Bifacial Tracking Testbed at NREL

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20 modules (7.5 kW) / row
Module electronics / monitoring

★ 4 PERC, 1 SHJ bifacial strings
● 3 PERC monofacial strings

▲ String kWh_{DC} monitoring
◌ Front, rear POA irradiance

Project Summary

Bifacial demonstration plant with 10 rows of single-axis trackers. Each row is independently monitored and grid tied.

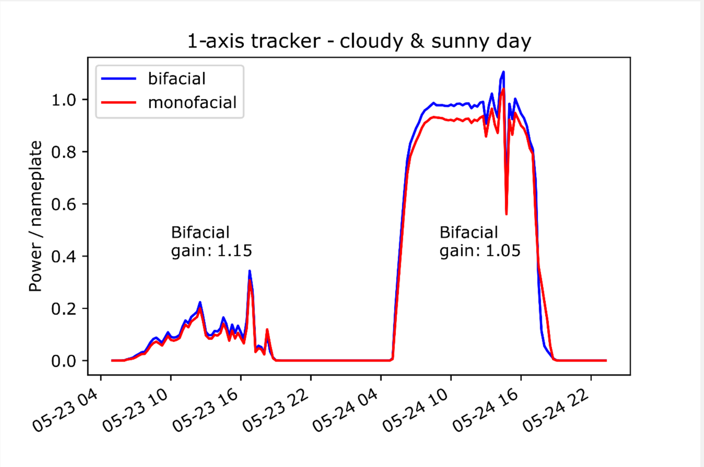
This project continues our work* on bifacial photovoltaic modeling, field evaluation and standards development.

Project Impacts

Collection of NREL-sited and commercially deployed bifacial systems provide confidence to owners and validate performance models.

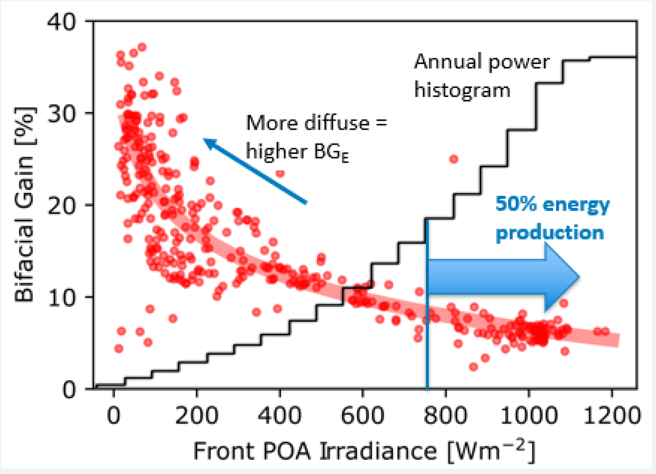
Improved bifacial models assess system performance impact from rear irradiance mismatch and rack shading.

Outcomes

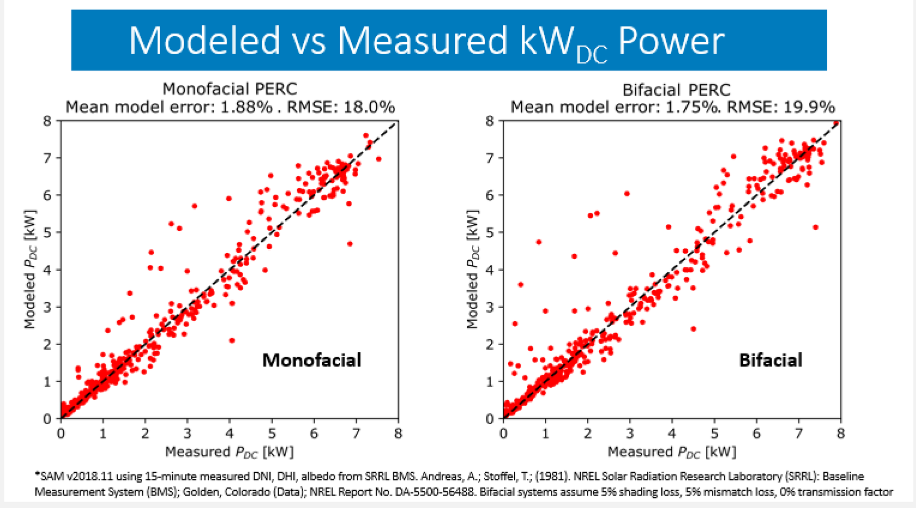


Initial data, showing the performance benefit of the bifacial modules relative to the monofacial ones (*Bifacial Energy Gain, BG_E*)

$$BG_E = \frac{E_{bifacial}}{E_{mono}} - 1$$



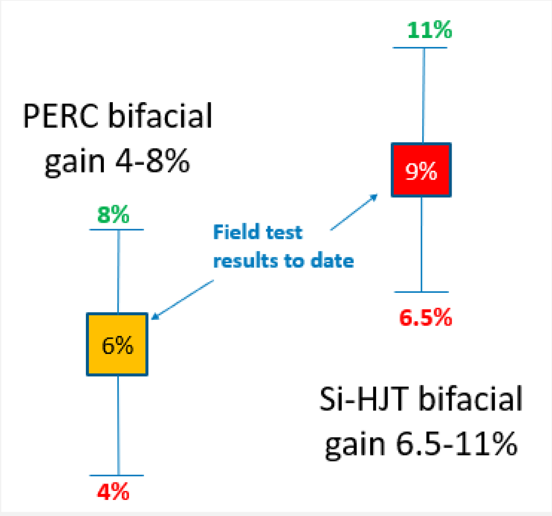
With high DC-AC ratio clipping being a concern, a lot of the bifacial energy benefits accrue during times when the system is not putting out max power. However, most of the energy generation happens at high irradiance.



Performance agreement between measured and modeled data (considering measured irradiance and temperature†), is about the same for both technologies within about a 2% offset error. This suggests that going to a bifacial technology doesn't significantly increase the model error.

3 sensitivity cases:	Ground albedo	PERC ϕ_{Bifi}	Si-HJT ϕ_{Bifi}
High case	0.30	0.75	0.95
Average case	0.20	0.7	0.90
Low case	0.15	0.65	0.85

Three sensitivity cases were selected to model bifacial energy gain in SAM for our site.



The average case is our best estimate for our site, and it coincides with field measured bifacial gains of 6% for the PERC bifacial system, and 9% for the higher ϕ_{Bifi} silicon heterojunction string.

BG_E is sensitive to albedo and module bifaciality. The range of typical BG_E values for other conditions are between 4 and 8% for PERC and 6.5 and 11% for the heterojunction system. Site-measured albedo is 0.19 – 0.21 during this period, matching 'Average case' assumptions.

†SAM v2018.11 using 15-minute measured DNI, DHI, albedo from SRRL BMS. Andreas, A.; Stoffel, T.; (1981). NREL Solar Radiation Research Laboratory (SRRL): Baseline Measurement System (BMS); Golden, Colorado (Data); NREL Report No. DA-5500-56488. Bifacial systems assume 5% shading loss, 5% mismatch loss, 0% transmission factor

*References

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