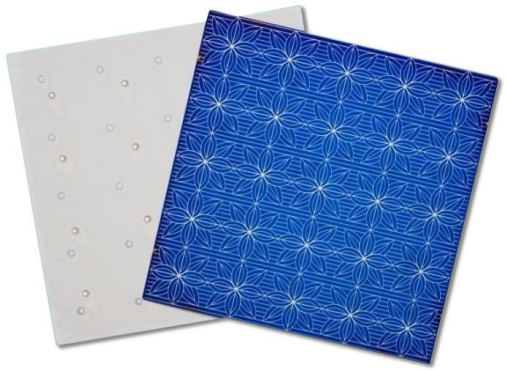
Technical compatibility

Good compatibility with other technologies, including black silicon, PERC, etc.

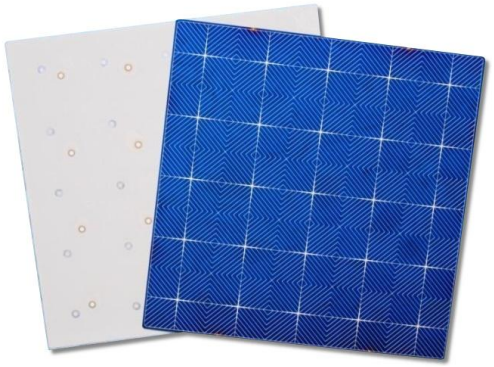
Personalized customization

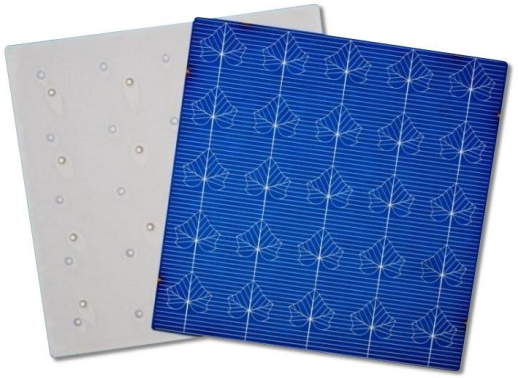
The pattern of MWT cell finger can be customized

01-MWT cell

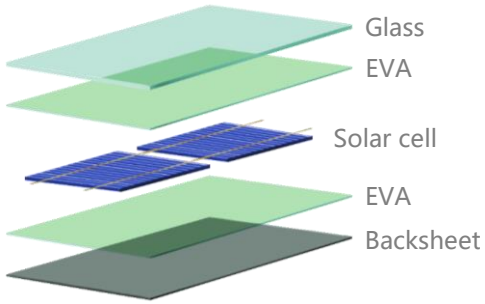


Personalized customization cell’ s figner

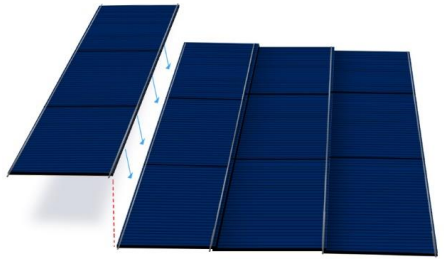




02-MWT module

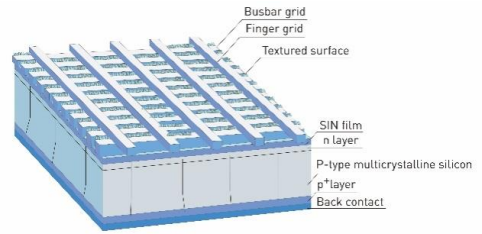


Conventional module



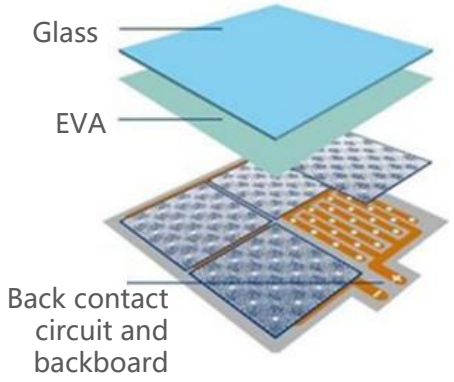
Shingled-cell module

+ light absorption area is enlarged
- Mechanical extrusion stress at edge of cell is big, increasing the probability of fragments and microcrack
- Patent protection; high difficulty in mass production



MBB-cell module

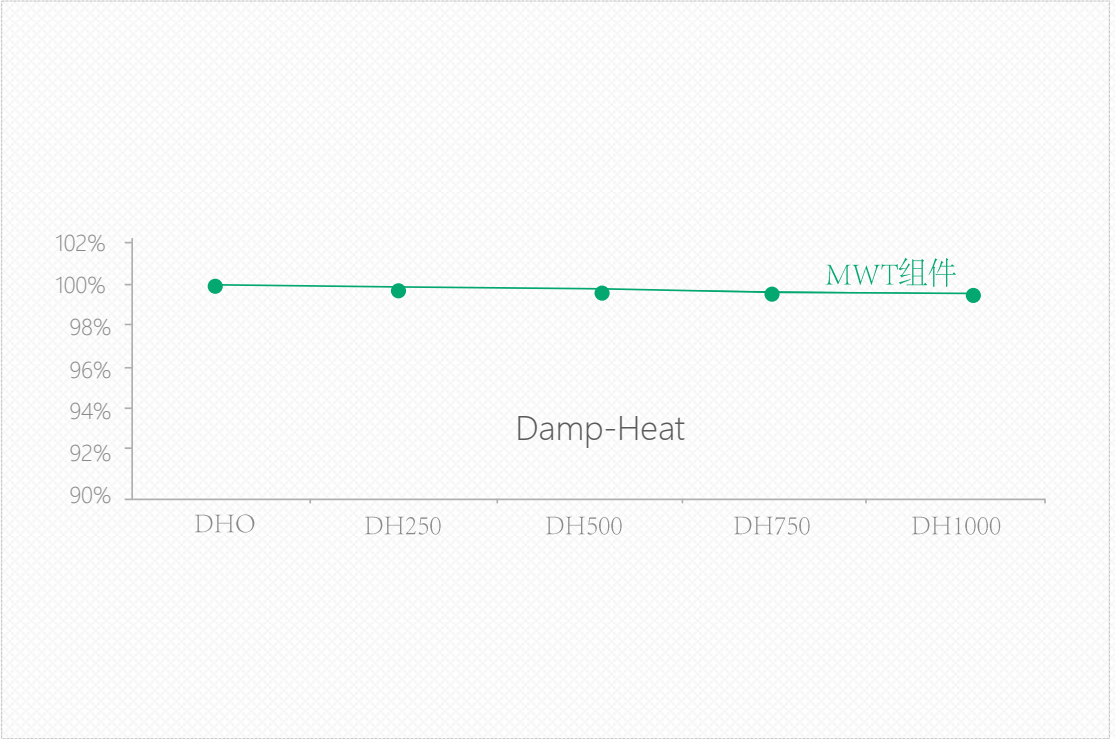
Narrow manufacturing process window
High cost

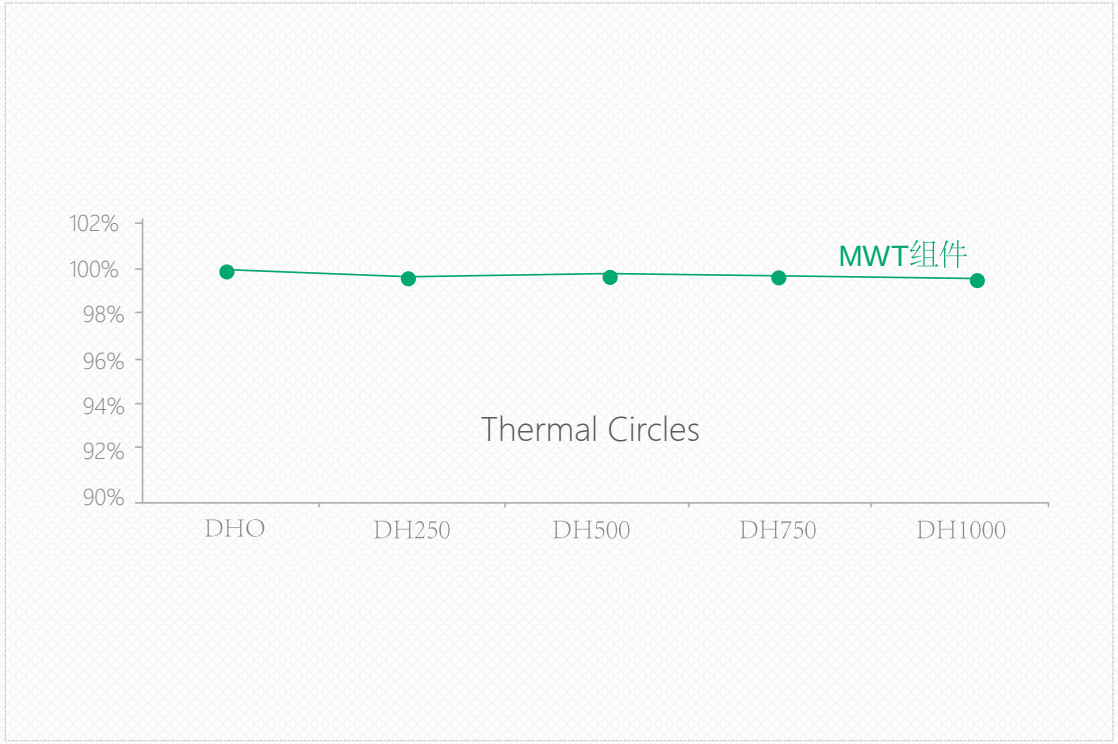


MWT module

+ Electric conduction of metallic membrane: low series resistance, low working temperature
+ Utterly put an end to mechanical extrusion stress between cells, which largely reduces the probability of fragments and microcrack
+ Beautiful appearance

Internal test





DH (dual 85): 1000H 85℃+85%RH, power ＞95%

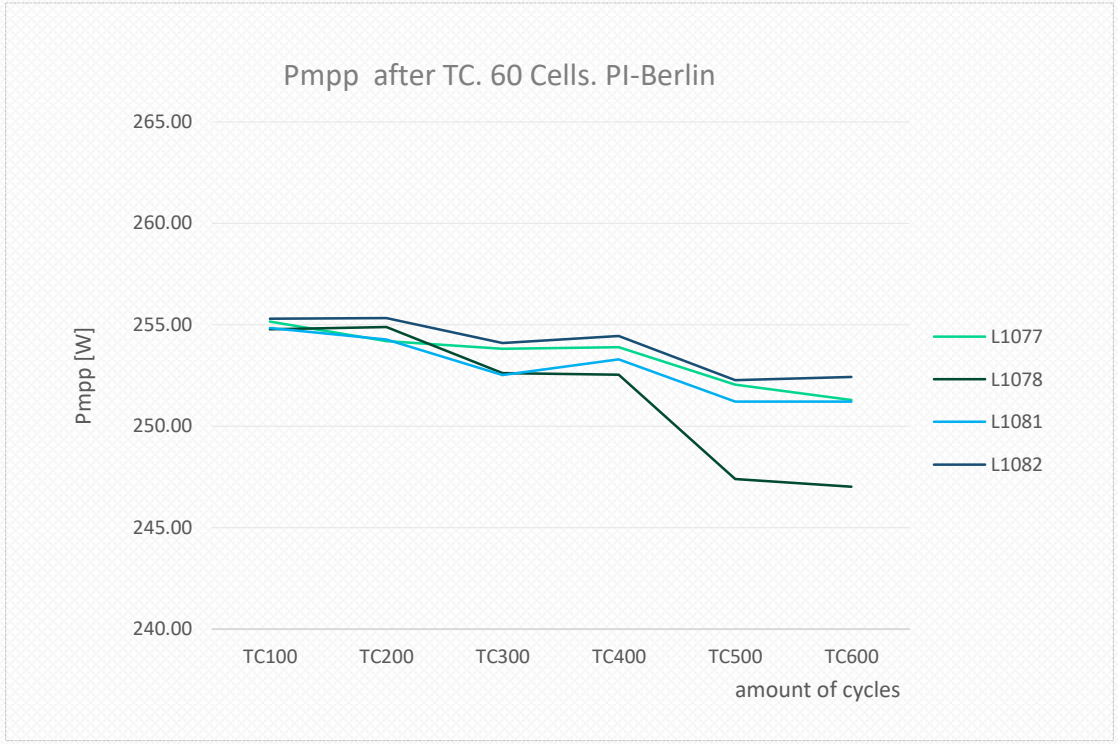
TC (thermal cycle): (85℃) → (-40℃) → (85℃) , power＞95%

Test result (Japan)

No.	試験名	項目	条件・結果	
1	高温高湿試験	製造番号	No.1822003330250407	
		温度	85℃	
		湿度	85%	
		試験時間	3000h まで※1（社内基準）	
		合格基準	出力保持率：95%以上	
		試験結果	初 期 出 力	264.7W
			DH1000h後の出力	260.2W
			DH2000h後の出力	258.8W
			DH3000h後の出力	258.7W
			出力保持率	97.7%
2	温度サイクル試験	製造番号	No.1822003330260472	
		温度	－40℃⇔85℃	
		温度勾配	100℃/h	
		試験サイクル	600 サイクルまで※2（社内基準）	
		合格基準	出力保持率：95%以上	
		試験結果	初 期 出 力	262.7W
			TC200 後の出力	260.7W
			TC400 後の出力	259.5W
			TC600 後の出力	259.2W
			出力保持率	98.6%

Power=97.7%（DH3000）
Power=98.6%　(TC600)

Test result (Europe)

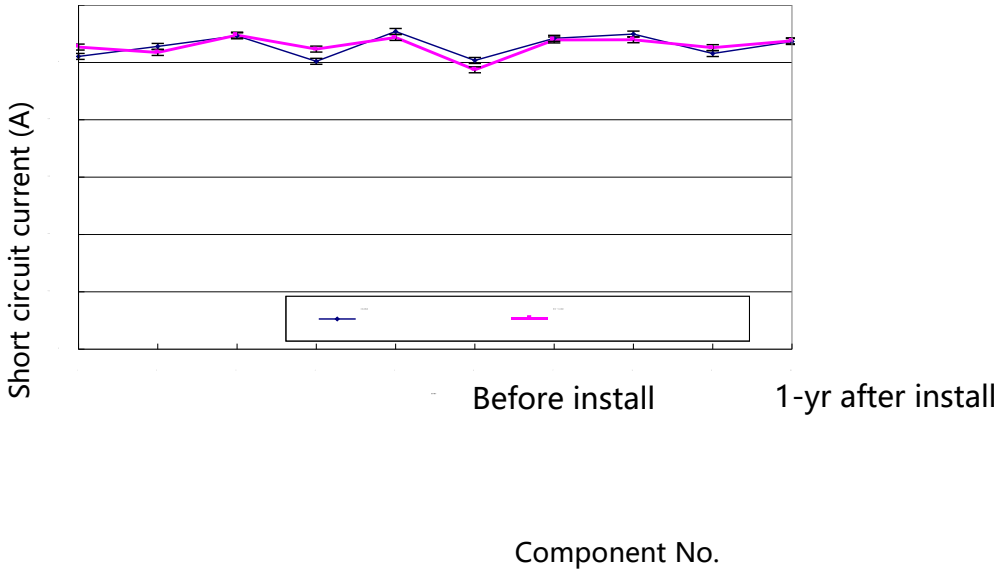


Power≥97%（TC600）

Outdoor application test of MWT module

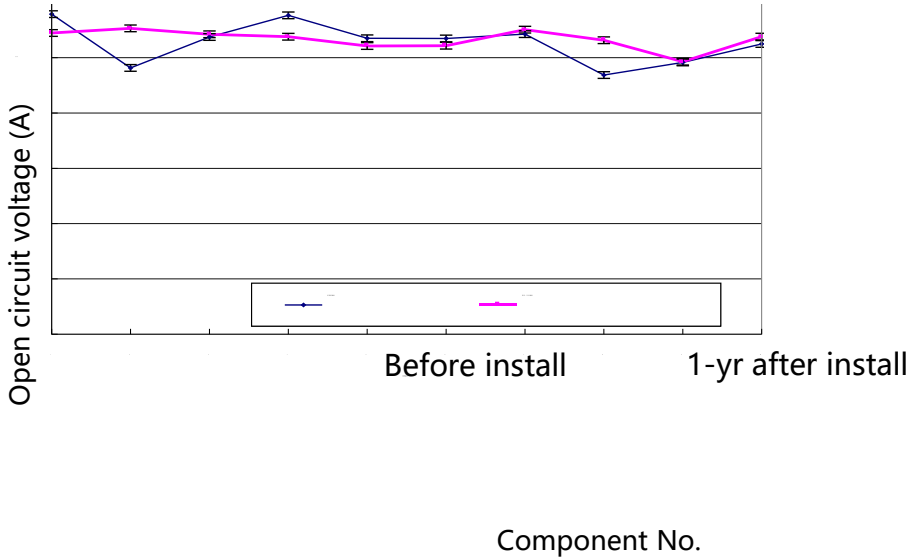
- **Test time:** Aug 2014- Aug 2015
- **Module quantity:** 10 pcs
- **Test scene:** outdoor
- **Project type**: Roof –top project

Short circuit current



Short circuit current **has no obvious change** after one year’ s operation

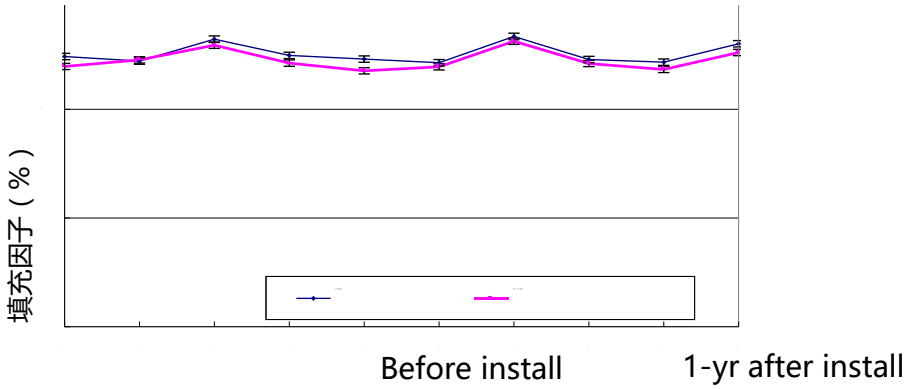
Open circuit voltage



After one year’ s operation, the open circuit voltage **has no obvious change**, and there is basically **no reduction trend.**

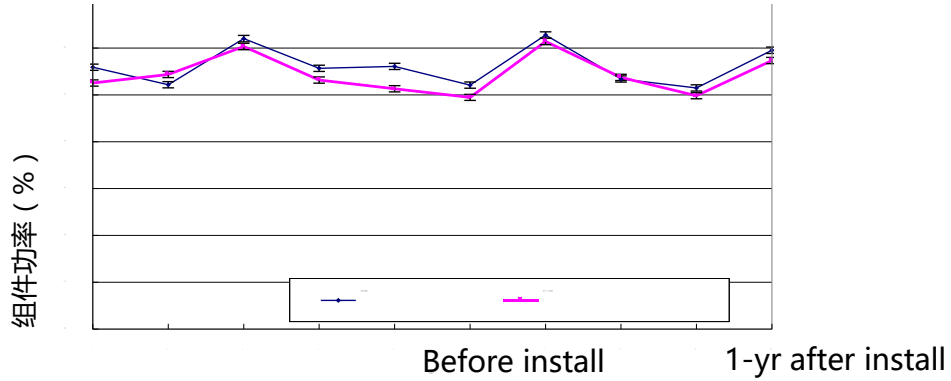
3 | MWT’s reliability (Outdoor Test)

Fill factor



After one year’s operation, the fill factor has **extremely small reduction.**

Maximum power



After one year’s operation, the power degradation of is only **1.78 W (0.69%)**

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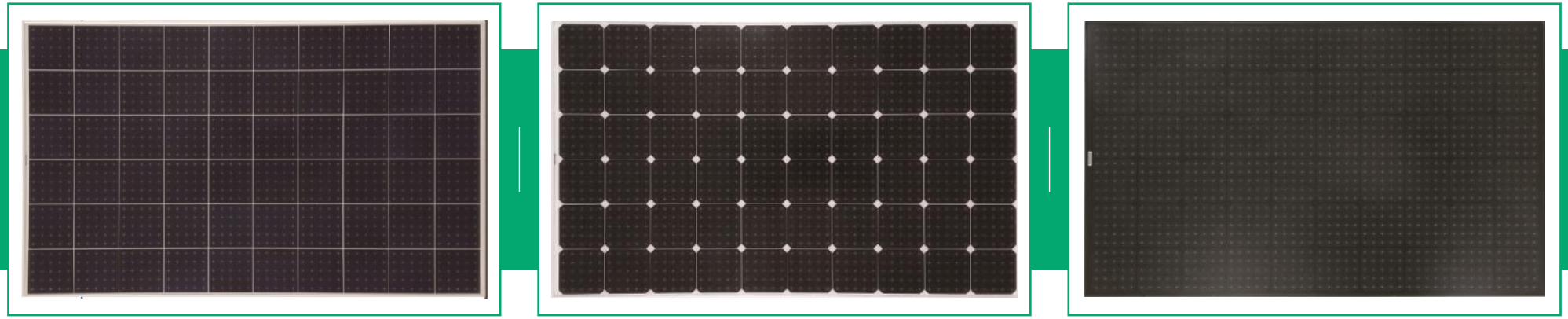
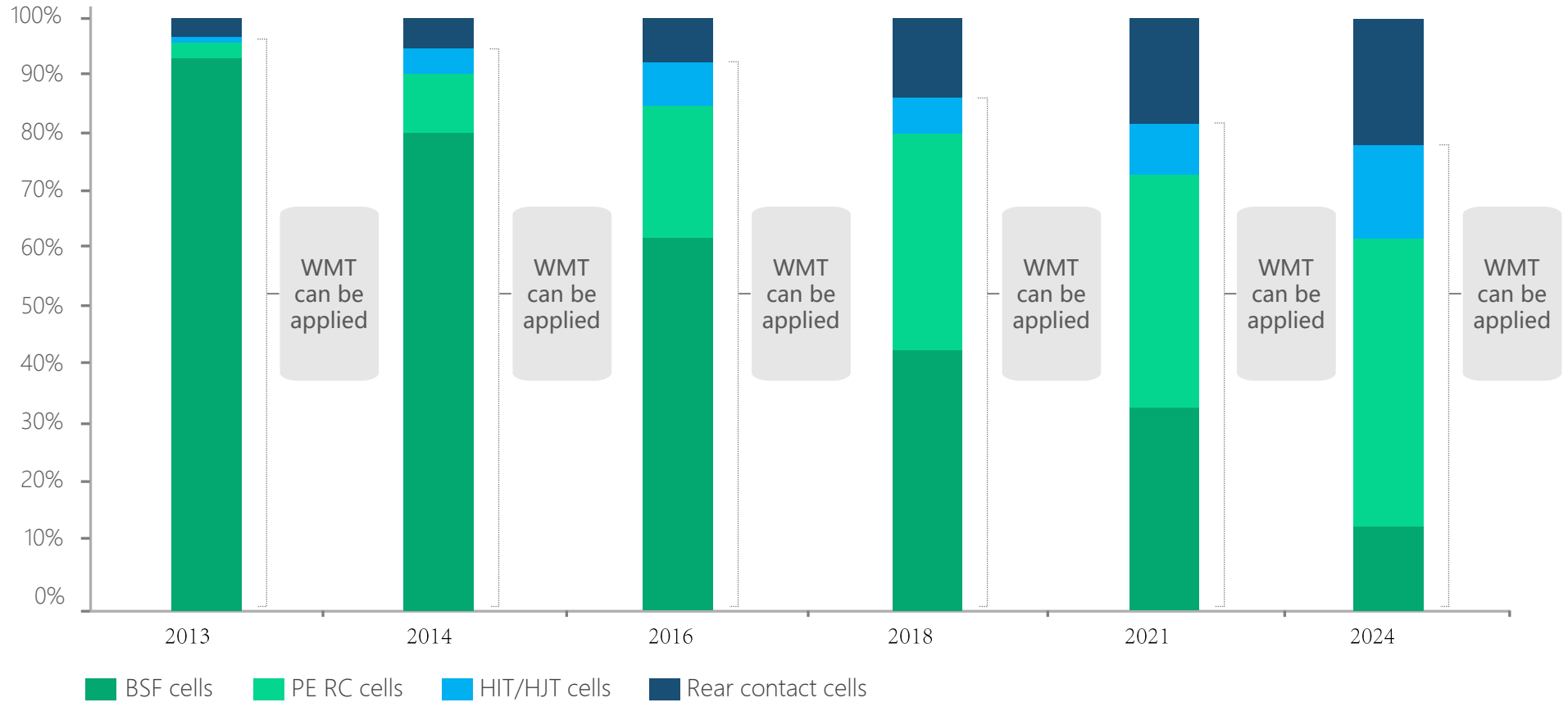
After one year’ s operation, how to understand the anti- degradation advantage of power of MWT module?

degradation mechanism →

- Impurity level in silicon wafer
- Welding stress or microcrack
- Water permeability of backsheet
- ……

MWT module still has power degradation , but much smaller!





Due to the compatibility of MWT technology:

It can respectively combine with BSF, PERC and HIT, and it will account for over 80% market share in crystalline photovoltaic technology!

Conclusion for technical advantages of MWT

Higher power 1	**Higher** generating capacity 2	**Better** reliability 3	**Lower** cost 4	**Better** technical compatibility 5

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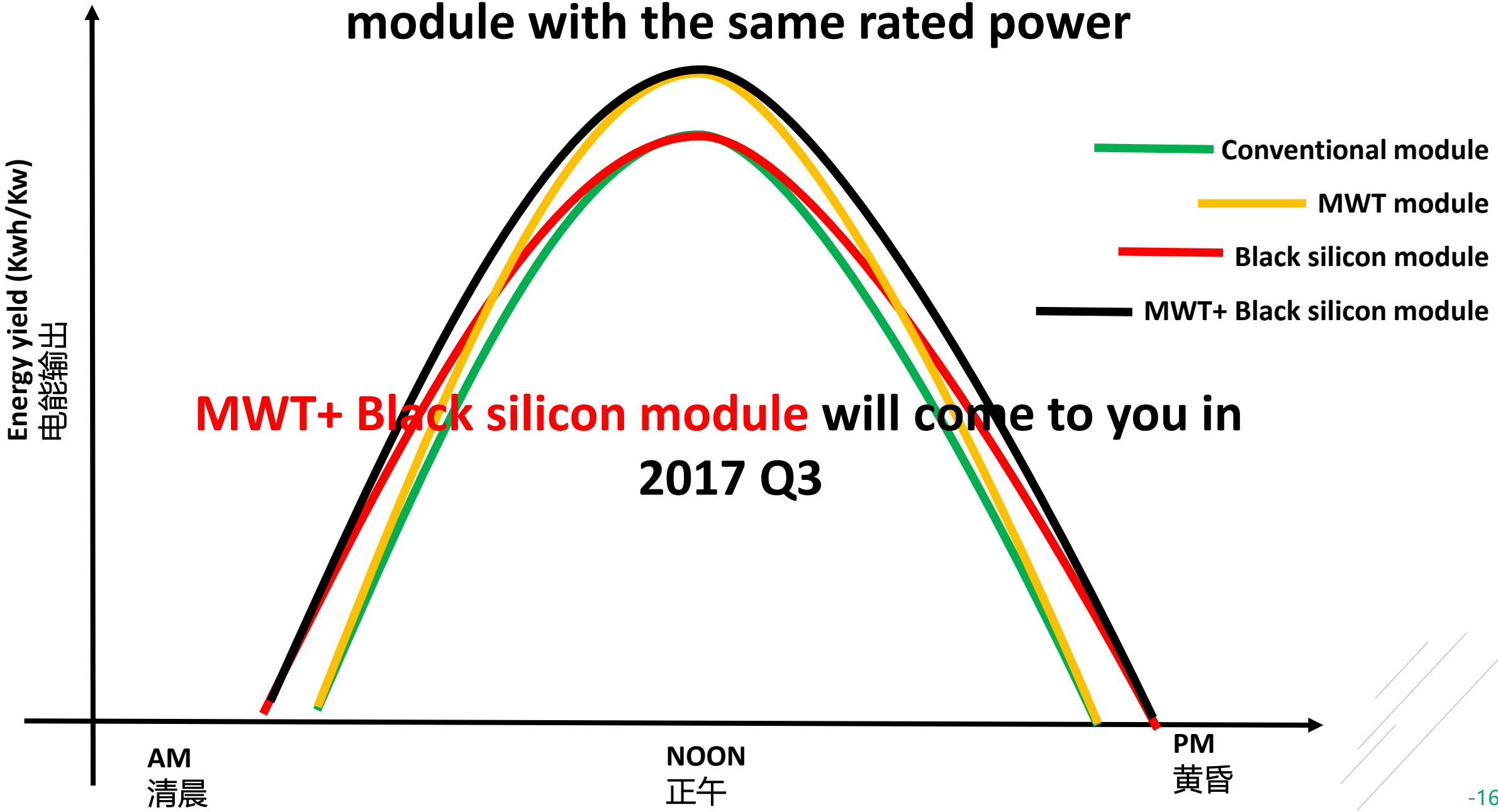
energy yield comparison for module with the same rated power



MWT+ Black silicon module will come to you in 2017 Q3