BIFACIAL MODULES ARE THE NEW FACE OF PV

Solar PV technologies has been continuously upgrading; thanks to the immense research and the need to reduce the LCOE of the solar power plant. While there are quite a few technologies available now, bifacial modules have now started gaining traction in the market. We in one of our first few blog titled “Is bifacial the new face of PV?” informed you on how bifacial is poised to be a game changer in the PV market. And now with the prominent underlying facts being discovered about the technology, it is clear that the share of the bifacial modules shall rise to as high as 60% in the next decade. Further for any technology to flourish in the market, it is important that it also is bankable. By a survey carried out by Bloomberg NEF, more than 80% of the PV community considers the technology to be bankable and by coupling both bifacial & half cut technology, this number touches as high as 90% (Figure 1). With the technology being set to dominate the market, it is important for all of us to understand how we design a bifacial plant & further what are the gains once can expect when we install a bifacial plant in India. In this part of the blog, we would look into what are the factors affecting the output of a bifacial plant. Further we would also give our readers an idea on what our suggestions are on each of those factors.

Figure 1: (At top) Market outlook of bifacial technology (Source: ITRPV), (at bottom) Bankability of different module technologies (Source: Bloomberg NEF)

PARAMETERS AFFECTING THE OUTPUT OF BIFACIAL MODULE

With the bifacial module generating power output from both the ends, it is important that both the faces of the module have maximum amount of light falling on them. It is hence important understand all such factors and how do the variation in energy output looks like. The factors which needs to be considered while designing a power plant are:

1. Albedo
2. Bifaciality
3. Ground Coverage Ratio (GCR)
4. Height or Clearance
5. Tilt Angle

While tilt angle is very well understood and the solar module are kept at the tilt angle equal to latitude, the other 4 factors need detailed understanding.

Figure 2: Parameters affecting the output of bifacial module (Source: NREL)

ALBEDO

A Solar module works on the principle of photovoltaics i.e. it generates electricity when the light falls on it. While the front side of the module has adequate exposure of light (mostly directly) falling onto it right from the sun. The rear side of the module however receives the light which reflects off the ground. Thus it is important that the land (or base surface) over which the power plant is erected has maximum light reflection. The ratio of the light falling on to the ground to the amount the ground is able to reflect back is known as its albedo. However due to different inherent properties of the surface, they have different albedo’s. Surfaces with glaze, white coatings, metal tops are known to have higher albedo compared to a blunt/ matt finished

material. The bifacial gain has a direct dependence on the ground albedo and with the enhancement in the ground albedo, the bifacial gain from the power plant increases. A plant utilizing sand (albedo 15%) as ground can have a bifacial gain of 5.50% and these number can go close to 25% bifacial gain if the ground is changed to white membrane/ white paint (albedo of ~85%) (Figure 3).

Figure 3: (From top) a typical setup of a bifacial plant, albedo of different surfaces and (at bottom) expected bifacial gain on different ground surfaces (Source: Míriam Guari Borrull, Performance Optimization of Bifacial Module PV Power Plants Based on Simulations and Measurements)

BIFACIALITY

While the first point of the contact of light is the ground, the next comes the rear side of the bifacial module. While it is known that all the PV modules comes with conversion efficiency, a bifacial module additionally comes with a factor which is known as bifaciality. Under the same testing conditions, the ratio of the power output produced by the rear side to that of the front side is known as the bifaciality. This means that the rear side of the module does not always generate the same power exactly equal to front side. This property is not a limitation of the bifacial module but is an inherent property of bifacial cell itself. Different bifacial cells, depending on the type of wafer and the technology utilized have different bifaciality. The highest amongst these is HJT cells which have a bifaciality of around 93% (refer Figure 4).

Figure 4: Bifaciality of different wafer technologies

GROUND COVERAGE RATIO (GCR)

The pattern in which a bifacial power plant is installed also makes an impact on its energy generation. It is important that we allow the light to incident on the ground justly to obtain the necessary generation from the rear face of the module. This is where the GCR comes into play. GCR is the ratio of the module length to the inter row spacing (Figure 2). It generally gives an idea as to in a power plant how the modules are spaced. A very high GCR (of say 70~80%) would mean that there are numerous rows of bifacial module which leads to reduced inter row spacing for a given area. This further means that we are not allowing adequate light to fall onto the ground which leads to reduced & even negative bifacial gains. Further, a low GCR (of say 10~20%) would mean that while we allow adequate light to fall on the rear surface, the area required to install a fixed power plant increases exponentially. It is hence necessary to strike a balance between the amount of area required and the amount of energy generated by the power plant. We suggest a GCR between 40~50% for optimized results (Figure 5).

Figure 5: Bifacial gain v/s GCR for a bifacial power plant

HEIGHT

Apart from GCR, height also has a significant effect on the bifacial gains once can expect from the power plant. Height may be defined the distance from the ground to the lowest point of the PV module (Figure 2). The light (direct reflected off from the ground and/or the diffused) need to be incident perfectly at the rear surface of the bifacial module. Keeping the modules at a fair height maximizes the light incident on the module. While it is known that increasing the structure height increases the bifacial power gain, the curve flattens at a height of 2 m. Further it should also noted that increasing the height would lead to increased wind loads on module which would require sturdy under structure. Hence it is recommended that a height of 1.2 to 1.3 meter is maintained for optimized results.

Figure 6: Variation of energy generated v/s Height for a bifacial power plant

While this part covered the basics to bifacial PV and the necessary parameters which needs understanding while designing and/or installing a power plant, the further parts would detail discussion on the simulation study we carried out. This study covered different climatic zones of India and an analysis of gains (both technical & commercial) one can expect from bifacial module. Keep looking onto this space for out next article.

Let us all pledge to make solar energy the primary source of energy in the near future.