

Introduction of Solar Module Technology

Bi-Facial Solar Module

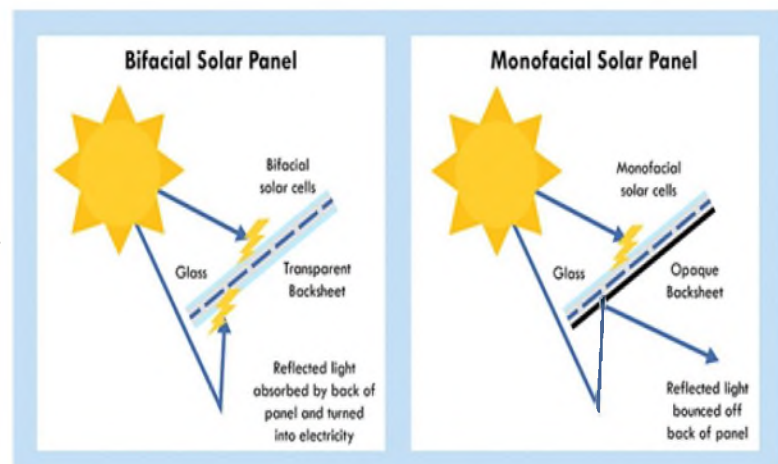
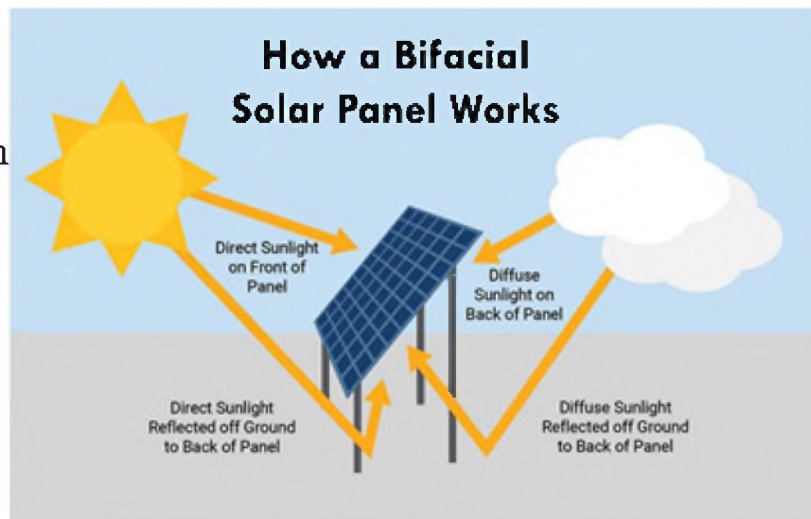
Bifacial solar modules offer many advantages over traditional solar panels. Power can be produced from both sides of a bifacial module, increasing total energy generation. They're often more durable because both sides are UV resistant, and potential-induced degradation (PID) concerns are reduced when the bifacial module is frame less.

Balance of system (BOS) costs are also reduced when more power can be generated from bifacial modules in a smaller array footprint.

Bifacial modules produce solar power from both sides of the panel. Whereas traditional opaque-back sheeted panels are monofacial, bifacial modules expose both the front and backside of the solar cells. When bifacial modules are installed on a highly reflective surface (like a white TPO roof or on the ground with light-coloured stones), some bifacial module manufacturers claim up to a 30% increase in production just from the extra power generated from the rear.

Bifacial modules come in many designs. Some are framed while others are frame less. Some are dual-glass, and others use clear back sheets. Most use monocrystalline cells, but there are polycrystalline designs. The one thing that is constant is that power is produced

from both sides. There are frameless, dual-glass modules that expose the backside of cells but are not bifacial. True bifacial modules have contacts/busbars on both the front and back sides of their cells.



Who will be Use Bifacial Solar Panels?

Bifacial panels can be a great way to pack a big punch with less room. If you're limited on space, opting for bifacial panels can help your system produce more electricity with fewer panels. However, bifacial panels aren't for everyone. There are a few factors that increase how much your bifacial system will produce.



The more vertical the bifacial panels are tilted, the more light will reach the backside, and the more energy they can produce. Because of this, bifacial panels often perform the best as ground mounts or as raised mounts on flat roofs, making them a good option for many commercial and utility-scale systems.

Bifacial panels installed on tilted roofs are often not ideal, because the panels are flush against the roof, leaving little to no room for light to get to the rear side. As many homes have sloped roofs, bifacial solar panels are not commonly used on residential solar systems. However, if you are looking to install a ground mounted system, solar carport, or solar pergola, bifacial panels may make sense for you.

How Much More Electricity do Bifacial Panels Produce?

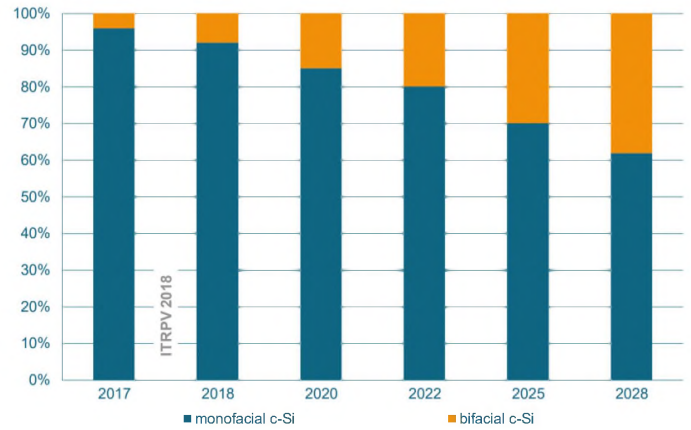
The main advantage of bifacial panels is the additional production. While most properly-designed bifacial solar systems should produce more electricity than a monofacial system, don't expect production to double. Because the backside is using reflected energy, it will inevitably produce less than the front side that's receiving direct sunlight.

Because there are so many factors, like installation angle and surface albedo, it's hard to give a solid estimate on how much extra electricity bifacial panels will generate. Most sources say you could see an increase in production between 05% to 30%.

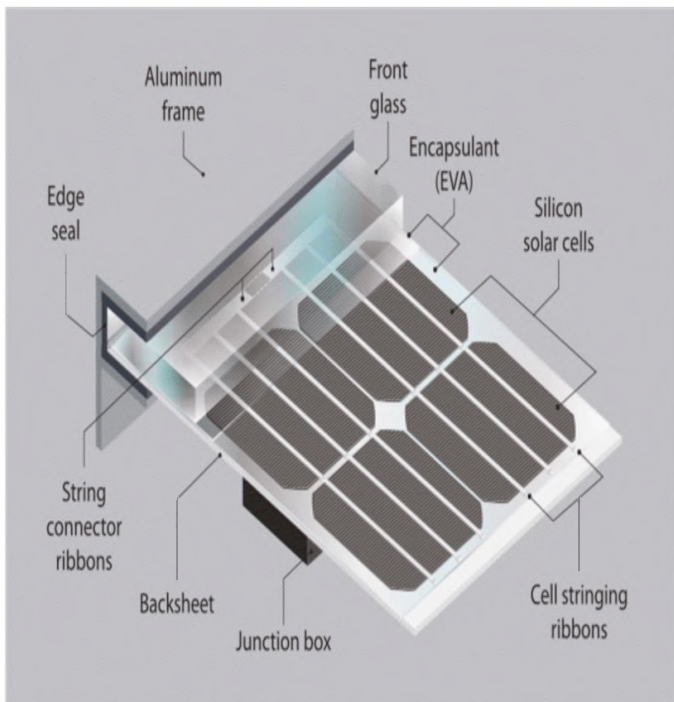
Are Bifacial Solar Panels Widely Available?

While monofacial panels still make up the majority of solar systems installed today, that's expected to steadily shift as bifacial panel technology becomes more available. You may find it difficult to find a plethora of installers that install bifacial panels this year, all signs are pointing to that changing as they gain more popularity.

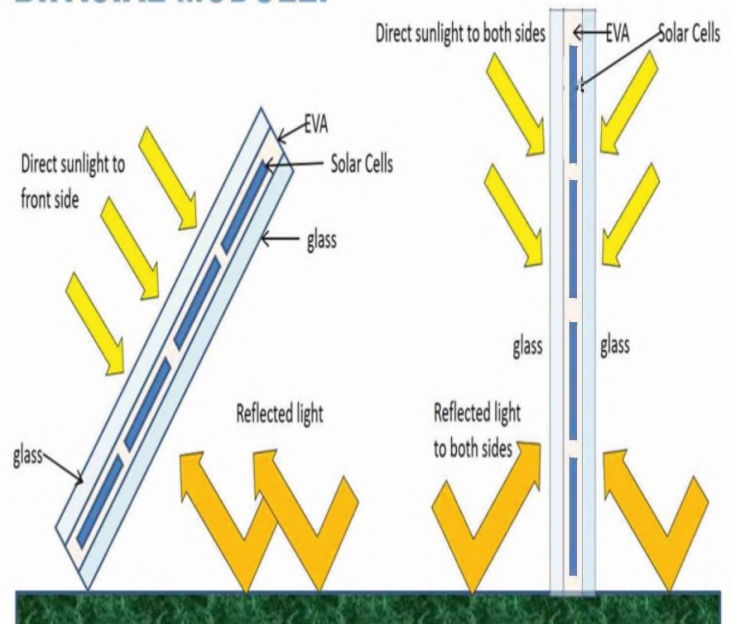
Bifacial cell technology
World market share [%]



Facts Of Bifacial Solar Panel



BIFACIAL MODULE:



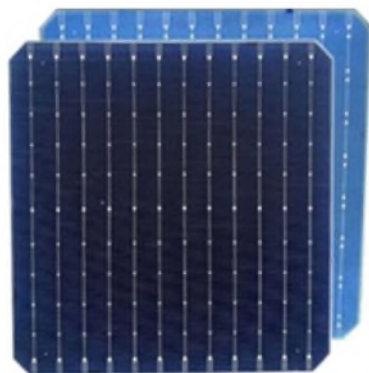
N-TYPE MONO -CRYSTALLINE SILICON BIFACIAL SOLAR CELL

Product Characteristics

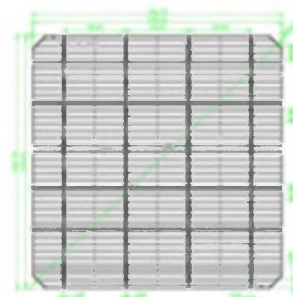
- High Conversion Efficiency with High Reliability
- No Light-Induced Degradation
- Uniform Cell Performance with Stable Process Control
- Both Sides Can Generate Electricity
- Cells Up To 85% Bifacility
- Low Mismatch Of Cell Performance During Encapsulation
- Excellent Power Generation Performance Under Low Irradiation
- Low Hotspot Effect
- Perfect Appearance and Colour Uniformity

Quality Control

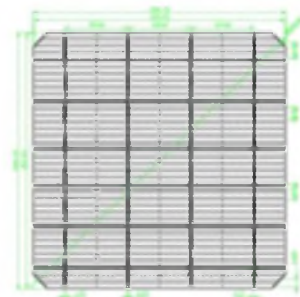
- Proper Inspection Through Incoming Production Outgoing And Packaging
- Efficiency Tested Within $\pm 0.1\%$ Accuracy
- 100% Checked for Reverse Current and Visual Appearance
- Reference Cell Call Calibrated from Fraunhofer
- Iso 9001, Iso 14001 And Ohsas 18001 Certified by Tuv Nord
- Soldering Peel Strength ≥ 1.0 N/Mm Bus Bar Width
- Only Positive Power Tolerance Binning



CELL LAYOUT



Front side



Rear side

Multi-Crystalline Silicon Poly Solar Cell

Features

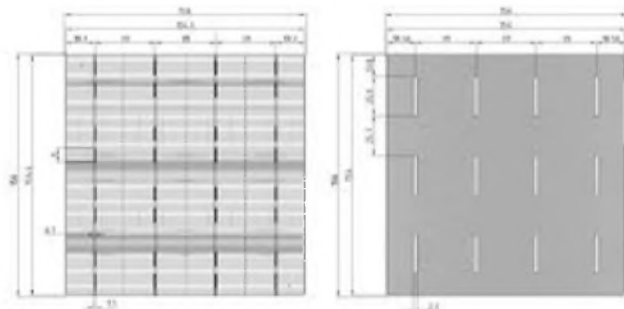
High Efficiency Solar Cells with An Acidic Etched Surface
Silicon Nitride Anti-Reflection Coating
Silver Front Contact Bars and Covered Aluminum Back Contact Field
Perfect Appearance and Color Uniformity

Performance And Quality

Proper Handling from Incoming Inspection Through
Production, Outgoing Inspection
100% Checked for Reverse Current and Visual Appearance
Calibrated Against Fraunhofer Ise
Rohs Compliance
Iso 9001, Iso 14001 And Ohsas 18001 Certified by Tuv Nord
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CELL LAYOUT



Mono-Crystalline Silicon Poly Solar Cell

Features

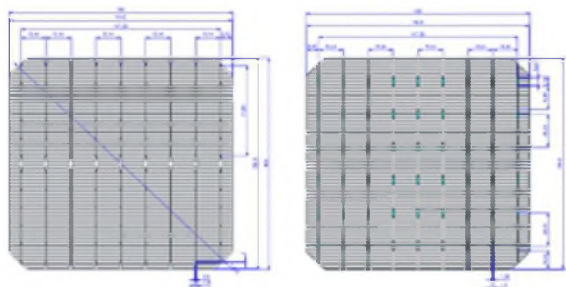
High Efficiency Solar Cells with Anisotropically Etched Surface
Silicon Nitride Anti-Reflection Coating
Silver Front Contact Bars and Covered Aluminum Back Contact Field
Perfect Appearance and Color Uniformity

Performance And Quality

Proper Handling From Incoming Inspection Through
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Lid Regenerated Solar Cells To Minimize Lid Loss
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Only Positive Power Tolerance Binning



CELL LAYOUT



SOLAR PANEL TECHNICAL COMPARISON

Type of Solar Module	Poly Module	Mono Perc	Bi-Facial
Solar Module Quality and Performance Details	Modules with low Temperature Co-efficient, High fill factor, Excellent low right irradiances Performance	Modules with low Temperature Co-efficient, High fill factor, Excellent low light irradiances Performance	N-TYPE Modules up to 87% Bi-Facially up to 13% gain with no reflective surface using fixed tilt over lifetime. 1500 V rated variant for large scale installations
GENERATION	NORMAL	10% MORE THAN POLY	15 TO 25% MORE THAN POLY DEPENDS ON REFLECTIVE SURFACE
CELL & PANEL WATT	72 CELL MODULE POWER OUTPUT 330-345 WP	72 CELL MODULE POWER OUTPUT: 365-382	72 CELL MODULE POWER OUTPUT :355-400
POWER DEGRADATION	POWER DEGRADATION <.2.5% IN FIRST YEAR <.0.68% / YEAR IN 2-25 YEARS	POWER DEGRADATION <.3% IN FIRST YEAR <.0.68% YEAR IN 2-25 YEARS	POWER DEGRADATION <.0.8 % IN FIRST YEAR <. 0.40%/ YEAR IN 2-30 YEARS
Generation Per Kw	4 Units (Approx)	5 Units (Approx)	6 Unit (Approx)