

Whitepaper

Transparent Backsheet VS Dual Glass--- Advantages and Disadvantages



GLOBAL PM, JINKOSOLAR

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Bifacial with transparent backsheet (bifacial TB) or bifacial with dual glass (bifacial DG), which one is more competitive? It is rather a known dispute in the industry. Either bifacial TB or bifacial DG, has its advantages and disadvantages. Based on the study of two types of bifacial products and long-term outdoor performance test carried by JinkoSolar, comparisons from multiple perspectives are discussed below.

1、Weight

Since 2019, solar modules have become more and more diversified. But the trend that larger size, higher power is definite. Along with the size increase, the module weight is also growing. Compared with the dual glass, transparent backsheet can successfully decrease module weight, and the difference between glass-transparent backsheet module and dual glass module increases with growing module size. For 410Wp product, the weight difference is only 3.3kg but for the future 560Wp products (estimation based on the power and efficiency increasing trend), the difference is increasing up to 6kg. Using transparent backsheet as encapsulation material for the rear side can keep module weight under 30kg when the module size is as large as 2.7m², which benefits installation and transportation, as well as cutting down BOS cost.

Table 1 Weight Calculation based on different module size

Power	405	445	465	500	560
Area (m ²)	1.98	2.21	2.28	2.41	2.70
G/B (kg)	23.3	24.8	25.7	27.1	30.3
2.0mm G/G (kg)	26.6	29.7	30.0	32.4	36.3
2.5mm G/G (kg)	30.8	34.4	35.5	37.5	42

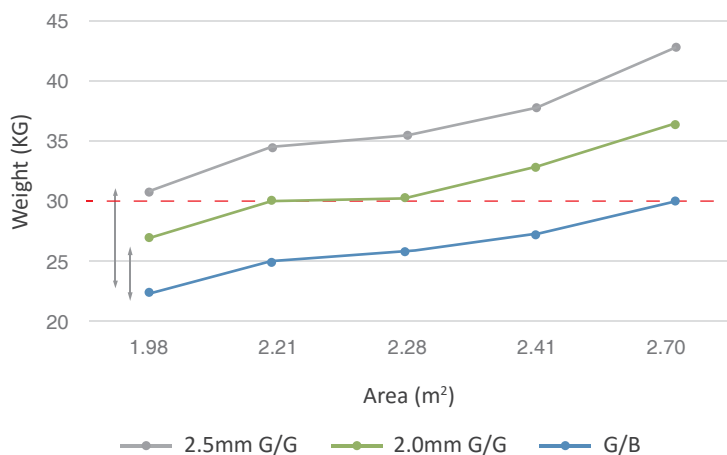


Figure 1 Weight changes with different module size

2. Mechanical properties

The front side glass of bifacial TB is 3.2mm tempered glass, whereas front side glass of bifacial DG is 2.0mm heat strengthened glass. Owing that tempered glass has higher impact strength, bifacial TB has lower risk if used in regions with hail weather. Bifacial DG has symmetric structure that both side glass could contribute to the mechanical strength, thus bifacial DG has higher wind load, higher dynamic mechanical load. In some high wind speed regions (wind load higher than 2400Pa), bifacial DG means lower risk, whereas bifacial TB can also be used with extra fixing equipment. In fact, the certified 5400pa snow load / 2400pa wind load can meet the design requirements of most power plants. From this point, bifacial TB and bifacial DG are basically the same in terms of mechanical properties.

Table 2 Mechanical properties of bifacial TB and bifacial DG

Type	Bifacial with Transparent Backsheet	Bifacial with Dual Glass
Structure		
Features	<ul style="list-style-type: none"> • Front side glass is tempered glass-- higher impact strength • Asymmetric structure, backside is backsheet-- lower wind load, lower dynamic mechanical load 	<ul style="list-style-type: none"> • Front side glass is 2.0mm heat strengthened glass-- lower impact strength • Symmetric structure, both side glass contribute to the mechanical strength--higher wind load, higher dynamic mechanical load
Impact Strength (Drop ball test)	4.76 N-m	Front side: 4.28 N-m Black side (with holes): 3.28 N-m
Maximum static load	+5400/-2400	+5400/-2400
Dynamic load	±1000Pa, 1000 times Slight micro cracks, no power degradation	±1000Pa, 1000 times No micro cracks, no power degradation

3、Reliability in extreme weather

Dual glass modules have been known for their excellent vapor-resistance. The risk of breakage for the dual glass modules is lower compared with normal products in the environment with high humidity such as offshore area and floating projects. 30-year lifetime solution of bifacial TB is using transparent backsheets with fluorine materials on both sides combined with vapor-resistance POE. The outer layer of transparent backsheets is Dupont Tedlar film, which is anti-aging and anti-corrosion. The inner layer is fluorine coating (thicker than 10μm) which can effectively block UV and keep backsheets' excellent mechanical properties in extreme environments. POE is a polymer material with more stable molecular chain without acid groups and has better water resistance than EVA. The combination of PVF-based transparent backsheets and POE contributes to the good performance in the strict reliability test up to DH3000, and the degradations are all within 4%.

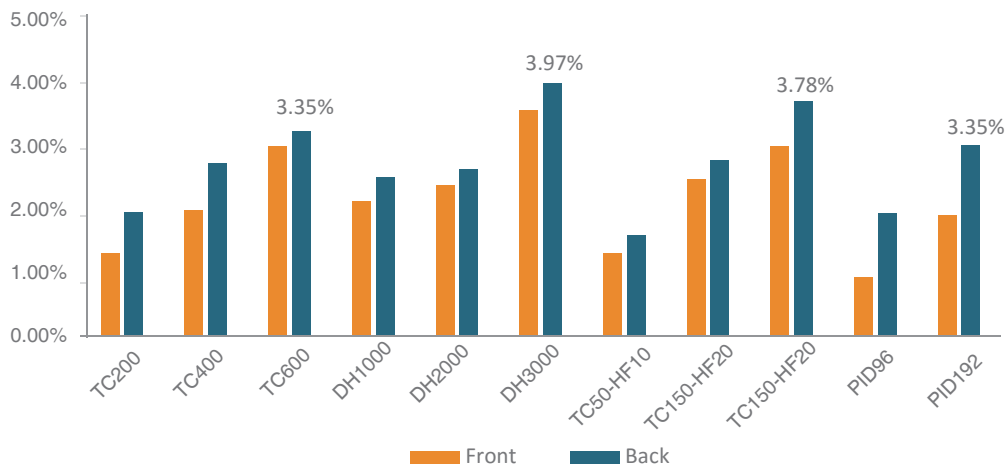


Figure 2 Degradation in strict reliability test of bifacial TB

In the DH2000 test, the degradation of the bifacial TB is slightly higher than that of bifacial DG (POE is also used as the encapsulation material). And in PID192h test, the degradation of bifacial TB and bifacial DG is basically the same, with both side degradation within 4%. For most regions, these two kinds of bifacial modules can withstand the 30-year humidity and heat impact, maintaining a low degradation level. Only in the extreme hot and humid environment, bifacial DG is more competitive.

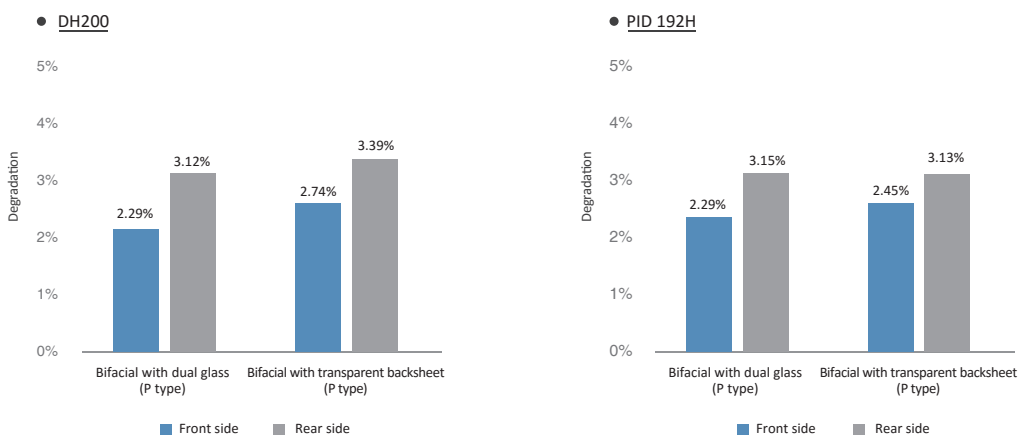


Figure 3 DH2000 and PID 192h test results

4. Anti-UV properties

There is an obvious difference in the ultraviolet transmittance of transparent backsheet and glass. UV transmittance of transparent backsheet is less than 1%, whereas UV transmittance of glass is 40-50%. Due to the common use of high-transparency POE for bifacial modules, bifacial DG cannot block the damage of transmitted UV from backside to the packaging materials and cells, while transparent backsheet can block UV and thus protect cells and packaging materials.

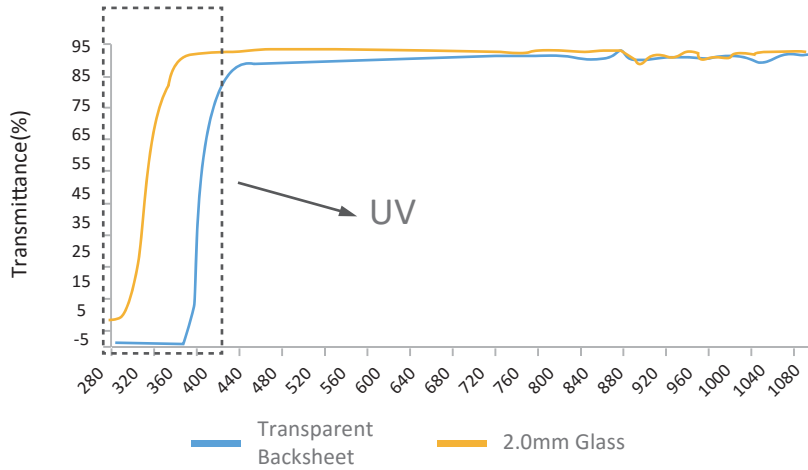


Figure 4 Transmittance of transparent backsheet and 2.0mm glass

Rear-side power degradation after UV 30kWh/m²

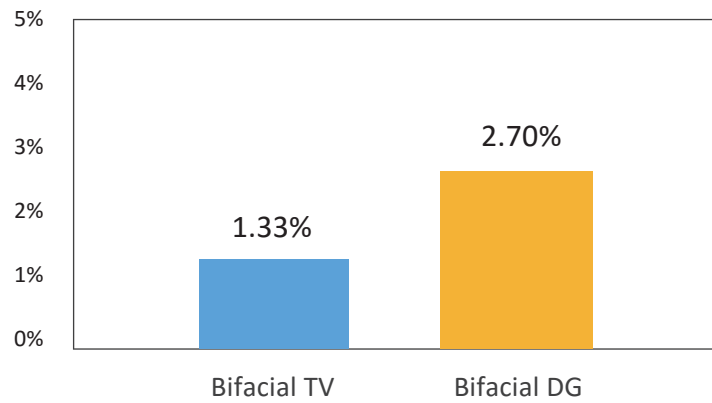


Figure 5 Rear-side degradation after 30 kWh/m² UV exposure

5、 Resistance to saline alkali corrosion

The main component of glass is silicate, which has certain solubility in alkaline solution. It is easy to be corroded in the alkaline environment and form white spots which are difficult to clean. The transparent backsheet has excellent resistance of saline alkali corrosion, thus the risk of transparent backsheet module is lower in the greenhouse, saline-alkali soil and PV agricultural project.

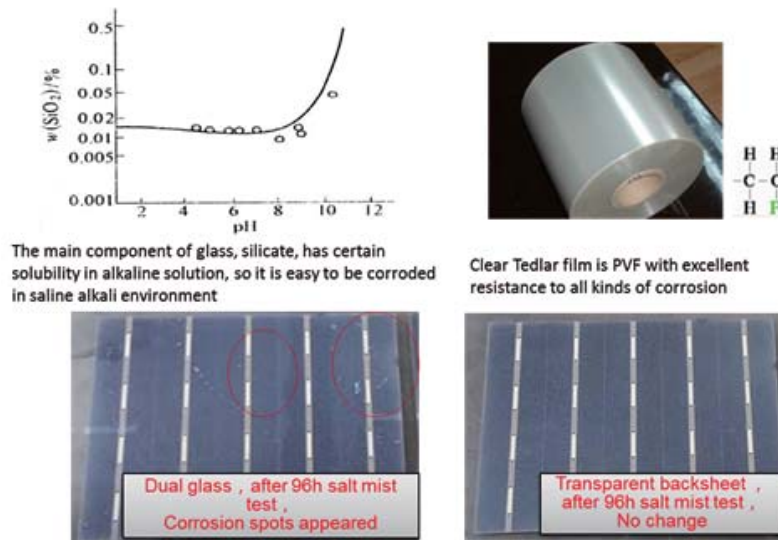


Figure 6 Anti- saline alkali comparison of transparent backsheet and glass

6、 Resistance to abrasion

Glass is a kind of hard inorganic material, almost no abrasion in sand region. The outer layer of transparent backsheet is Tedlar film, which can withstand more than 50L falling sand. Transparent backsheet can also withstand sand abrasion of more than 30 years in desert area.

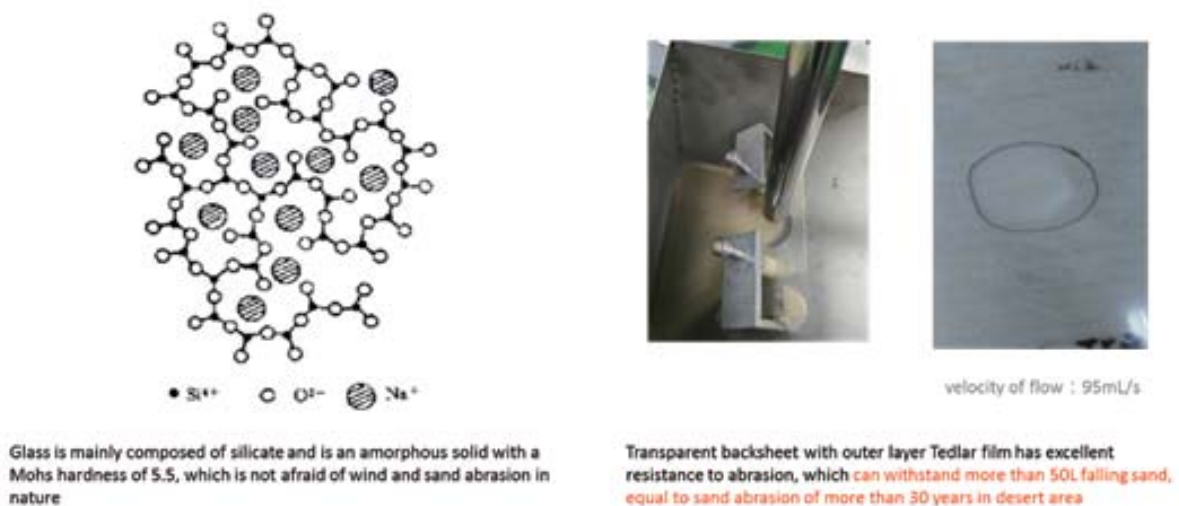


Figure 7 Resistance to abrasion of transparent backsheet and glass

7、Stain-resistance and easy to clean

The stain-resistance of transparent backsheet makes the rear side of bifacial modules easier to clean and maintain than glass. There are three soiling layers as shown in Figure 8 on the surface of modules operating outdoor.

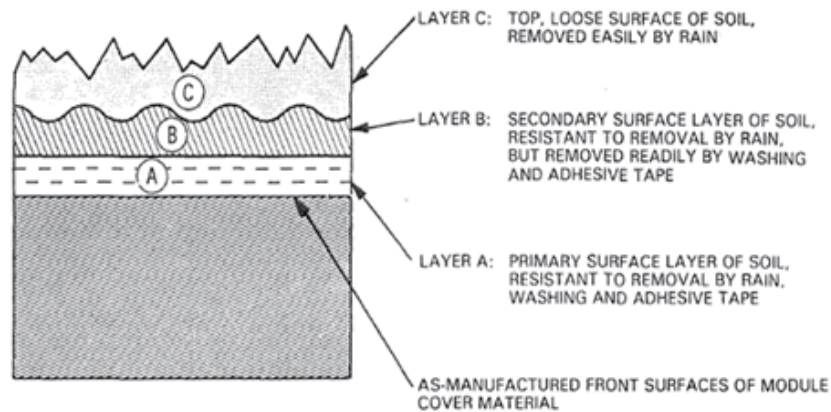


Figure 8 Three soiling layers

There are a lot of fluorine atoms on the surface of transparent backsheet, which is extremely electronegative. As a result, the soiling on the surface of transparent backsheet are dust which is combined with the backsheet though physical absorption. These kind of stains are very easy to clean by rain; thus, the stain is difficult to accumulate on the surface of backsheet and will not have effects on the energy generation. Glass is hydrophilic. During long-term operating, there are mud spots formed by mixing ash and rainwater and dried on the surface of glass, while there is no obvious dirt on the surface of transparent backsheet, as shown in Figure 9.

Bifacial with transparent backsheet :
There is no obvious dirt, and very little dust in the middle area

Bifacial with dual glass :
There are dirt and mud spots which is not easy to clean

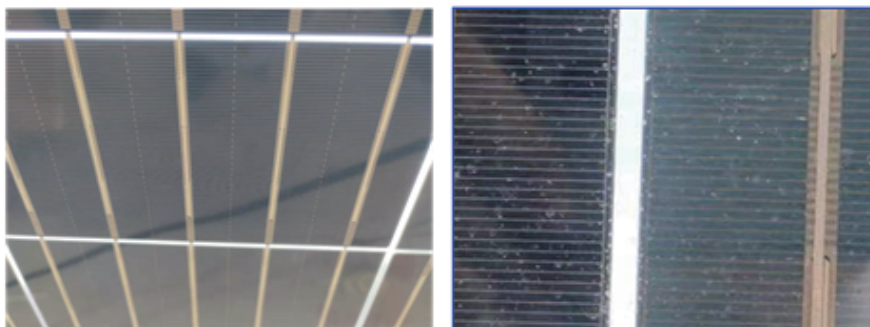


Figure 9 Outdoor soiling test

The surface of the transparent backsheet is hydrophobic, and the water drops are easy to roll off and take away the dust. On the contrary, the glass surface is hydrophilic, the water drop will spread, and stains form stronger combination with the surface, so the glass is more difficult to clean. Test the easy-to-clean performance of transparent backsheet and glass surface refer to GB / T 9780-2005, as shown in Figure 11. Only by water washing (flow rate 0.3-0.5m / s) for 10s, the dirt on the surface of transparent backsheet is cleaned, while there are still many residues on the surface of glass.

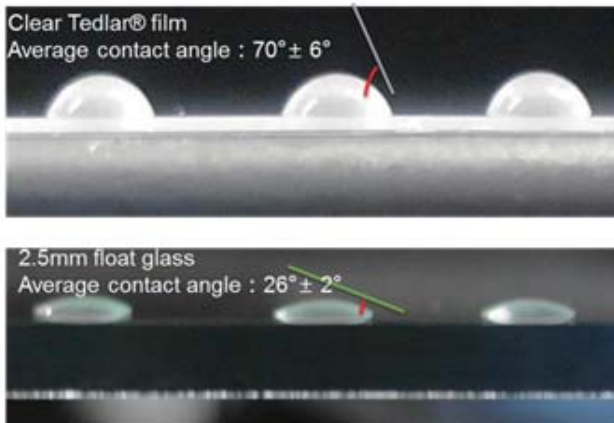


Figure 10 Tedlar film is hydrophobic and glass is hydrophilic

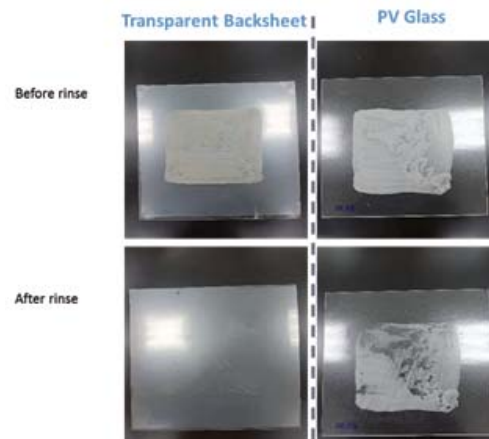


Figure 11 Clean test comparison

8、 Energy generation

Energy generation property is undoubtedly the most important property. In 4 different field tests, bifacial TB has more energy generation compared with bifacial DG. The detailed energy gain is shown in Figure 12

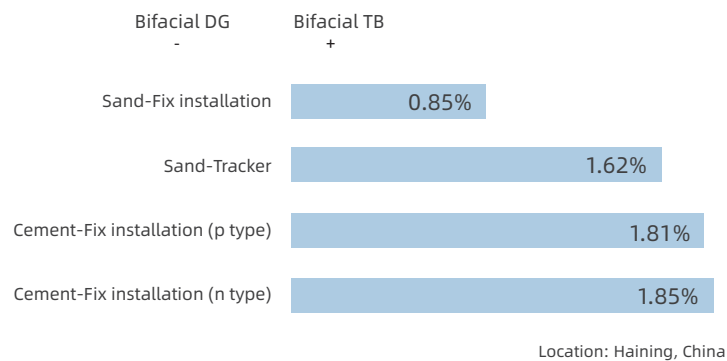


Figure 12 The energy gain of bifacial TB (benchmark: bifacial DG)

Analyzing the data of irradiance and daily yield per watt of cement-fixed installation (P type) project, daily yield per watt of transparent backsheet module is higher when higher irradiance. It is also obvious that the slope of the fitting function of the transparent backsheet module is larger, so the power generation difference between the bifacial TB and bifacial DG will increase under high irradiance. The higher power generation of transparent backsheet is originate from the lower operating temperature. Glass becomes opaque at wavelengths longer than approximately 3 μm, while the transparent backsheet in the infrared spectrum is transparent to the heat dissipation of solar cells from the back of the module. The heat dissipation mechanism of bifacial TB is more comprehensive, so it can have lower operating temperature.

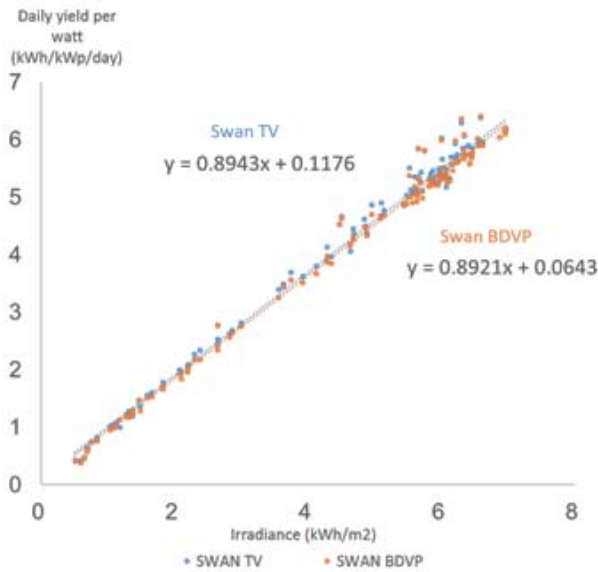


Figure 13 Daily yield per watt and irradiance relationship

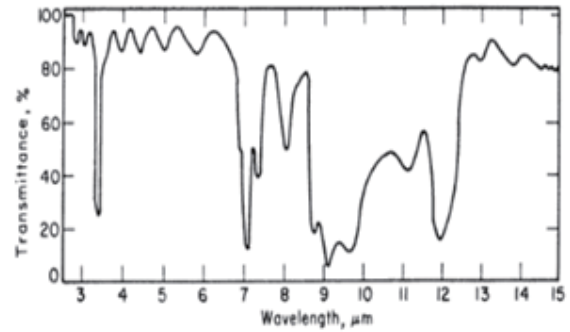


Figure 14 Infrared spectral transmittance of Tedlar film

Summary

Bifacial with transparent backsheets and bifacial with dual glass have their own advantages and disadvantages. The radar chart can help customers evaluate those two products and their application scenarios more comprehensively. As can be seen from the figure below, bifacial TB is an all-around module with balanced performance in different aspects. The bifacial DG is better in terms of the resistance to humidity and mechanical properties, but worse in terms of resistance to UV, saline-alkali, weight and easy-to-clean property. And the energy generation is slightly worse than that of bifacial TB.

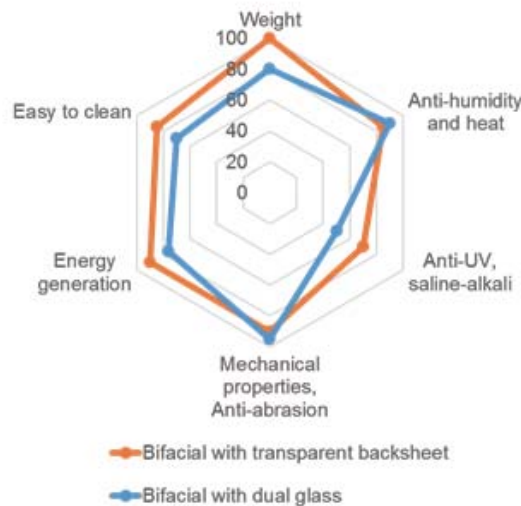


Figure 15 Comparison of bifacial with transparent backsheet and bifacial with dual glass

Based on the above analysis, application scenarios of these two kinds of bifacial modules are as follows:

Table 3 Application scenarios of bifacial TB and bifacial DG

Type	Bifacial with Transparent Backsheet	Bifacial with Dual Glass
Recommended application area	<ol style="list-style-type: none"> 1. Most on-ground PV station in not very hot and humid area. 2. High labor cost area, like EU, Japan, Australia (can effectively receive labor cost). 3. Commercial roof-top project 	<ol style="list-style-type: none"> 1. Most on-ground PV station. 2. In very hot and humid area as well as high wind speed area, bifacial with dual glass is a better choice
Limitation	<ol style="list-style-type: none"> 1. High wind speed area 2. Very hot and humid area 	<ol style="list-style-type: none"> 1. Places with hail weather 2. High UV region 3. Saline-alkali corrosion region

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