The simulation of the energy yield of Bifacial PV modules is not straightforward, since most of the light reaching the back side of the PV modules is scattered back from the ground. For tracking systems this is particularly challenging since the geometry is changing as the sun moves through the sky. In PVsyst, a simplified 2D model was introduced to describe bifacial horizontal single axis trackers with regular spacing. The approach uses view factors to model the fraction of light that is scattered back to the back side of the PV modules. The bifacial calculation includes ground scattering to the front and back side of the modules as well as direct and sky diffuse contributions on the back side.

Abstract

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Bifacial model

The single diode model applies like for monofacial PV modules

View factors

The view factor describes the fraction of irradiance that reaches a given surface. View factors are calculated for ground to rear side and ground to front side.

Simulation steps

Approach for modelling ground scattering:
- No contributions from the sides (long rows)
- Ground scattering is the same for all rows (regular width and spacing, many rows)

This allows to use a 2D-cross section of the rows for all the calculations

Simulation parameters

Parameters needed for bifacial simulations:
- Pitch, width, height
- Stroke limits
- Ground albedo (yearly or monthly values)
- Rear side shadings from mounting structures
- Mismatch factor for rear side contribution

New result variables

- Irradiance on ground
- Reflection loss
- View factor loss
- Diffuse and direct sky irradiance on rear side
- Additional irradiance on rear side
- Ground scattering to front side
- Bifacial mismatch

The bifacial model used in the PVsyst software, has been extended to horizontal axis tracker systems. The model is based on a simplified view factor approach, that can be reduced to a two-dimensional calculation. This is a suitable approximation for large fields of trackers with regular row spacing and width. The model captures the main bifacial contributions, namely the direct and diffuse light scattered back from the ground, and the direct and diffuse light reaching directly the rear side of the PV modules. The model was used to study the bifacial and tracking gain as function of ground covering ratio, mounting height and latitude, as well as for different climates.

Parametric studies

Evaluating the potential benefit coming from Trackers and Bifacial PV Modules

System configuration (GCR and height)

Climates with more diffuse irradiance have a larger bifacial gain.

For horizontal axis trackers the bifacial gain for diffuse light is always larger than for direct light.

The bifacial gain for direct light decreases with the tilt.

Bifacial gain for diffuse light increases with tilt.

Climates with more diffuse irradiance have a larger bifacial gain.

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The bifacial gain for direct light decreases with the tilt.

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Bifacial gain for diffuse light increases with tilt.