

Bifacial PV System Fixed Tilt and Horizontal Single Axis Tracking

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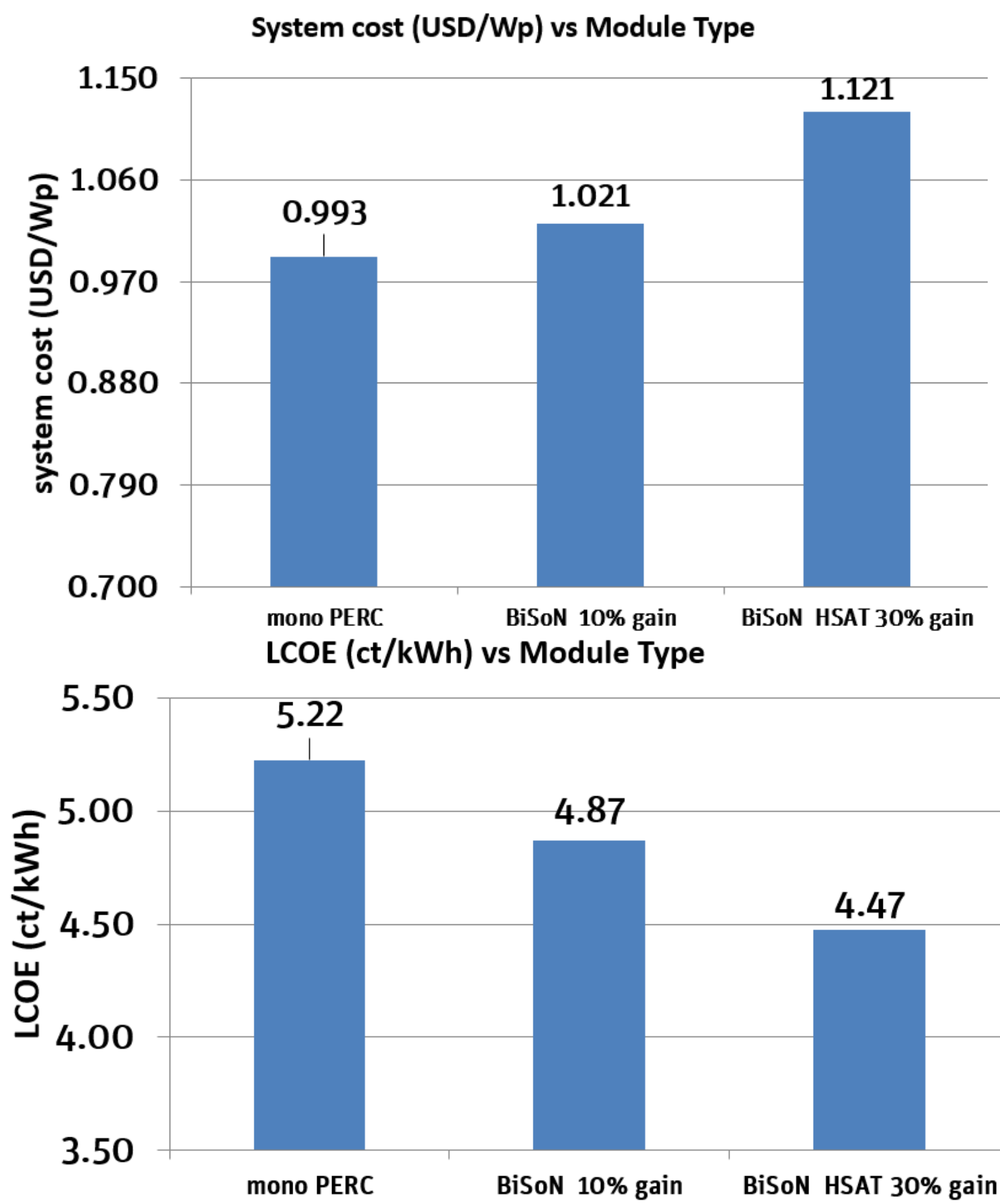
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Motivations

\$/kWh Vs. \$/Wp mentality



Right, a bifacial PV system can be more expensive than its monofacial counterpart in terms of \$/Wp... BUT the end user is interested in \$/kWh.

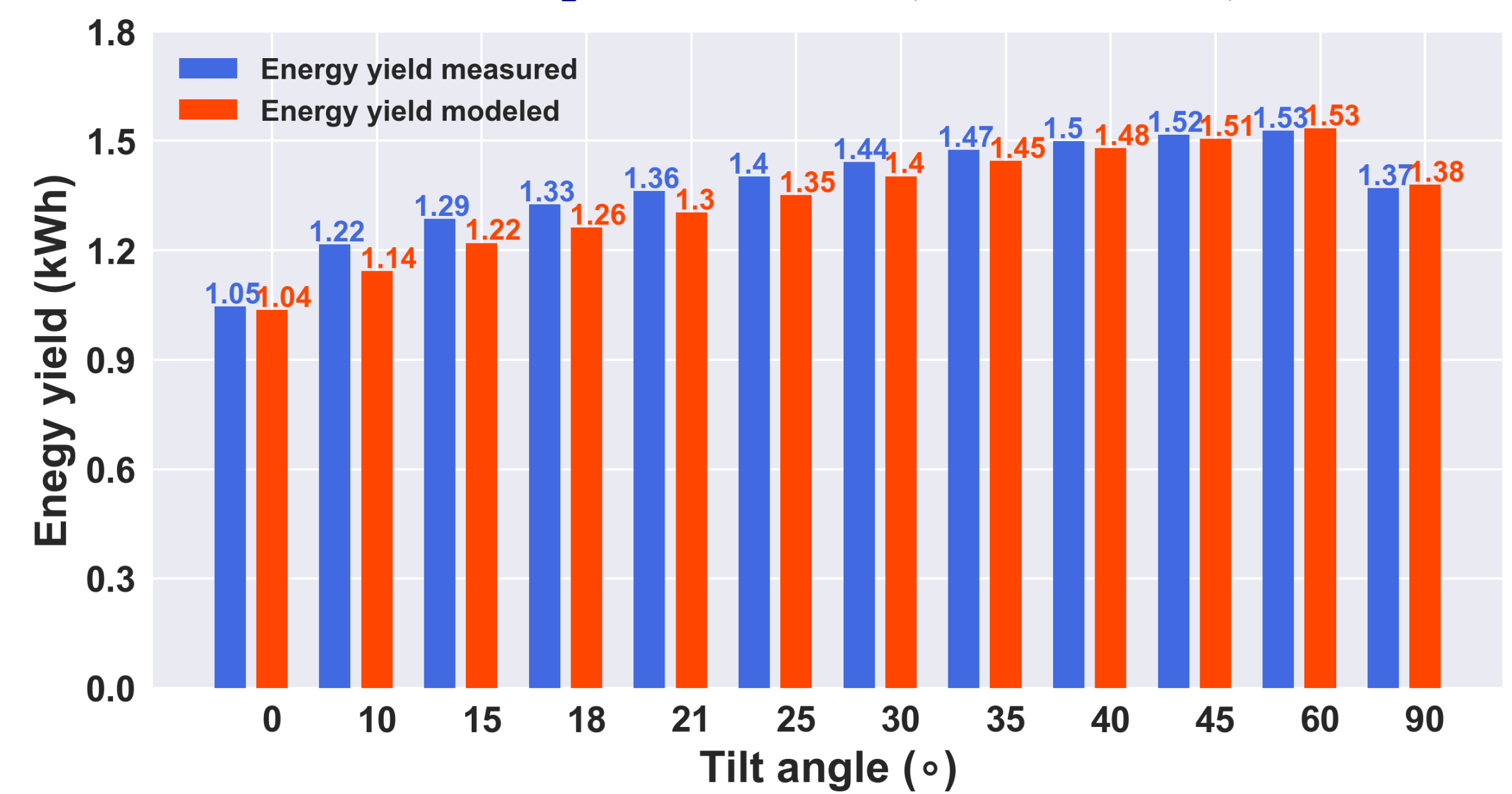
The LCOE for bifacial PV systems is lower than for monofacial PV systems.

The main assumptions-June 2018

Parameter	mono-PERC	BiSoN	HSAT BiSoN
module cost (USD/Wp)	0.312	0.338	0.338
Total BOS cost (USD/Wp)	0.681	0.684	0.783
GHI (e.g certain areas in Arizona (USA))	2240	2240	2240
Yearly degradation rate	0.40%	0.40%	0.40%
Gain vs monofacial fixed tilt	-	10%	30%
WACC (discount rate)	6.50%	6.50%	6.50%
System lifetime (Years)	25	25	25

MoBiDiG: Bifacial Fixed Tilt Validation

Measured BIFOROT and simulated MoBiDiG accumulated energy yield during one sunny day for module tilt angles from 0 to 90°(for module "M2")



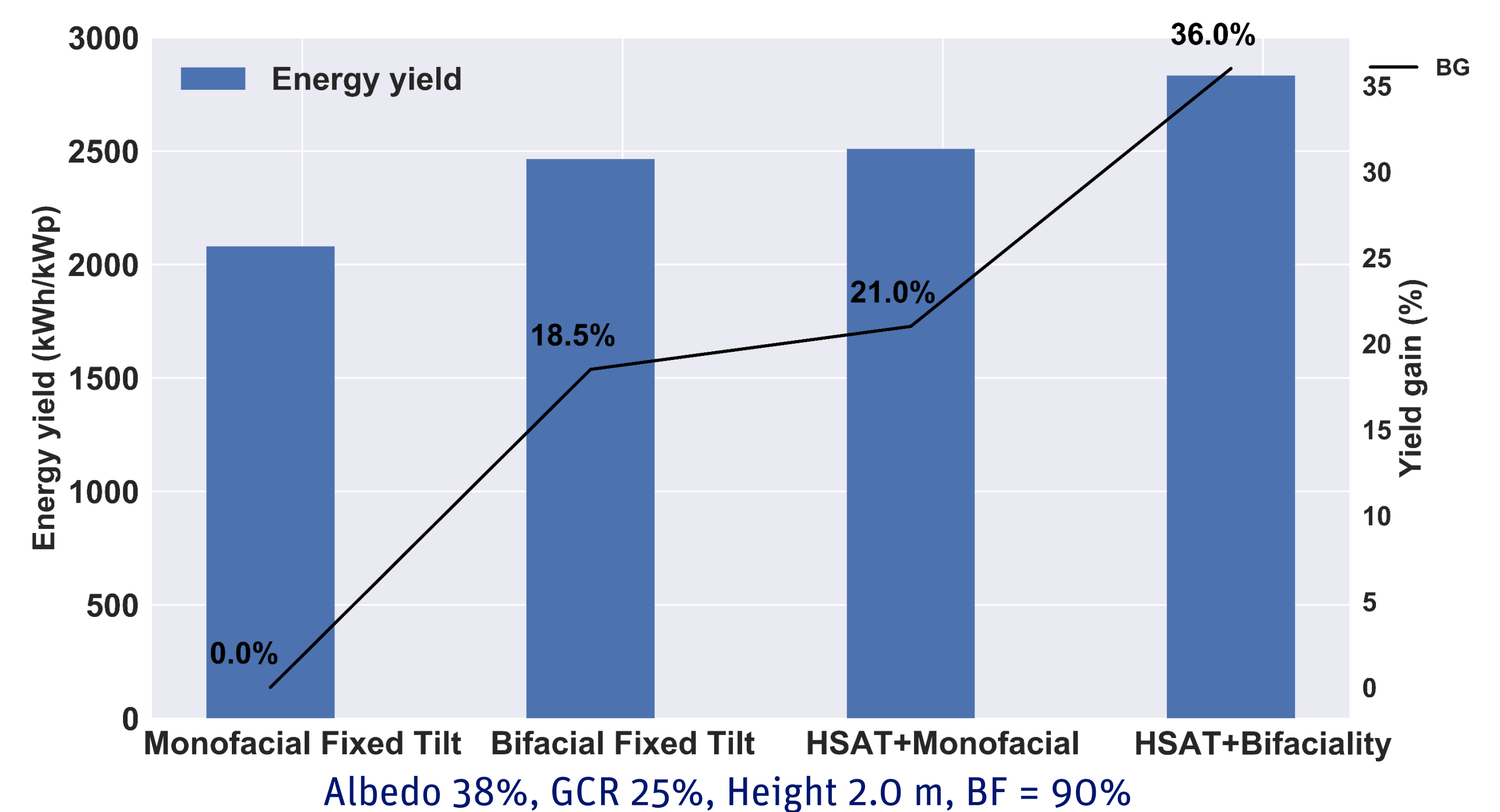
Results:

- Quite good match between measured and modeled results over all tilt angles.
- Overall relative underestimation seen for all tilt angles.

MoBiDiG: Comparison of Different PV Systems

Location: MENA region

Overall comparison of different PV systems installed on the site under exploration. The bar chart represents the yearly energy yield of different PV systems after the optimization. The line plot reveals the yield gain for each bifacial PV system considering the monofacial fixed tilt as a reference.

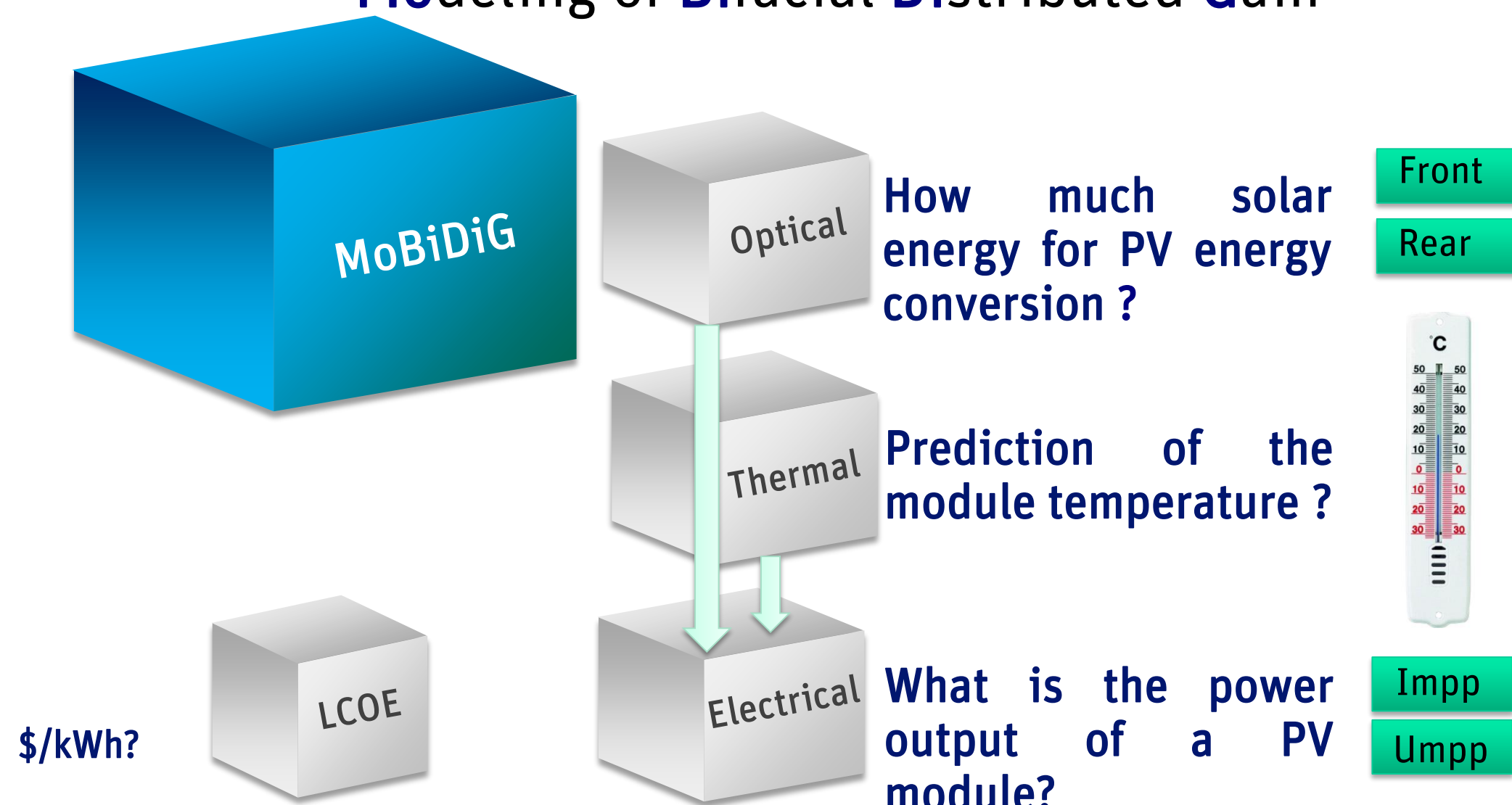


Results:

- Coupling bifacial modules with HSAT pushes further the power output to more than 2832 kWh/kWp which is equivalent to 36% yield gain that is the highest record among the examined PV systems.

MoBiDiG : Sub-Models Overview

Modeling of Bifacial Distributed Gain



[1] I. Shoukry. "Bifacial Modules: Simulation and Experiment", Master thesis, Konstanz: s.n., 2015.

[2] D. Berrian, J. Libal, S. Glunz, "MoBiDiG: simulations and LCOE", 4th BIFI workshop, Konstanz, Oct 2017.

MoBiDiG Vs. BIFOROT: Validation

Bifacial Outdoor ROTor Test

Module 3 (M3) : Rear covered for the front measurement of Isc.

Module 2 (M2) : IV curve measurement (Isc, Bifacial module).

Module 1 (M1) : Front covered for the back measurement of Isc.



Biforot test rig in permanent rotation, 12 tilt angles from 0° to 90° every 1 minute

A Summary of Some Previously Conducted Bifacial Studies

Type of the bifacial PV system	Region	Albedo (%)	Monitoring Period	Irradiance Source	Bifaciality Factor (%)	GCR ² (%)	Height (m)	BG (%)
Fixed Tilt	South America	20	1-year	TMY	76	27	1.0	6.14
Fixed Tilt	Europe (roof)	78	One week	Site measurement	79	40	0.30	14
HSAT	MENA	35	1-year	TMY	85	36	2.1	8.1*
HSAT	South America	28	9 months	Site measurement	75	42	1.5	7.5*
HSAT	Europe	30	1-year	TMY	90	30	2.0	10*
HSAT	MENA	35	1-year	TMY	75	36	1.56	5.1*
HSAT	South America	27	4-months	TMY	85	33	2.0	9.2*

GCR : ground coverage ratio.

* Compared to monofacial HSAT.

Conclusions

- A simulation tool (MoBiDiG) for energy yield prediction of bifacial modules (fixed tilt or tracking) has developed and validated to the outdoor field data for and at tilt angles.
- The bifacial PV array (BIFOROT) has been modeled and compared to the measured data for different tilt angles, a good match has been found.
- Pairing bifacial solar panels with solar tracker leads to unbeatable power generation, especially when considering bifacial solar cells with a very high bifaciality.

Acknowledgements

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