Soltec

Ph.D Javier Guerrero, specialist in Bifacial technology and Project Manager at BiTEC, presents real field-data on Bifacial Gain with solar trackers ////

Colin Caufield, VP of Sales for Soltec USA, in charge of searching and presenting the highest-quality and most innovative solution in the Single-Axis Solar Tracker market ////

BITEC

Bifacial Tracking, The Real Deal

Soltec history

Global Force

Soltec is working with 15 years of industry experience and a global labor force of more than 1,500 people

Tracker Specialist

Top-tier manufacturer and supplier of single-axis solar trackers and specialist in customer experience and innovation

6.7+ GW in projects all over the world

The company has manufacturing facilities in Argentina, Brazil, China and Spain as well as offices in Australia, Chile, Denmark, Egypt, India, Israel, Italy, Mexico, Peru and the US

Bifacial Tracking, The Real Deal.

Our bifacial story

2015

'La Silla' solar plant (Chile), 2015. Soltec produced **the first solar tracker specifically designed for bifacial modules** installed in a utility scale solar plant.

2017

Soltec launchs SF7 Bifacial Single-Axis Tracker.

- Higher mounting height
- Shadow-free backside
- Wide-aisle reflecting surfaces

2018

Soltec Leads with the World's First Bifacial Tracking Evaluation Center

BiTEC (Bifacial Tracker Evaluation Center) measures bifacial performance and its effect on yield.

2019

1.1 GW SF7 Bifacial in projects worldwide

Soltec Supplies SF7 Bifacial Single-Axis Tracker for Sao Gonçalo PV plant in Brazil (475 MW)

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BiTEC
Bifacial Tracker Evaluation Center

Objectives of study from Soltec:

1. **Lay out criteria**
    - Optimal height
    - Different Ground color and texture
    - Pitch
    - Configuration
2. **Energy Yield** = f(G, h, Pitch, Soil color)
3. **Tracking algorithm optimization for bifacial**

- Measure albedo in different soils
- Measure different GCR
- Measure different heights
- Measure in real conditions
- Shadow interference losses
- Module temperature impact
- TeamTrack Backtracking

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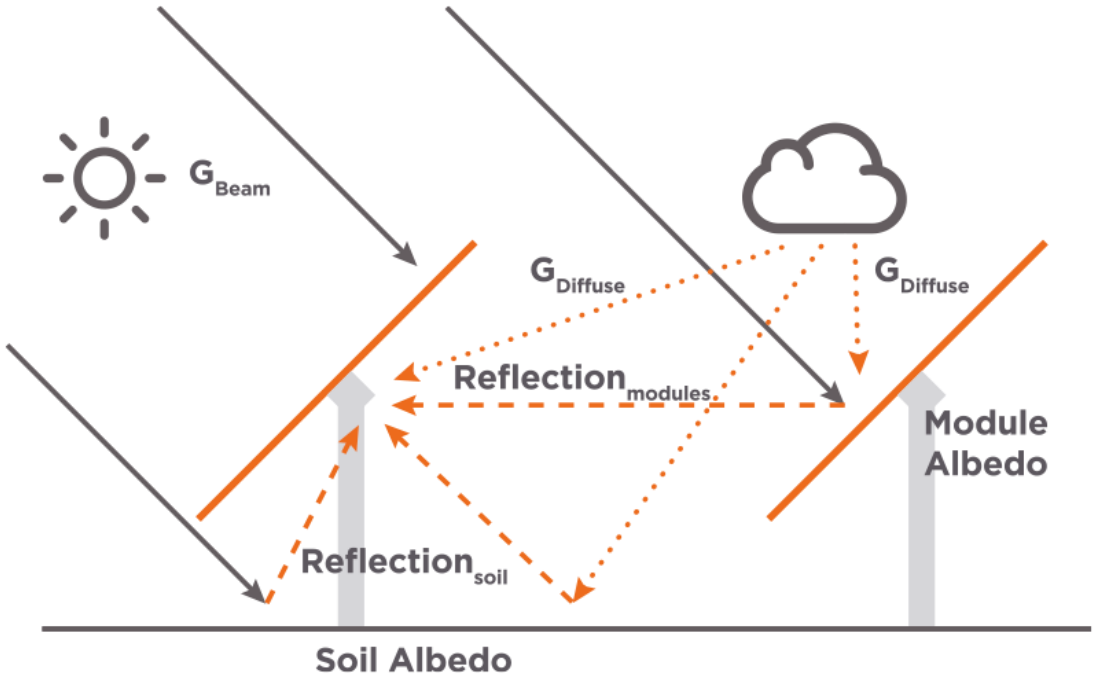
Bifacial Gain

$$E_{bifacial} \Rightarrow E_{monofacial} \times (1 + \underbrace{Bifacial\ Ratio \times bifaciality}_{\text{Bifacial Gain}})$$



Bifacial ratio:

Ratio of the irradiation that reaches the rear side of a module (Grear) to the irradiation that reaches the front-side (Gfront).

Module Bifaciality:

Ratio of the energy conversion efficiencies of the rear and front sides of a module.

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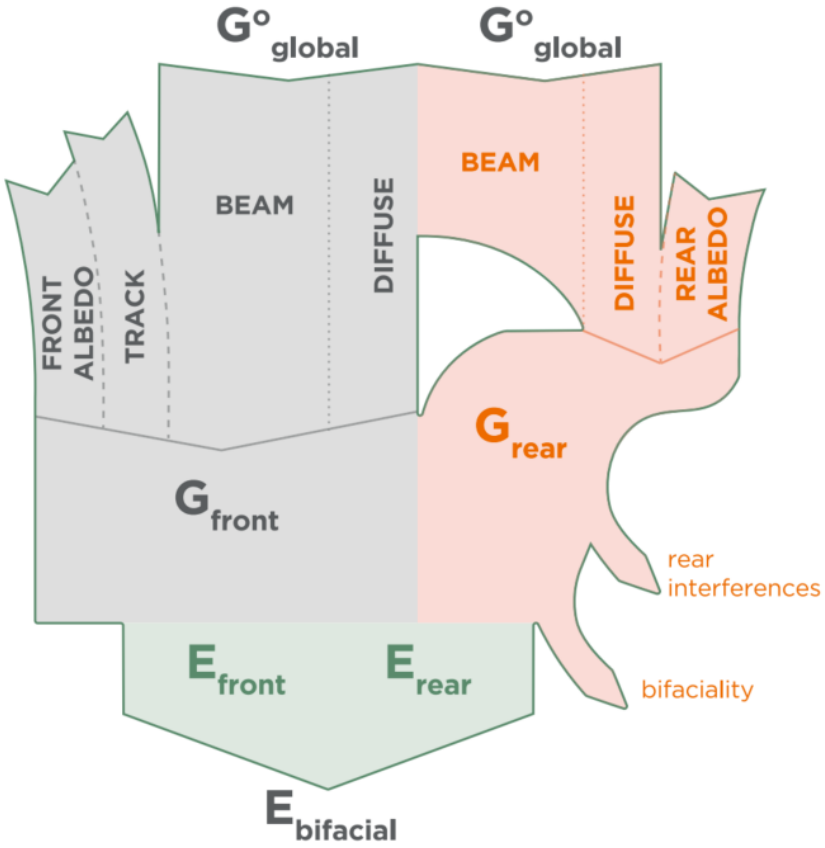
Bifacial Gain

Optimizing power generated by the rear side: bifacial trackers

↑ **Bifacial Gain**

- ↑ Bifaciality — PV module feature
  - ↑ G_{rear}
    - ↑ $G_{diffuse}$
    - ↑ $G_{reflected}$
  - ↑ Albedo — Soil feature
  - ↑ Pitch — Layout feature
  - ↑ Height
  - ↓ Rear shadow

Racking feature



Measured BiTEC Results		Bifacial Gain Estimation	
Albedo (%)	**Bifacial Ratio (%)**	**Module Bifaciality (p.u.)**	**Bifacial Gain**
Seasonal 18,9%	8,8%	0,75	6,6%
		0,80	7,0%
		0,85	7,4%
White 58,1%	20,3%	0,75	15,3%
		0,80	16,2%
		0,85	17,3%

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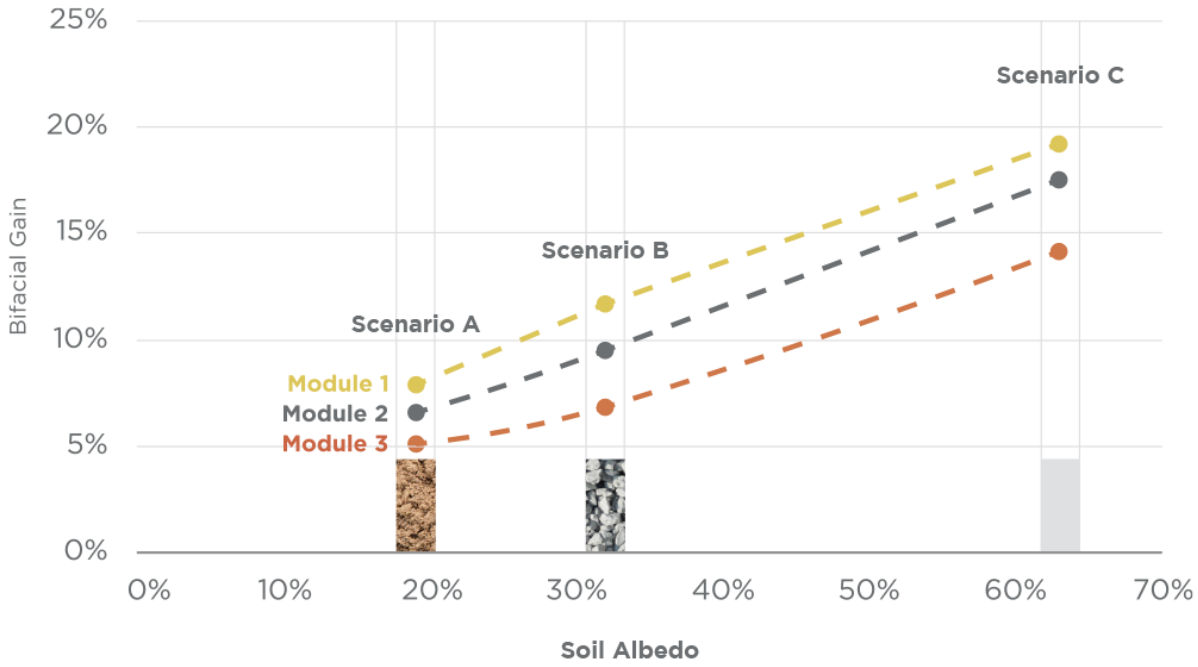
Bifacial Parameters
Albedo

The albedo varies with the **color and characteristics of the surfaces** that reflect light on to the rear of a module.

Light colored, smooth surfaces have high albedos which can lead to high energy output from the rear of a module.



Type of ground	Albedo				Bifacial Gain			
	Fall	Winter	Spring	9 months	Fall	Winter	Spring	9 months
Scenario A: White	62,8%	55,50%	53,2%	58,2%	19,2%	14,3%	13,1%	**16,2%**
Scenario B: Gravel	32,0%	25,50%	27,2%	29,0%	11,9%	9,3%	7,8%	**10,1%**
Scenario C: Seasonal	19,2%	17,20%	19,6%	18,9%	7,9%	6,5%	6,1%	**7,0%**

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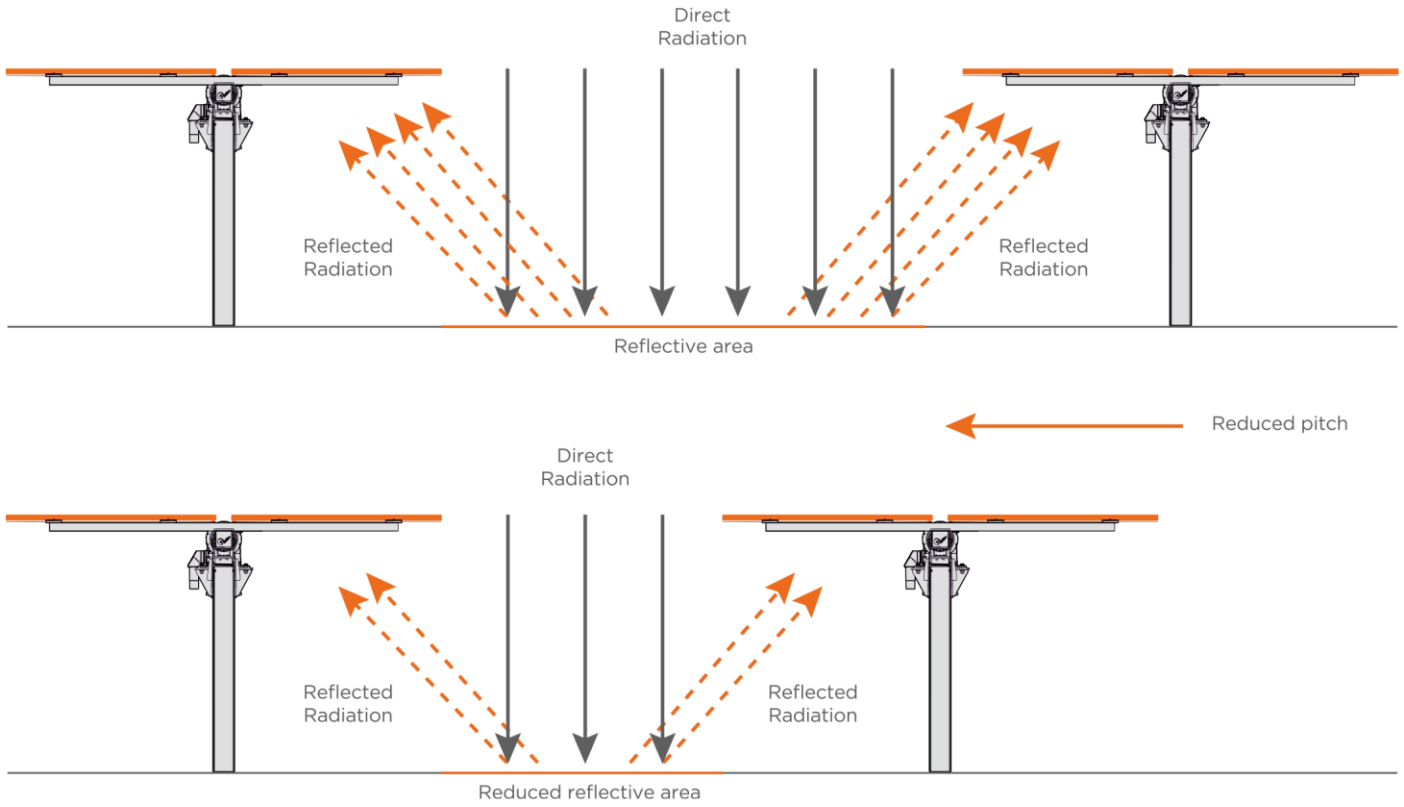
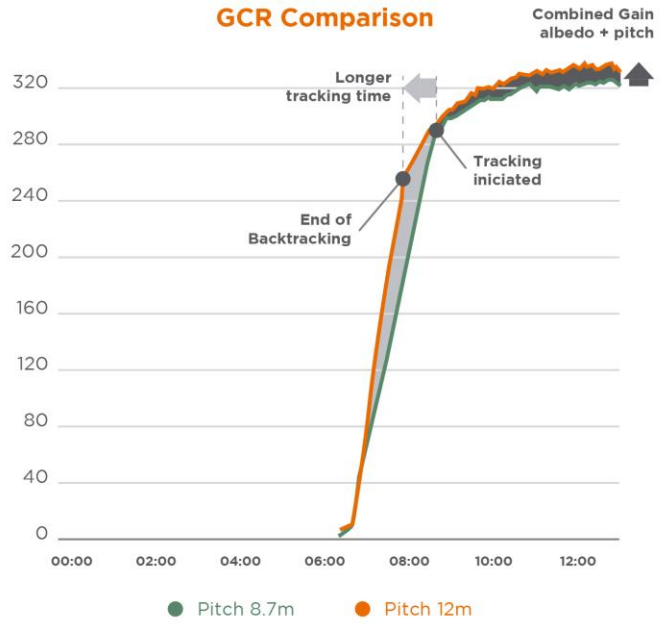
Bifacial Parameters

Pitch

Pitch	8.7 meters	10 meters	12 meters
Bifacial Gain	9.49%	12.11%	14.58%
Δ	- 2.62%	Baseline	2.47%





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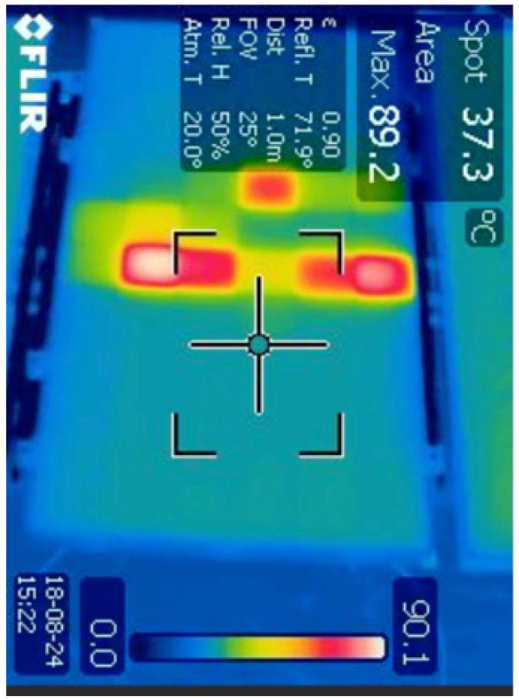
Bifacial Parameters

Shading

1P PVSyst simulation

Structure Shading Factor = 5.6%



Front Side IR Image

Module on short circuit.
Albedo 63%

Torque-tube shading in 1P bifacial module configuration

Rear Side

Torque-tube shading in 1P bifacial module configuration

Racking Shades Interference

4 inch clearance from module to Torque-Tube

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Bifacial Parameters
Shading

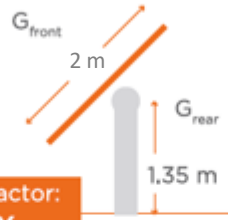
Racking shading could reach
↓20% rear irradiation loss

SF7 Bifacial PVSyst simulation
Structure Shading Factor = 0%

Simplified Modeling
PV syst / SAM / bifacial radiance

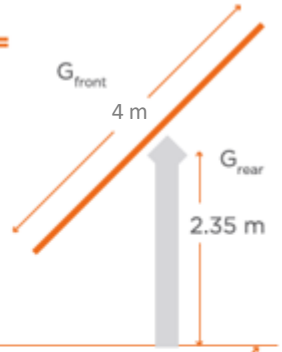
No shading

Module 1 = continuous plane
No torque tube



Shading factor: **-5.6%**

Module 1 + Module 2= continuous plane
No torque tube

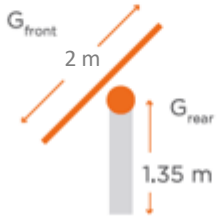


Shading factor: **0%**

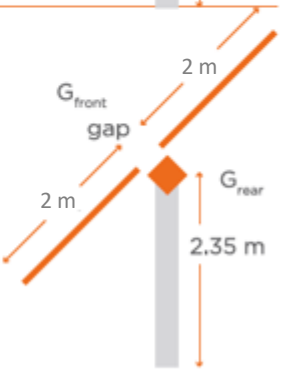
Comprehensive Modeling
bifacial radiance

Real module location torque tube shading

Module 1 = continuous plane
With torque tube



Module 1 + Gap + Module 2
With torque tube



Example of central row. Simulations count with my rows.

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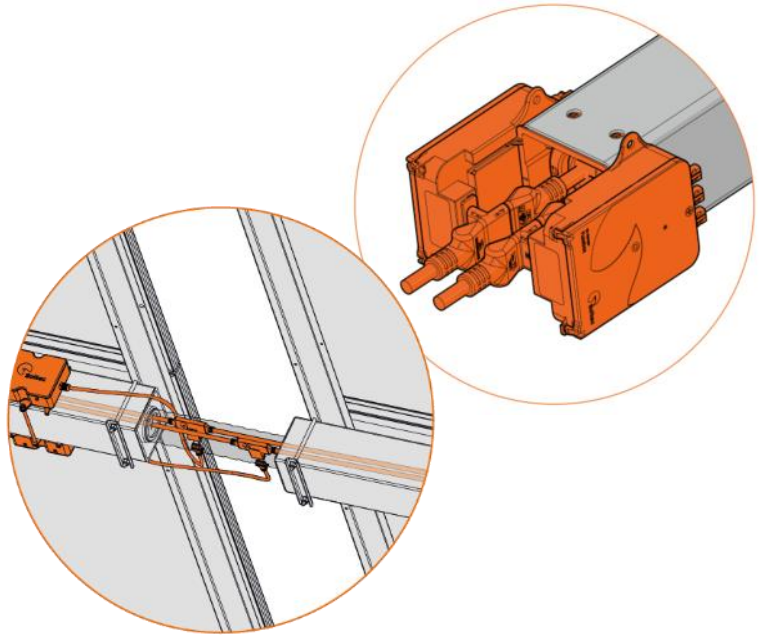
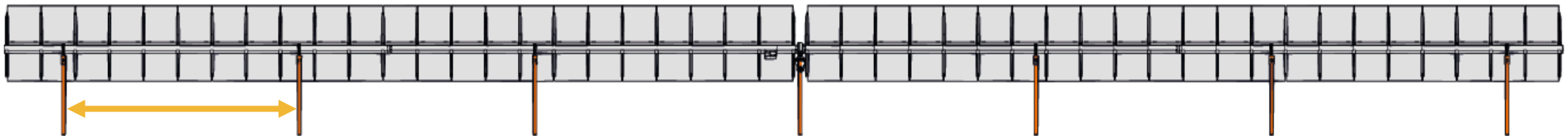
Bifacial Parameters
Shading

SF7 Bifacial PVSyst simulation
Structure Shading Factor = 0%

Minimizing the number of objects shading:

- ✓ No rear shading from torque tube→ **5% less interferences**
- ✓ **F**ewer piles/MW
- ✓ No hanging wires → **81%** less wiring → StringRunner
- ✓ No dampers





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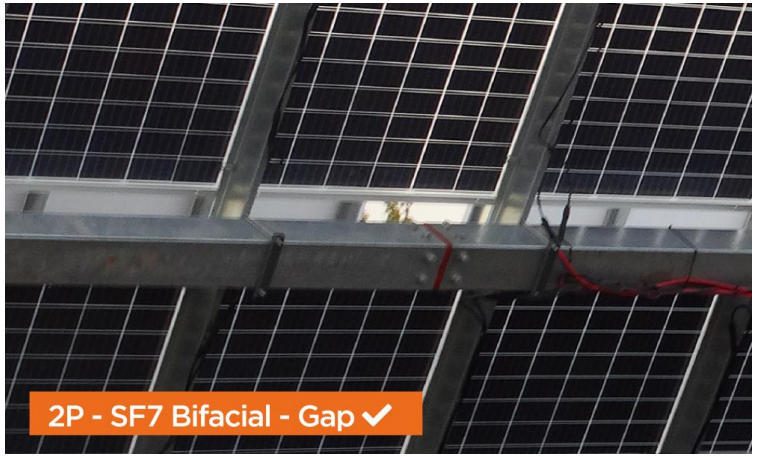
BITEC: Comparing the Energy Output of Bifacial Modules

1P Solar Trackers Vs. 2P Solar Trackers



Tracker	Height	Albedo	GCR 0.4 Pitch	Bifacial Gain			
				Fall	Winter	Spring	Overall
2P (SF7 Bifacial)	2,35 m	58,2%	10 m	19,2%	14,3%	13,4%	16,3%
1P	1,35 m	58,2%	5 m	16,8%	12,6%	11,4%	14,1%
				Δ **2,4%**	**1,7%**	**2,0%**	**2,1%**

Parameters	Calculated Bifacial Gain
Lower average module temperature (better cooling)	+1,3%
No torque tube shading	+0,7
Higher module height and other design details	+0,1
Total	**2,1%**

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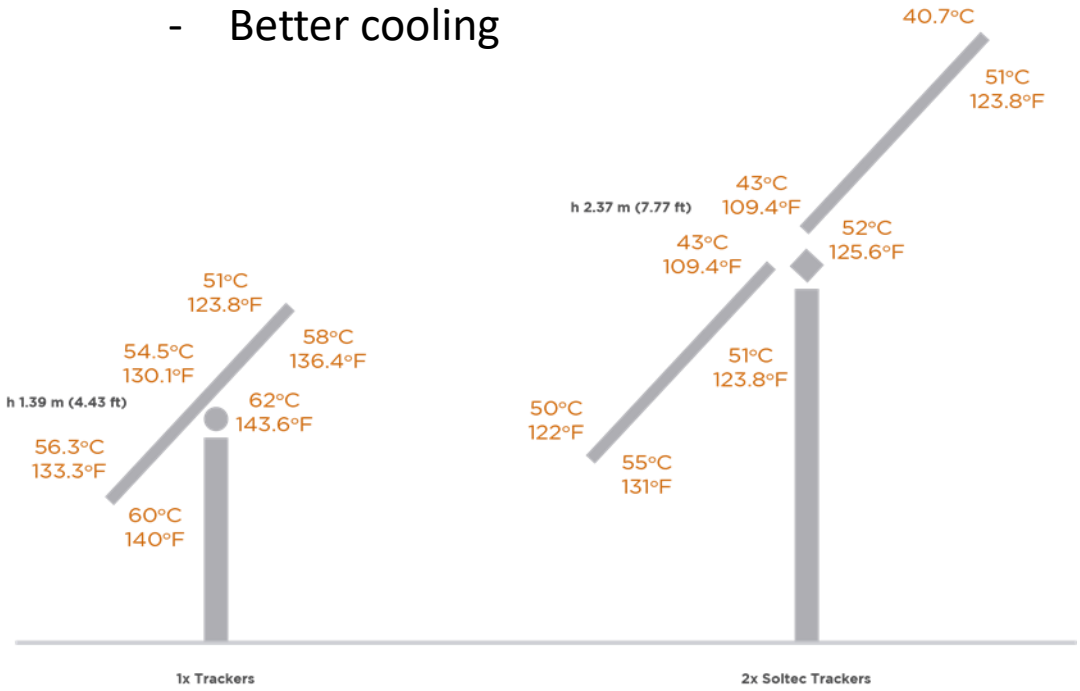
Bifacial Parameters
Module Temperature

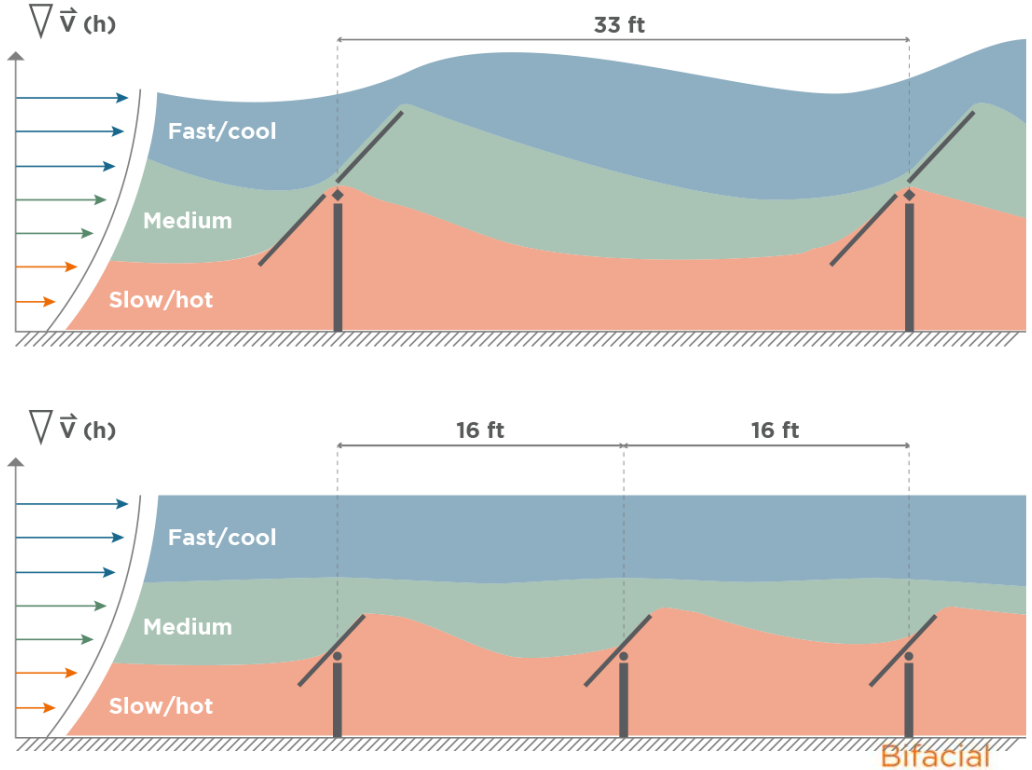
2P SF7 Bifacial +1.2% more power than the module on the 1P tracker because:

- The tracker is higher
- Better cooling



SOLTEC White Papers, link online:
[Bifacial Trackers, The Real deal]
[How to simulate Bifacial Projects]

2P SF7 Vs. 1P Tracker cooling



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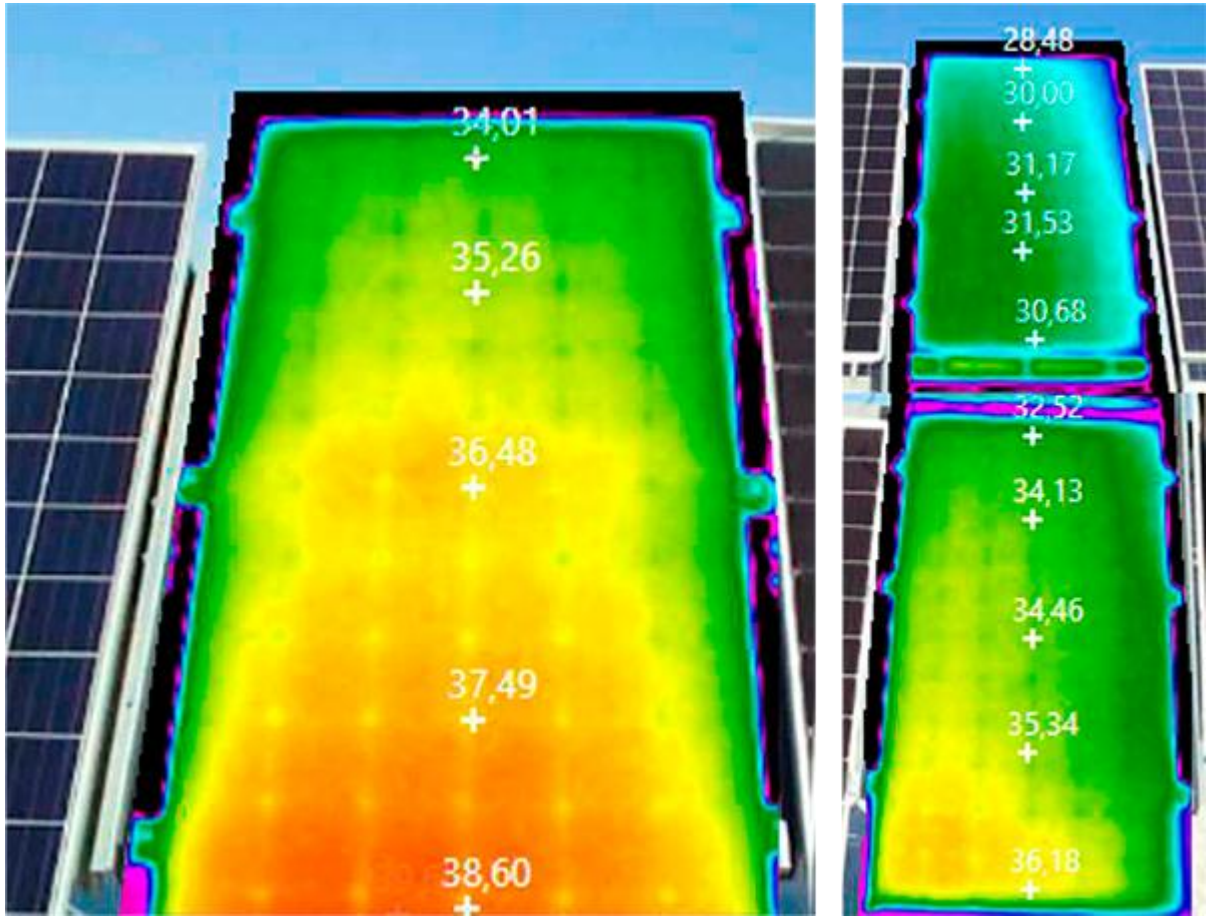
Bifacial Parameters

Module Temperature

Field data from BiTEC shows that **2P module temperatures tend to be lower** than those of 1P trackers, as seen in Figure 10. SF7 Bifacial tracker design allows for airflow through the tracker and considers the installation of modules higher above the ground, hence favoring overall cooling. Lower performance temperatures lead to increased power generation.



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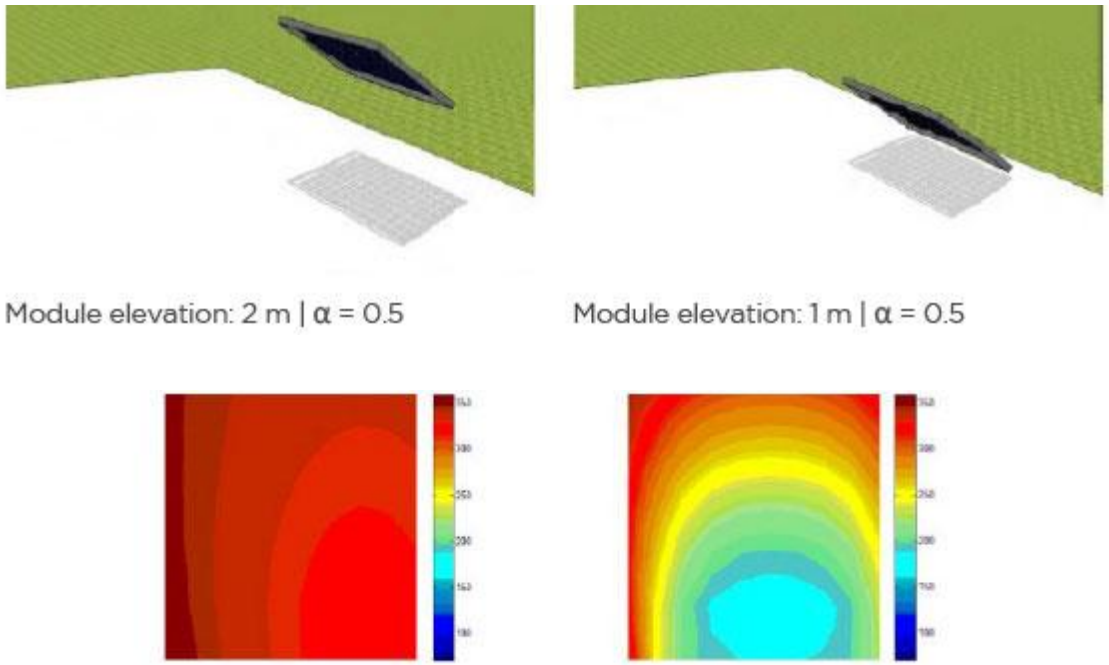
Bifacial Parameters
Module Height

Mismatch loss standard 1P = 10% W/m²
Mismatch loss SF7 Bifacial = 3.1 % W/m²

Module height affects the irradiance on the rear of a module:

- The modules higher off the ground see **more diffuse radiation** than those closer to the ground.
- The modules higher off the ground receive **more radiation reflected**.
- Higher modules tend to operate at **lower temperature**.



Irradiance at the module rear side [W/m²] on an examplary summer day in Cairo

Bifacial Tracking, The Real Deal.

Parameters adjustments in PVsyst® for the SF7 Bifacial tracker

Parameters	Standard 1P trackers	SF7 Bifacial
Angle	–	-60º +60º
Height	1.35 meters	2.35 meters
Structure Shading Factor	5.6%	0%
Shed Transparent Fraction	MT%	(MT* + 3.75) x 1’017 (%)
Thermal Loss factor Thermal factor (Uc)	29 W/m2 k	31 W/m2 k
Thermal Loss Factor (Uv)	0 W/m2 k/m/s	1.6 W/m2 k/m/s
Mismatch Loss Factor	10 %	3.1 %

*MT: Module Transparency from module manufacturer

Bifacial Tracking, The Real Deal.

BiTEC results – 9 months tests

Albedo	Pitch	Height (m)	Tracker model	Shade	Bifacial Gain
18,9%	10 m	2,35 m	2V (SF7 bifacial)	0%	**7,0%**
29,0%	10 m	2,35 m	2V (SF7 bifacial)	0%	**10,1%**
58,2%	10 m	2,35 m	2V (SF7 bifacial)	0%	**16,2%**
58,2%	5 m	1,35 m	1 V	5,3%	**14,1%**

- **7-16%** Bifacial Gain for variable albedo soils
- **+2,1%** Bifacial Gain increment with SF7 Bifacial tracker
- **PVsyst** parameters

SOLTEC White Papers, link online:
Bifacial Trackers, The Real deal
How to simulate Bifacial Projects

Bifacial Tracking, The Real Deal

Conclusions

- Bifacial Gain for 2P SF7 Bifacial tracker is **2.1% higher** than a solar tracker with 1P configuration.
- This difference is mainly caused by the **lack of shading in the rear side** of the module, by the **higher position of the solar panels**, and by a **lower operating temperature**.
- Field data from BiTEC obtained between September 2018 and June 2019 show a Bifacial Gain of **16.3%** for individual bifacial tracker modules with an albedo of about 58.1%.
- Under seasonal albedo conditions, in which ground albedo changes throughout the year, Bifacial Gain was **7%.**
- The specific performance and advantages of bifacial modules can be simulated using available software, such as PVsyst®, provided bifacial parameters are properly entered. To do that, it is necessary to adjust the values for **Structure Shading factor, Shed Transparent fraction, Field Thermal Loss factors and Mismatch Loss factor.**

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Thank you

Ph.D Javier Guerrero
R&D Engineer-PV
javier.guerrero@soltec.com

Colin Caufield
VP of Sales Soltec USA
colin.caufield@soltec.com

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