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Designing Bifacial PV projects in Australia

The results of the tests on the Bifacial Tracker Evaluation Center to measure what is the impact on bifacial production of factors such as module mounting height above grade, rear-side obstructions that cause shading, and inter-row spacing distance.

Soltec Company Overview

Soltec specializes in the **manufacture** and **supply of single-axis solar trackers** with global operations and workforce of **over 750 people** blending **experience** with **innovation.**

15 years
Company history

6+ GW
Production Capacity

6.4+ GW
Track-record

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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**

Variables:

- 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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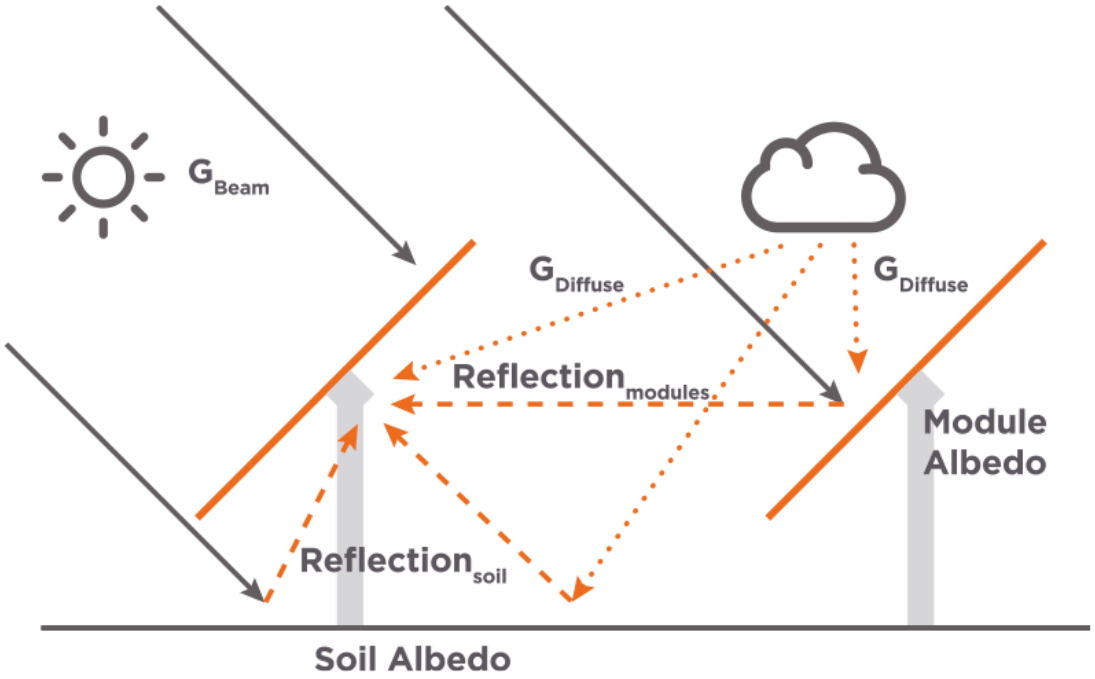
Bifacial Gain

Bifacial Gain

$$E_{bifacial} = E_{monofacial} \times (1 + Bifacial\ Ratio \times bifaciality)$$



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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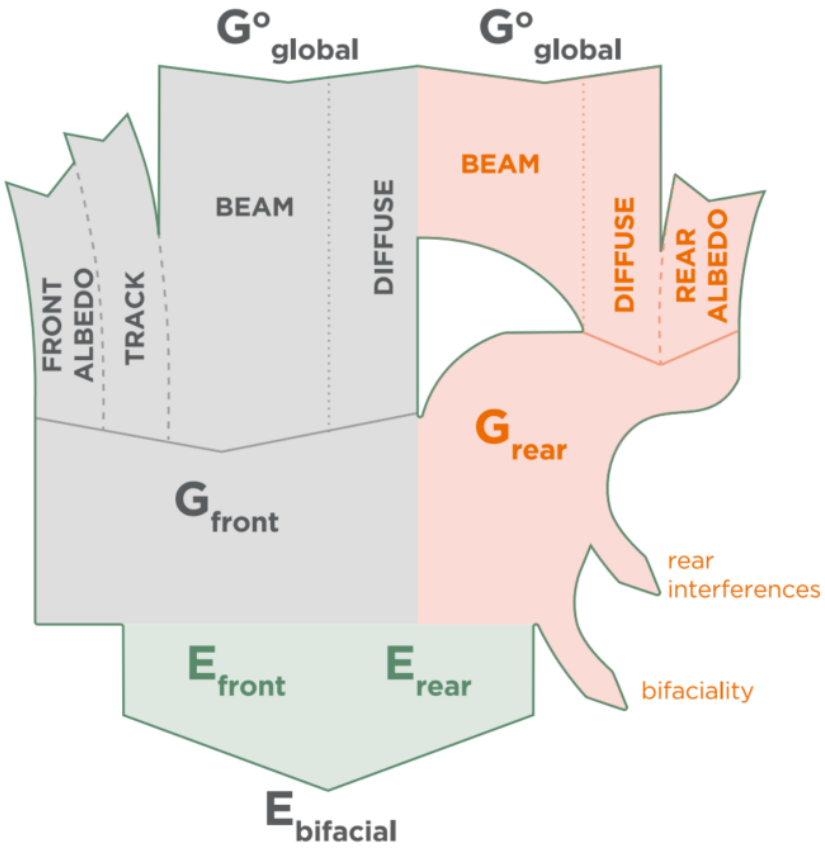
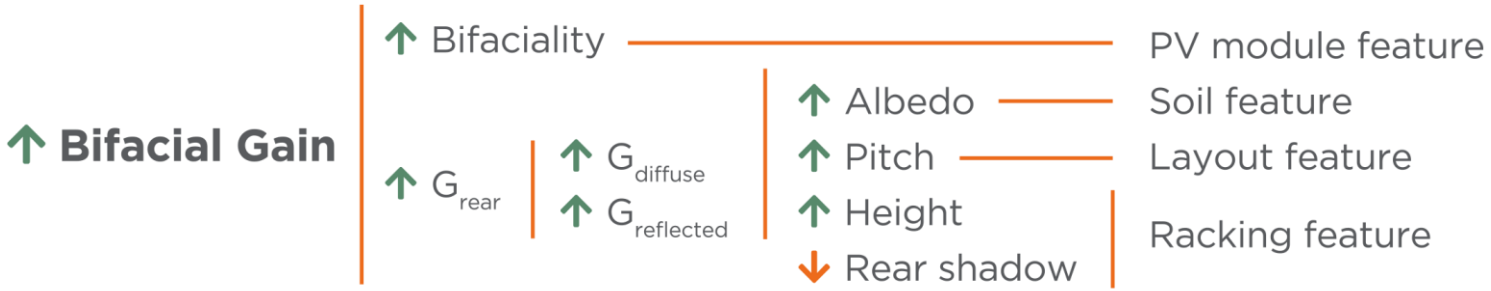
Bifacial Gain



Optimizing power generated by the rear side: bifacial trackers



Albedo	Ratio bifacial	Module bifaciality	Bifacial Gan (%)
19%	10%	0.75	7.5
		0.80	8
		0.85	8.5
63%	24%	0.75	18.0
		0.80	19.4
		0.85	20.4

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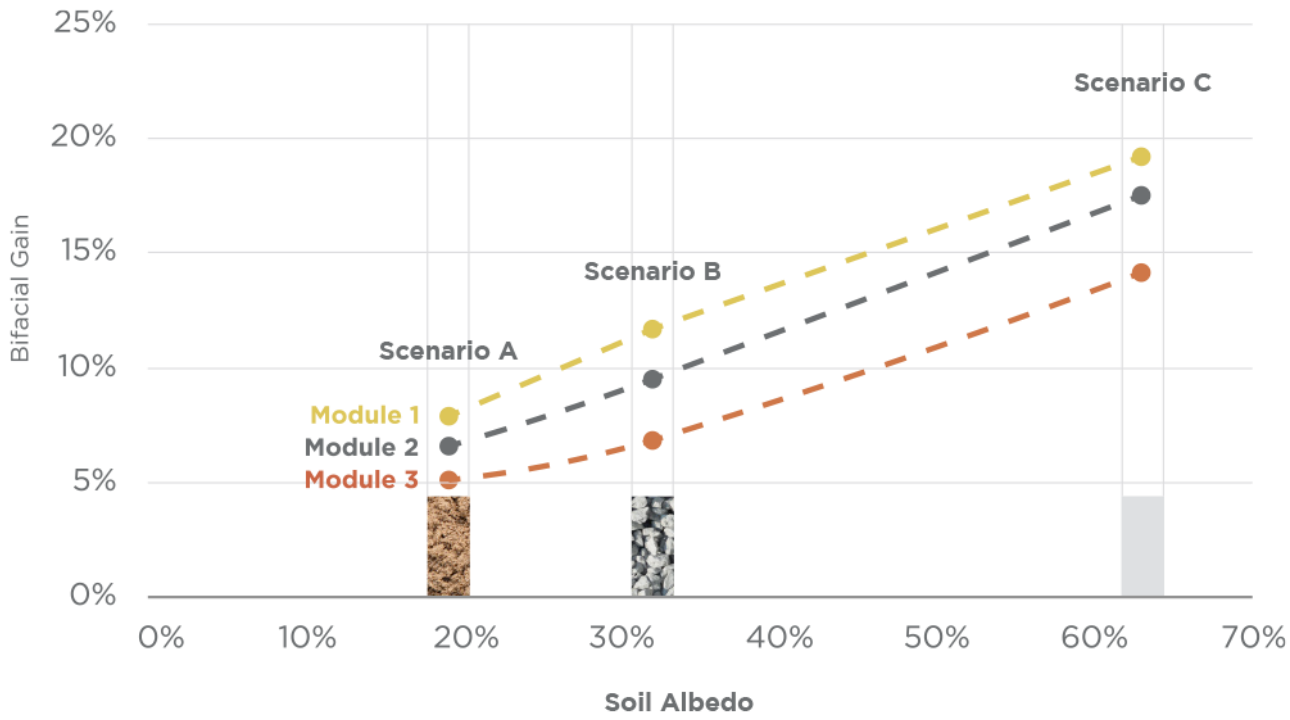
Bifacial parameters

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.



Types of ground	Albedo (%)	Estimated Bifacial Gain (%)
Scenario A: Seasonal	19	7.9
Scenario B: Gravel	32	11.9
Scenario C: White	63	19.2
Interpolation	38	13.3

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Bifacial Parameters: Shading

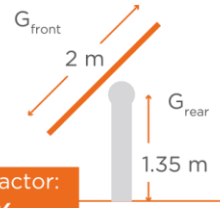
Racking shading could reach ↓20% rear irradiation loss

SF7 Bifacial PVSyst simulation
Structure Shading Factor = 0.7%

7a. Simplified Modeling
PV syst / SAM / bifacial radiance

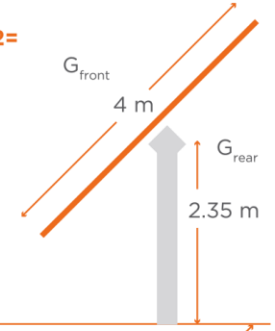
No shading

Module 1 = continuous plane
No torque tube



Shading factor: **4.5%**

Module 1 + Module 2= continuous plane
No torque tube

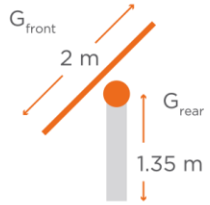


Shading factor: **0.7%**

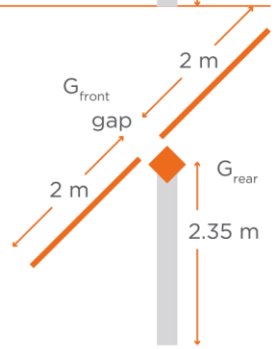
7b. Comprehensive Modeling
bifacial radiance

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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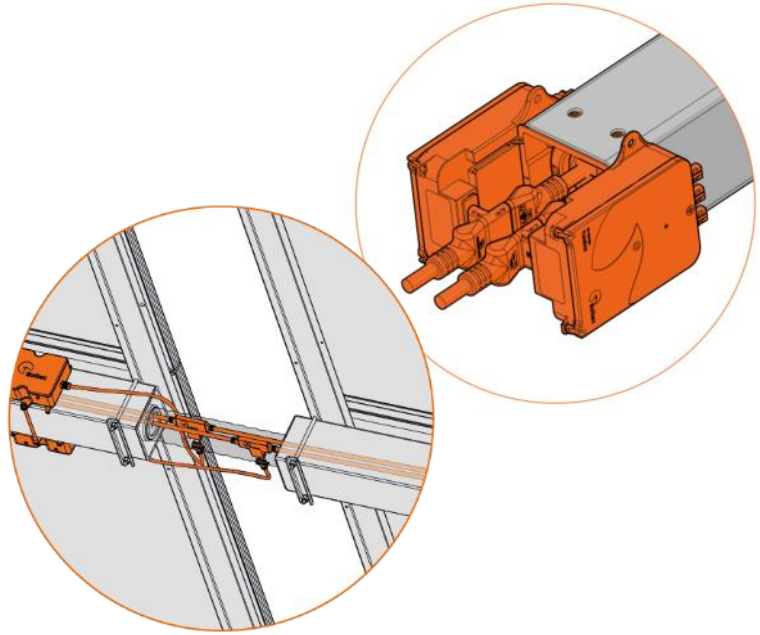
Bifacial parameters

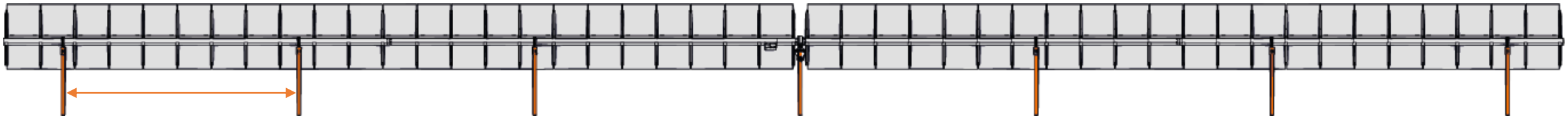
Shading

SF7 Bifacial PVSyst simulation
Structure Shading Factor = 0.7%

Minimizing the number of objects shading:

- ✓ No rear shading from torque tube→ **5% less interferences**
- ✓ 7 piles/90 modules → **46%** fewer piles/MW
- ✓ No hanging wires → **81%** less wiring → StringRunner
- ✓ No dampers





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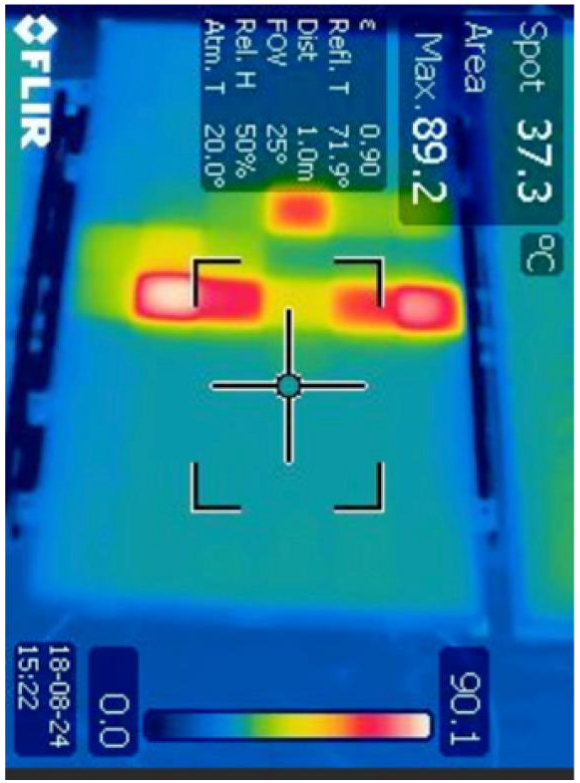
Bifacial parameters

Shading



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

1P PVSyst simulation

Structure Shading Factor = 4.5%

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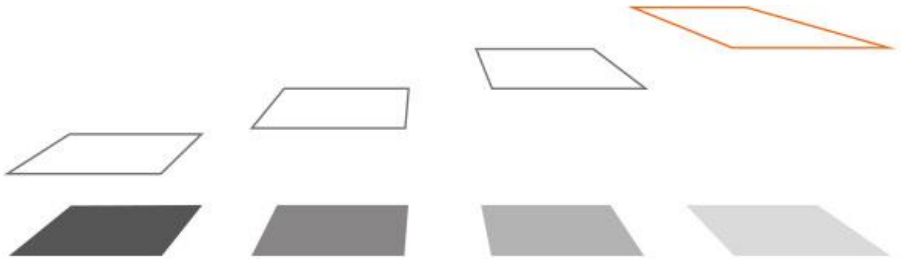
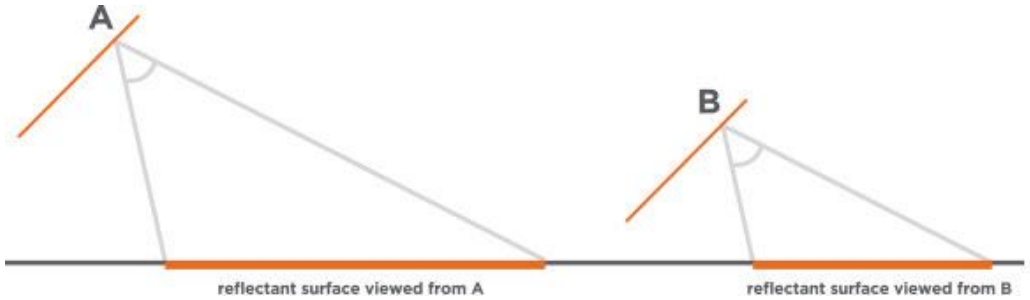
Bifacial Parameters: Module Height

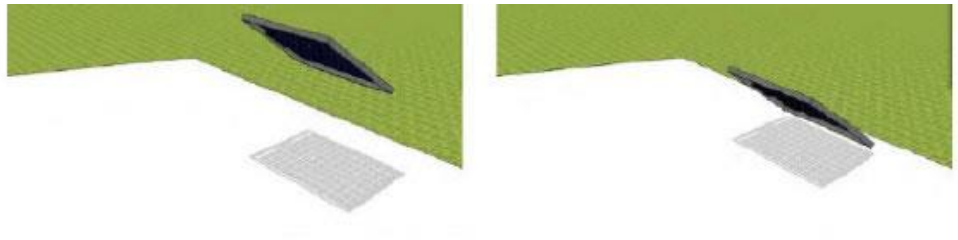
SF7 Bifacial PVsyst simulation
Mismatch loss factor= 6%

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**.

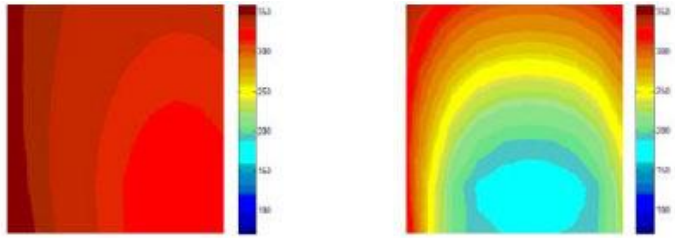






Module elevation: 2 m | α = 0.5

Module elevation: 1 m | α = 0.5



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

Mismatch loss standard = 10 % W/m²

Mismatch loss SF7 bifacial = 6 % W/m²

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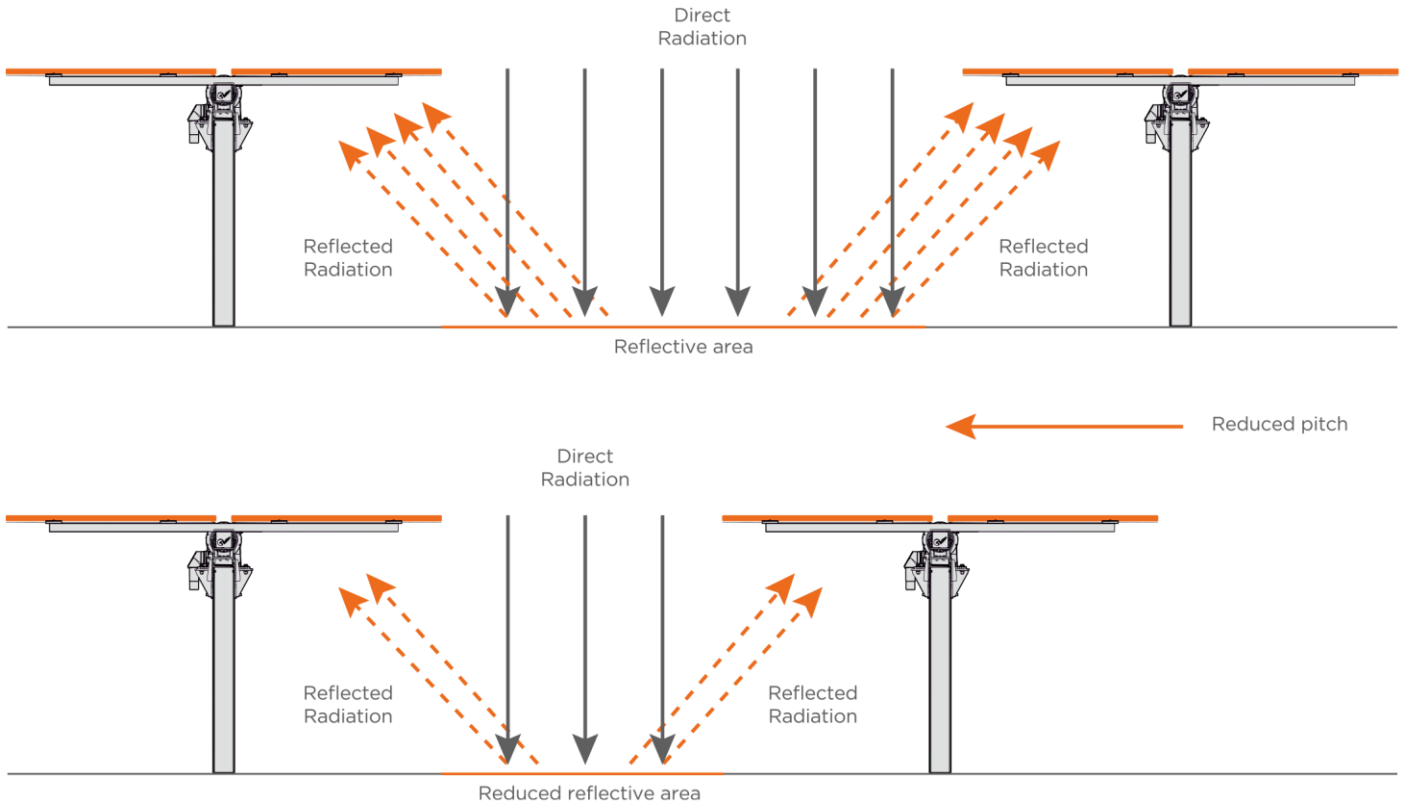
Bifacial Parameters

Distance Between Trackers or Pitch (GCR)

Albedo	Pitch	Δ Production
63%	12 metros	+2.47%
	10 metros	Basecase
	8.7 metros	-8.55%

Module level measurements performed by Soltec indicated that for an albedo of 63% and a pitch of 8.7 meters, the bifacial module energy output was 8.55% lower than for modules on trackers with a 10-meter pitch. When the pitch increased to 12-meters the module energy output increased by 2.47%.



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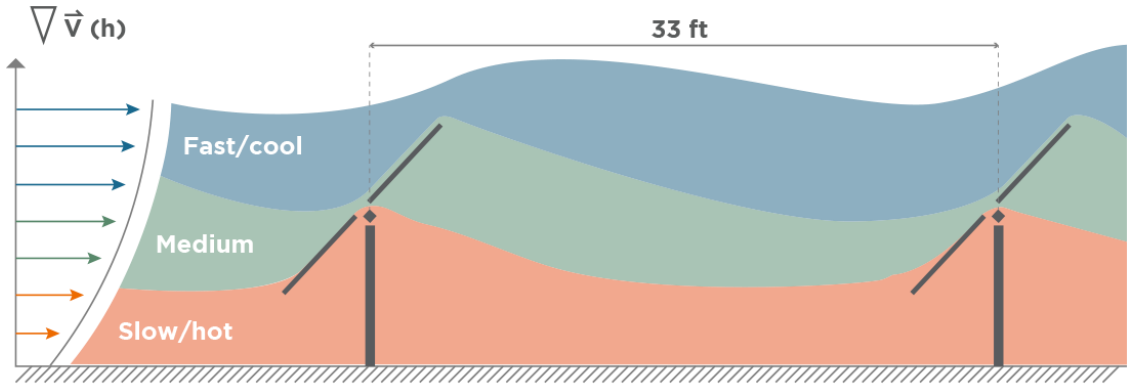
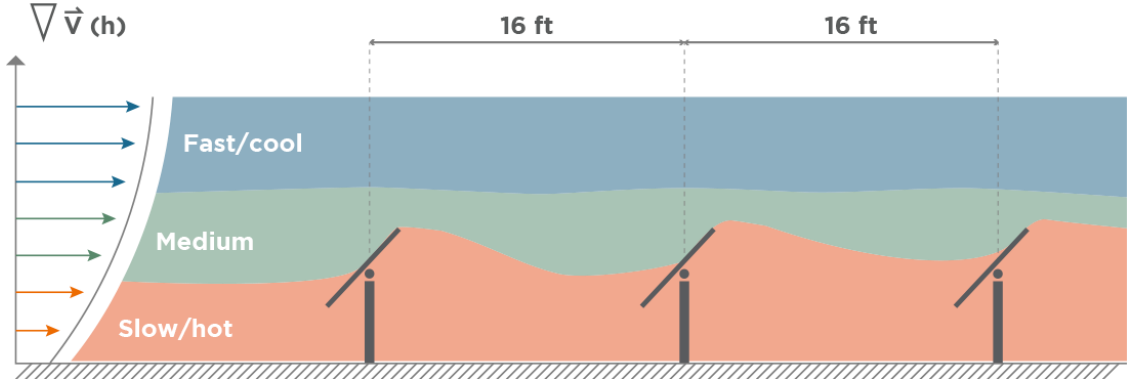
Bifacial Parameters:
Module Temperature

SF7 Bifacial PVsyst simulation
Thermal factor Uc = 37.7 W/m²K

2P Vs. 1P tracker cooling



Thermal factor SF7 bifacial Uc = 37.7 W/m²K



Thermal factor standard Uc = 29.0 W/m²K

Module operating temperatures 2P SF7 bifacial tracker should produce **1.3% more power** than the module on the 1P tracker because:

- The tracker is higher
- Better cooling

		1P Tracker	2P SF7 Bifacial			1P Vs. 2P	
Date (2018)	**Time**	**Single Module T(ºC)**	**Module down T (ºC)**	**Module up T (ºC)**	**2P T**	**ΔT (ºC)**	**ΔP %**
oct 18	11:01	33.0	30.8	22.0	26.4	6.6	2.4
oct 22	15:23	36.3	34.6	30.3	32.5	3.8	1.4
oct 23	10:23	27.3	29.4	24.4	26.9	0.4	0.1
oct 24	10:53	33.0	30.5	23.7	27.1	5.9	2.2
oct 25	15:23	40.2	41.3	37.4	39.4	0.9	0.3
Average		**33.96**	**33.32**	**27.56**	**30.44**	**3.5**	**1.3**

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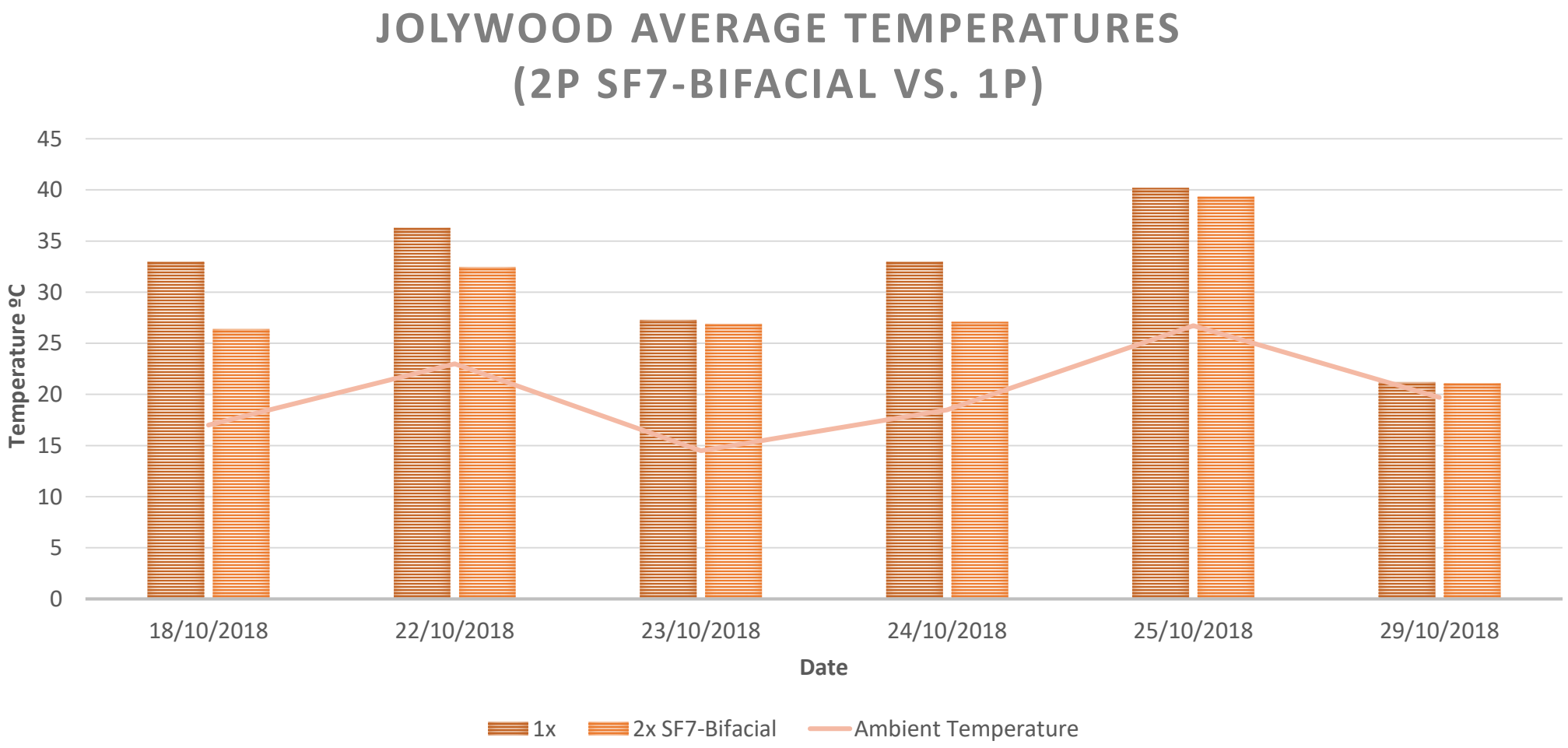
Bifacial Parameters:

Module Temperature

SF7 Bifacial PVsyst simulation
Thermal factor Uc = 37.7 W/m²K



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BITEC: Comparing the Energy Output of Bifacial Modules

1P Solar Trackers Vs. 2P Solar Trackers

Configuration	Module Height	Albedo	GCR	Bifacial Gain
1P	1.35 meters	63%	40% (5 m pitch)	16.8%
2P (SF7 Bifacial)	2.35 meters	63%	40% (10 m pitch)	19.2%

Bifacial Gain of the modules placed in the SF7 bifacial in 2P configuration was **2.4% higher** than that of the module in the 1P tracker configuration.

Parameters	Calculated Bifacial Gain
Lower average module temperature (better cooling)	+1.3%
No torque tube shading	+0.7%
Higher module height and pitch, and other design details.	+0.4%
Total	**+2.4%**

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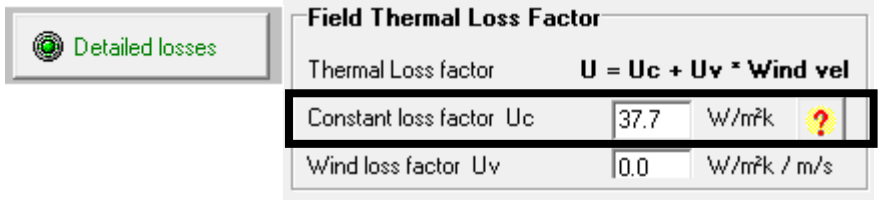
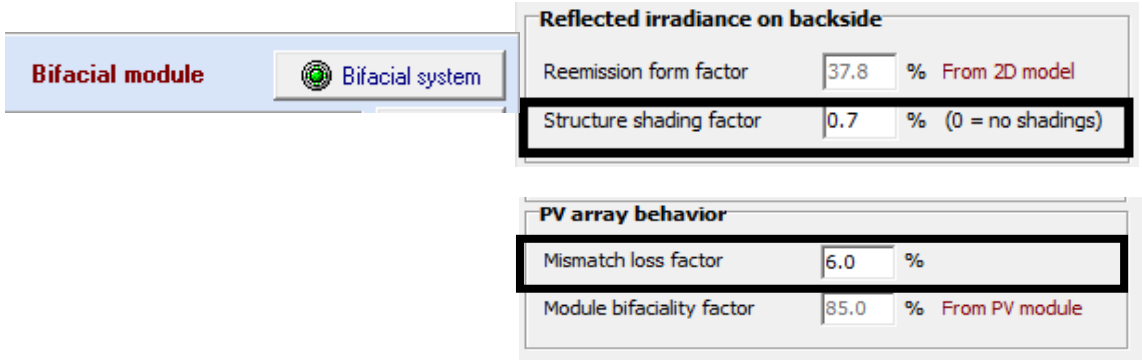
BITEC: energy production simulation

PVSyst simulation: trackers 2P SF7 Bifacial

Parameter	Standard	SF7
Angle	-	-60º +60º
Height	1.35 meters	2.35 meters
Shading loss factor	4.5%	0.7%
Shed transparent fraction	0.00%	3.75%
Thermal factor (Uc)	29.0 W/m²k	37.7 W/m²k
Mismatch loss factor	10%	6%





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Javier Vidal
Regional General Manager Australia
javier.vidal@soltec.com

Thank you