Bifacial PV

Technology Teaser Paper

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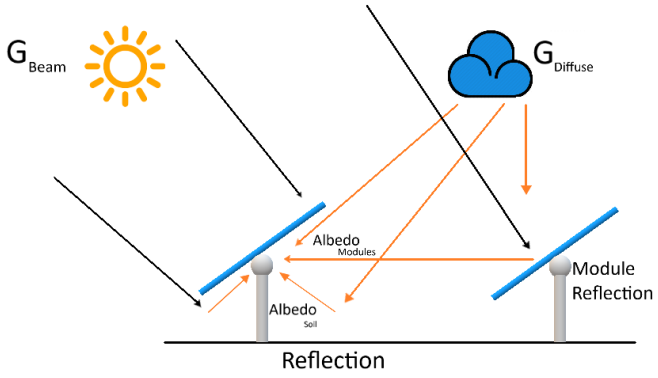
Bifacial PV Introduction

With some bifacial PV (BFPV) plants reporting bifacial energy gains of over 20%, the PV industry is showing growing interest deploying bifacial technology.

However, there are a number of technical and yield modelling challenges associated with the BFPV which need to be appreciated by a developer considering its use in new projects.

RINA has prepared a circa 60-page BFPV White Paper discussing these challenges and how they can be managed and mitigated, which is available to clients for a small fee.

This Teaser Paper provides an overview of these challenges.



As outlined in the figure to the left, BFPV technology works by gathering irradiance from both the front and the back of a PV module. The technology provides increased generation from both direct and diffuse irradiation.

Modules

There are a number of manufacturers who have a range of bifacial modules available, typically at a small price premium versus monofacial technology. These can be divided into modules based on n-type PV cells and those based on utility-scale p-type PERC monofacial modules.

The pace of innovation is currently high, with newer higher capacity modules coming onto the market regularly. Track record can be limited. Our White Paper provides an overview of key manufacturers providing bifacial modules, track record and production capability. Due to the limited track record of BFPV, we recommend a robust analysis of manufacturer claims, beyond that which might be undertaken for an established monofacial modules.

Our White Paper provides an overview of information which could be requested from suppliers, along with some comments on weaknesses observed in datasheets, and mitigation provided by the new 60904-1-2:2019 technical specification. We also provide information on warranties typically available in the market.

Plant Design

The fundamental energy gains which can be derived from bifacial technology depend on the irradiation, albedo and site conditions, in particular Diffuse/Global Irradiance ratio. Accurately modelling each of these parameters represents a challenge, in particular modelling of albedo, which is discussed further below.

Our White Paper has more information on how these factors might affect the potential bifacial gain from a PV project including quantification of the impacts of relevant factors on bifacial energy gain. While BFPV does not require a fundamentally different solar project design, there are a number of factors which need to be understood and optimised to ensure optimal yield/lowest cost of energy.

Key factors include pitch/Ground Coverage Ratio, which must be increased/decreased to ensure greater reflection of sunlight, module height, and tilt (for fixed deployment). In addition, mounting structures/trackers must be selected that minimise interference obstruction of reflected irradiation.

Our White Paper contains more information on how these and other factors such as inverter sizing can be optimised.

Another solution which has been discussed but not widely deployed is use of albedo enhancing materials at a site, and our White Paper includes discussion of challenges and opportunities associated with use of materials such as elastomeric coatings, coatings, geotextile materials and light-coloured or reflective rocks or aggregate.

There are a significant number of design parameters which need to be adapted and optimised for a BFPV site, and changes in these parameters can have complex and non-linear interactions with cost and yield.

As an example, RINA has noted from a number of design optimisation exercises that for a given site, and within typical ranges, decreasing Ground Coverage Ratio (GCR) for bifacial projects leads to a decrease in modelled Levelised Cost of Energy (LCoE). However, reduction in GCR can lead to a reduction in the capacity which can fit at site, and hence lower absolute revenues.

Our experience suggests that a full LCoE based design optimisation is crucial to ensure an optimum site, particularly in the context of growing auction popularity. Our approach is to produce a reference design against which EPC Contract tender responses can be evaluated rather than be prescriptive with design choices.

Yield Forecasting

Broadly, the approach to forecasting yield of a BFPV plant is similar to that for a monofacial facility. However, there are a number of particular factors which need to be considered. Two main bifacial models are used by RINA in its yield modelling approach; a View Factor model incorporated in PVsyst and a Ray Tracing model made available by NREL. Both models have strengths and weaknesses which are examined in the White Paper. Once a modelling approach is selected, inputs need to be carefully quantified. Key inputs into a bifacial yield model are ground albedo, module transmission factor, shading on the rear surface e.g. from the torque tube of a tracker, and bifaciality factor (ratio of maximum power from rear surface versus front surface of the module).

The White Paper contains information on how these and other factors can be best modelled, identifies shortcomings in current approaches, and quantifies how key inputs affect bifacial energy gain for selected sites. One of the most important factors in calculation of bifacial energy gain is ground albedo. Quantification of albedo is challenging for a number of reasons, including lack of appropriate data sources and the variation of albedo between seasons. Our White Paper explores a number of approaches to albedo quantification, including use of on-site photography and satellite data. RINA is also running a research project using site-based albedo measurement devices to attempt to further validate or challenge these approaches. As the technology is new limited operational performance data is available, particularly contrasting monofacial and bifacial performance at a specific site, and RINA is actively engaging with customers to obtain relevant data to validate yield predictions.

Commercial factors

Regardless of how well technical challenges are understood and addressed, developers ultimately need comfort through commercial protections such as price certainty and warranty provision. It can be challenging to obtain specific warranties for bifacial performance, but our White Paper provides some discussions of mechanisms we have seen made available on a project specific basis. Our White Paper also includes some commercial modelling as to the potential financial gains associated with bifacial technologies at specific sites in various configurations, quantified through LCoE.

Contact details

If you would like to arrange access to the full white paper for a small fee, or would like to discuss any other aspect of bifacial solar technology with RINA, please contact Richard Abrams.

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