DESIGNING BIFACIAL PV PROJECTS

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STERLING & WILSON

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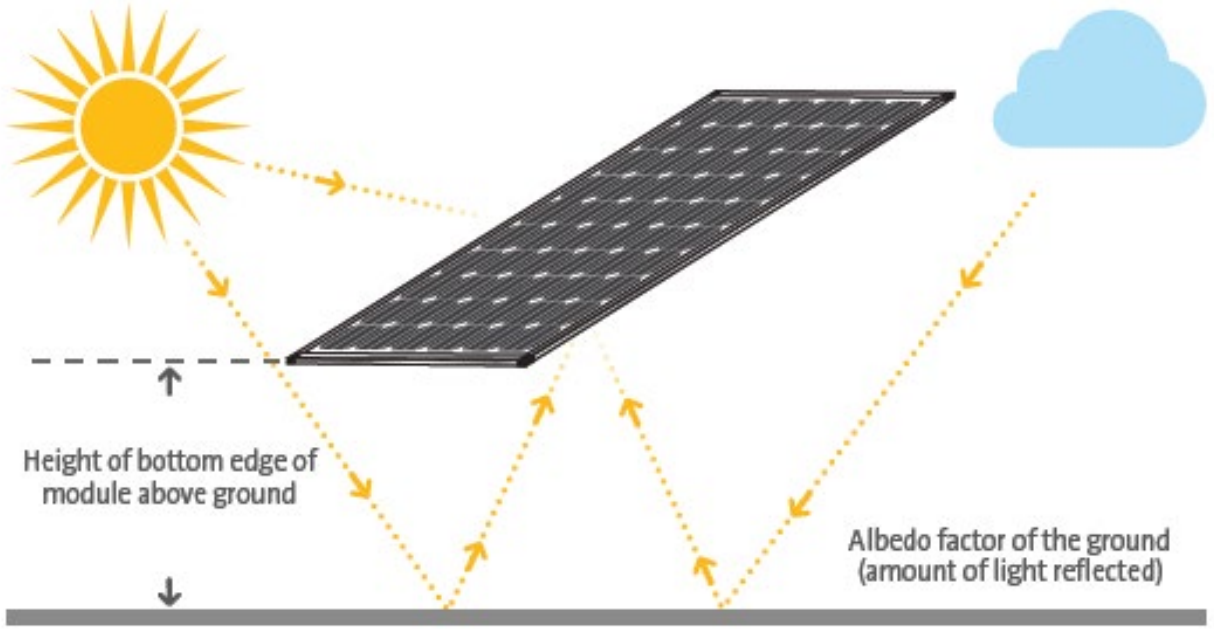
BRIEF ABOUT BIFACIAL

- Unlike conventional modules, the bifacial PV Module can produce energy from both the front and backside, utilizing sunlight on the front and reflected light on the back simultaneously
- The front side of the module works as a standard mono facial module, converting sunlight energy to voltage and current.

It has a symmetrical cell structure on the backside for additional sunlight absorption



BRIEF ABOUT BIFACIAL

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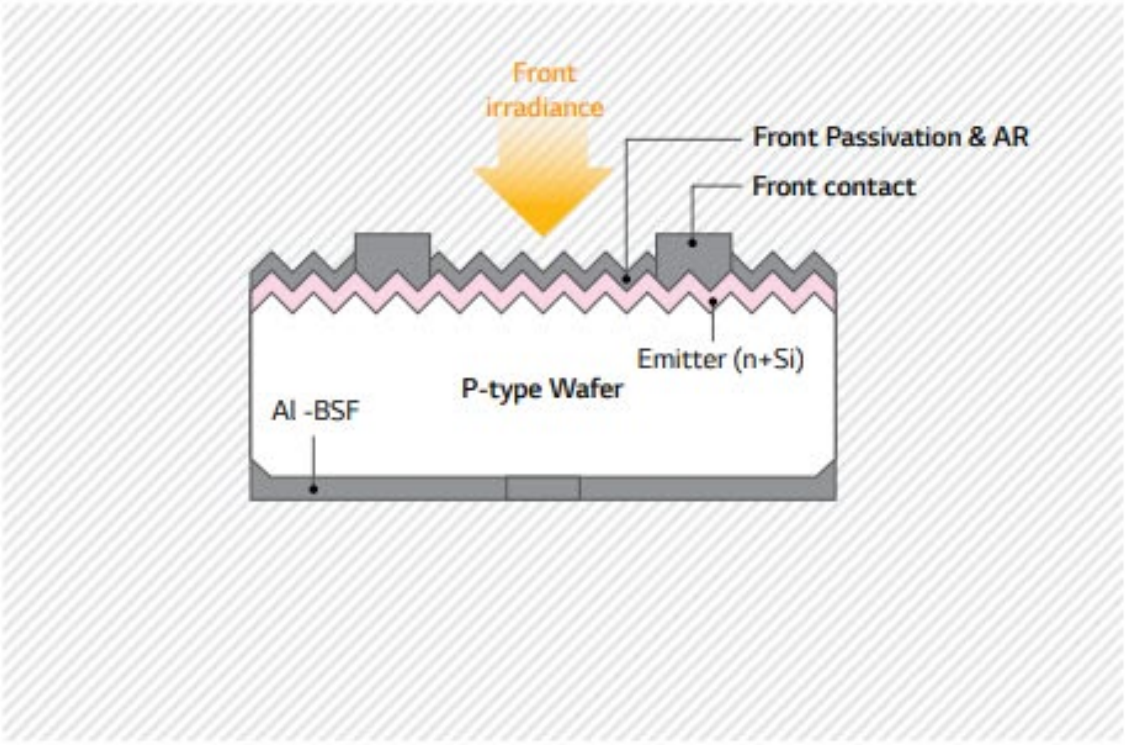
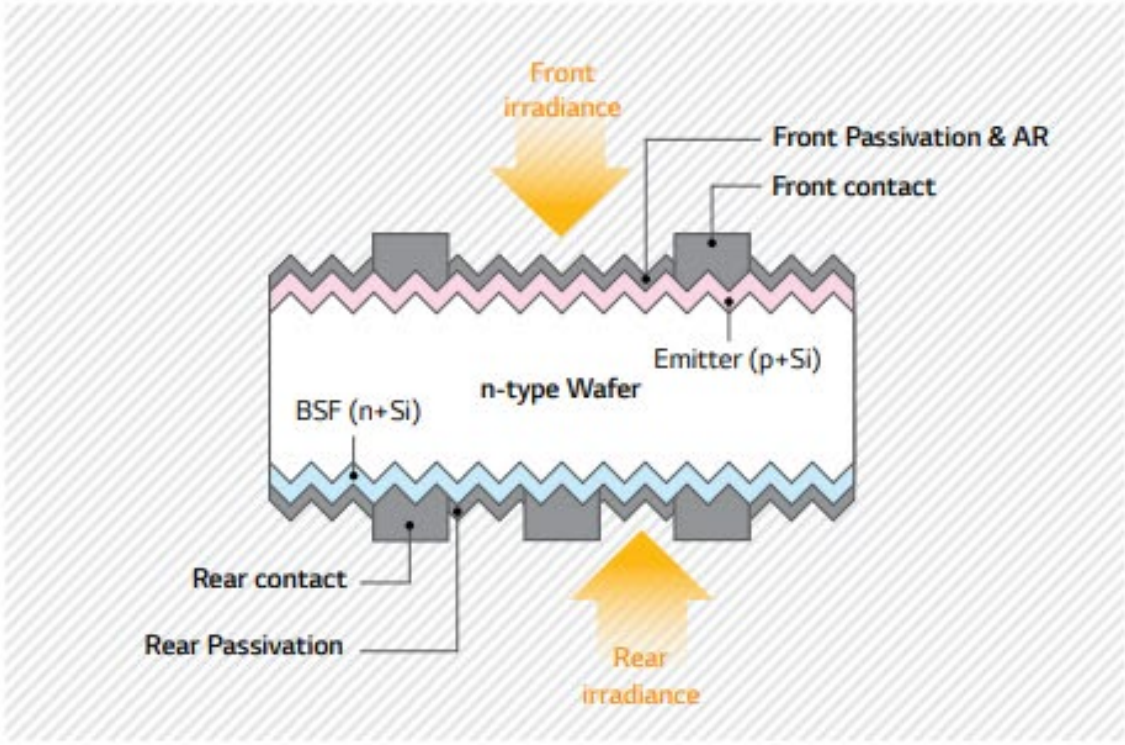
BIFACIAL CELL DESIGN AND CONVENTIONAL CELL DESIGN

Monofacial (Conventional)

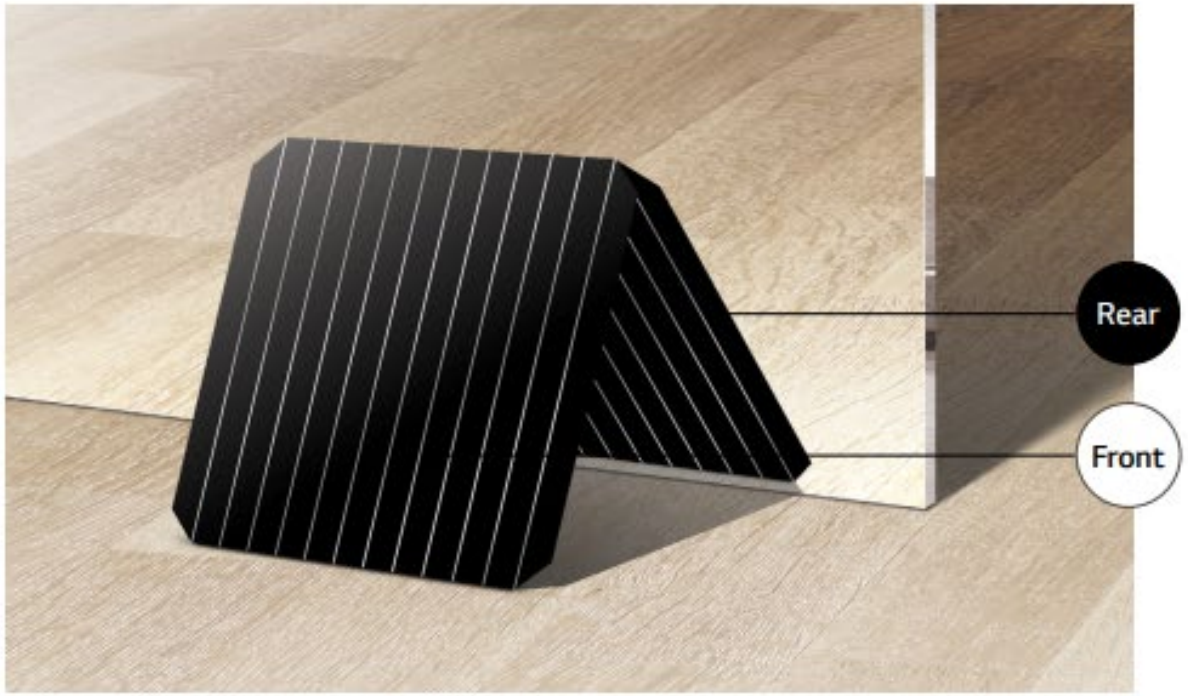


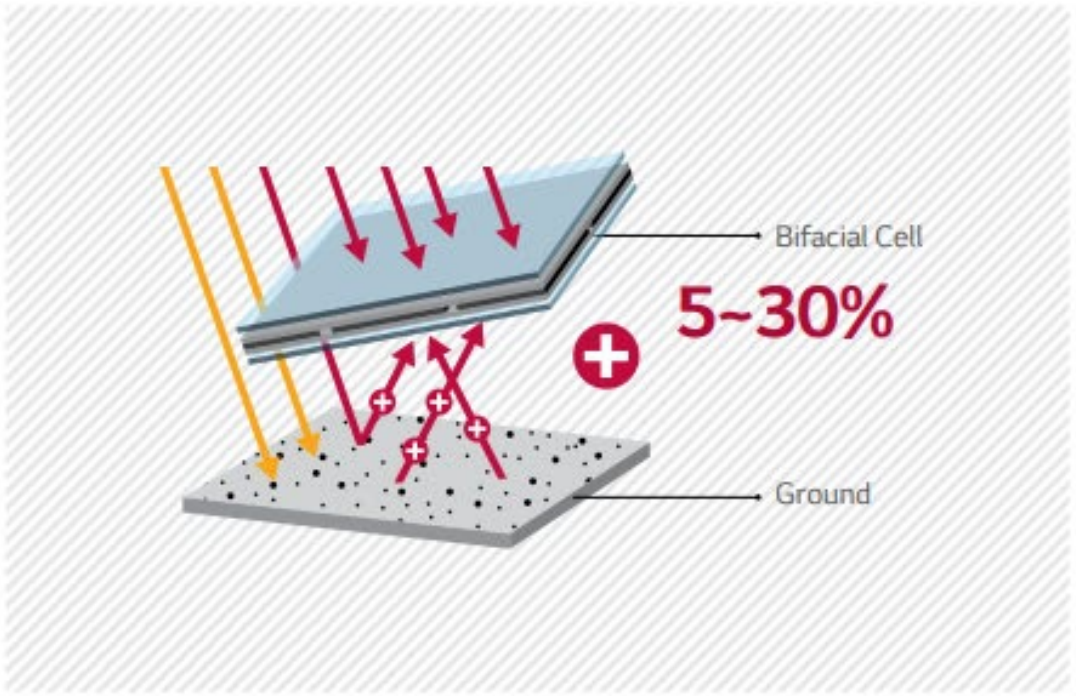
Bifacial



BIFACIAL PV MODULES

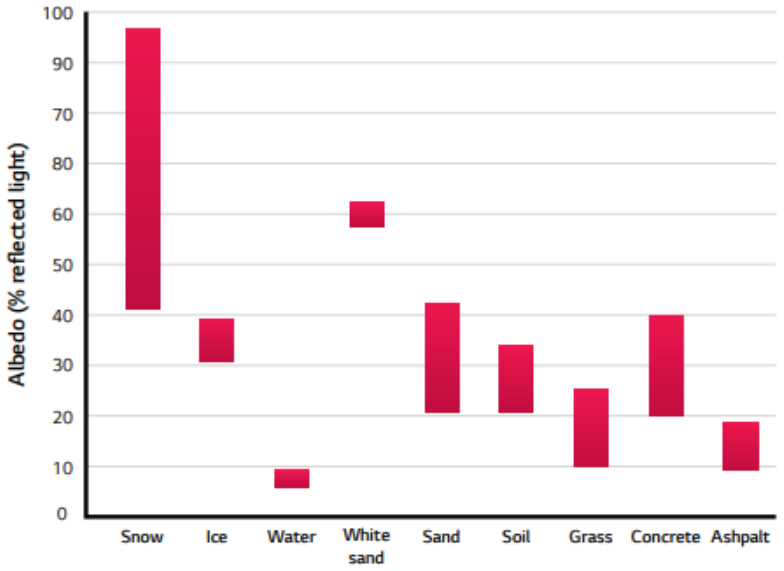
- The bifacial PV Module doesn't use a white back sheet but uses a transparent back sheet (or glass) on the back.
- (Total produced energy) = (Energy from the front) + (Energy from the back)
- The bifacial PV Module's performance depends on various conditions, such as system design, installation methods, location, etc.





ABOUT ALBEDO

ALBEDO RANGE FROM A VARIETY OF SURFACES



* Source : Helmholtz Alfred-Wegener Institute and the National Renewable Energy Laboratory (NREL)

- Albedo is represented as the ratio of light reflected from various sources of surface compared to incident radiation .
- The albedo has a range across a variety of surfaces, where 0% equates to no reflected light, and 100% represents perfect reflection

ALBEDOMETER

$$\text{Albedo} = \frac{\text{Reflected Light}}{\text{Incident Light}}$$

- An albedometer is simply two similar pyranometers measuring simultaneously, one looking up and one looking down, either back-to-back or in a single housing

HOW TO DETERMINE THE ALBEDO

The first step towards project design is to identify the albedo. There are 3 main methods for determining the albedo value:

01

Using Albedo reference table - Site inspection (Ground color, material, ground condition, etc.).
Look for expected albedo from table (i.e. PVsyst)

02

Measure the albedo of the site with a pyranometer (recommended) - Avoid obstacles and shading around the albedometer - Measure albedo over 5 different spots around the site for greater accuracy

$$\text{Albedo} = \frac{Isc_{\text{ground}}}{Isc_{\text{sky}}}$$

03

Using Solar GIS/Satellite Data: Solar GIS data can be used with an uncertainty of 3-5% on the values

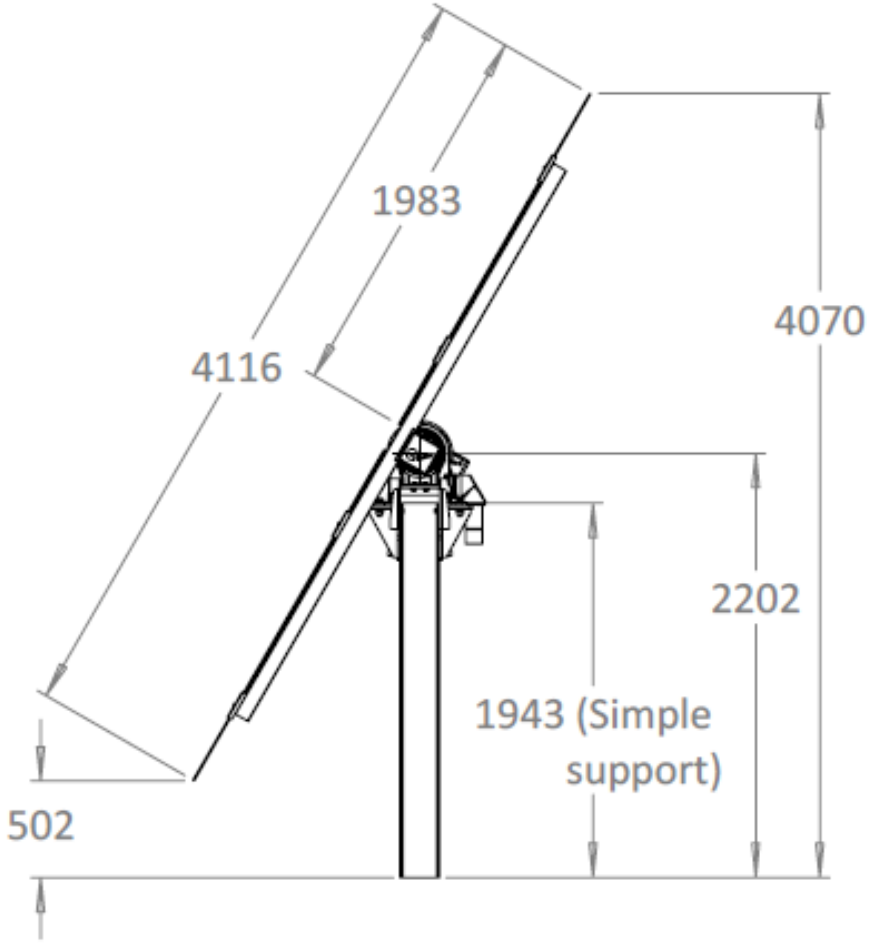
Albedo shall be considered for values greater than 300-400 W/m2, the test shall be done in conditions where the angle of the sun to the normal from the surface of interest is less than 45°; as per ASTM standard E 1918

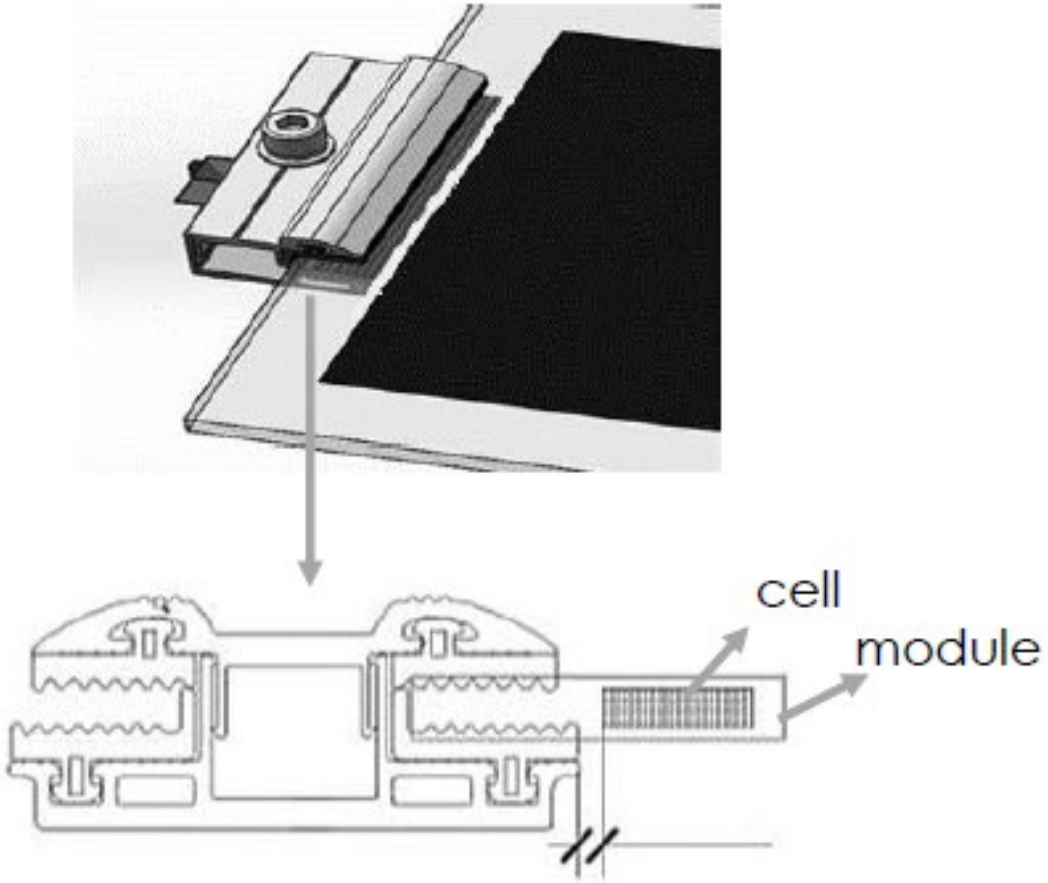
INSTALLATION

- Important to understand the installation of modules on the trackers, at tracker axis height of close to 1.8 m or above the ground.
- Proper cable management behind the modules, in order to avoid any shading effect
- Clamps are used similar to the installation of Glass to Glass Monofacial modules

Bifacial modules boast of the characteristic that both sides of the module can capture sun light, so it is important to minimize the shielding of the supporting structure and the shadow on the back of bifacial module. For this purpose, the supporting structure should be redesigned to avoid the beams and purlins crossing through the back side.

INSTALLATION





BOQ CHANGES

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Upon going with Bifacial Modules, against conventional Monofacial Modules, the major BOQ changes are as follows:

Y CONNECTORS CANNOT BE USED, DUE TO HIGHER CURRENT RATING:

- Hence the no. of inputs in the Combiner Boxes doubles
- No of inputs increase at Inverter side due to increase in Combiner Box.
- Though with the availability of 40A/50A fuses , it may be possible to use Y connectors or 3 input one output wire harness

DC CABLE INCREASES

- DC trench increase

COST PARAMETERS

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Modules	Depending on specific bifacial technology
Balance of Supply	Increase in tracker cost, cables, combiner boxes (added no. of inputs), addition of clamp cost
Installation	Increase in foundation length, cable trenching cost
Land cost	Optimum row-to-row distance is higher for bifacial compared to mono-facial PV systems, leading to a lower ground cover ratio for bifacial PV systems
O&M cost	If measures have been taken to artificially increase the ground albedo, CAPEX and O&M cost might be increased
Financing	Depending on the maturity (and track record) of a given bifacial PV technology (and the specific module supplier), the financing terms can be less beneficial for PV system based on bifacial modules compared to a system using standard mono-facial modules

ADVANTAGES

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- **Yield**: *Increased energy gain between 6% – 15% versus mono-facial PV modules*
- **Extended durability:** *By embedding of solar photovoltaic cells in a glass composite, they are highly protected against environmental and mechanical influences and therefore last longer*
- **More flexibility in solar PV system designs:** *With the use of bifacial solar modules, the direction that the modules are facing is of less importance*
- **Vertical installation:** *By installing PV solar panels vertically, heavy snow loads or sand will not inhibit the modules from generating electricity*
- **Warranties:** *Favorable warranties compared to mono-facial: 30 year lifetime warranty and 0.5% annual degradation are common;*
- **PID Free:** *Glass backing has a lower permeability to moisture than mono-facial backing materials, which reduces risk from Potential-Induced Degradation (PID)*
- **No Grounding required for frameless bifacial:** *The frameless panels are devoid of Aluminum frames. Hence, there is no need to ground these modules.*

ISSUES/ DISADVANTAGES

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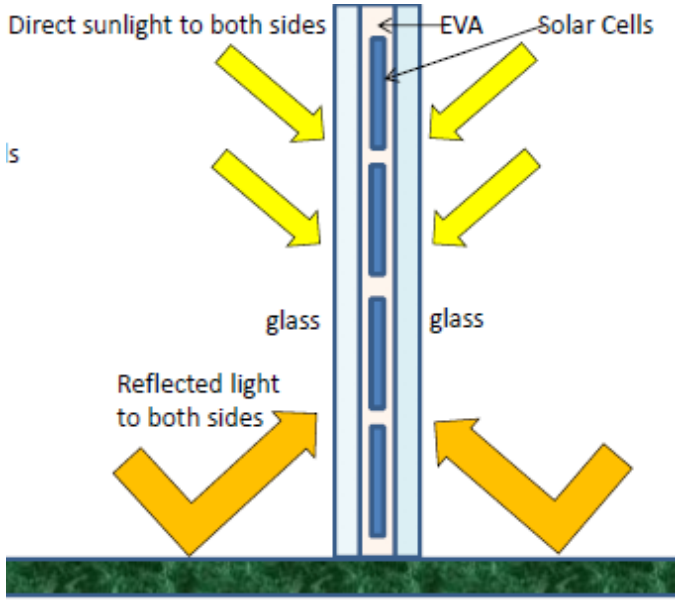
- **Heavy:** *Bifacial solar modules are made of double glass, which makes the module*
- **Maintaining Albedo:** *surface conditions can change over time due to environmental influences like aging, soiling or the natural alteration of ground conditions*
- **OPEX:** *Higher table heights required may result in difficulty in cleaning and maintenance, resulting in higher associated operational costs.*
- **Whether framed bifacial panels or unframed glass-glass bifacial panels**
  - Unframed modules tend to cause less backside shading
  - However , total BOS may wind up costing more than if a panel frame was used
  - Framed bifacial modules can trap sand or other soiling materials
- **Rear Shading:** *A more complex and higher mounting structure and cable layout is required to minimize rear-side shading;*

GOING FORWARD



VERTICAL INSTALLATION

- ~10-20% yield compared to south-facing
- Noon peak shaving
- Better matching with electricity need
- Rectangle" solar power generation

DOUBLE PEAK PROFILE

- Double Peak Profile
- 50% panels face eastwards to create a generation peak in the morning
- 50% is tilted westwards to also allow for a generation peak in the afternoon

FLOATING ON BIFACIAL

- Contribute to natural ecosystem
- Bifacial energy gain up to 30%

Thank You

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