STI norland
Oriented to you

Optimize your bifacial PV tracker project to deliver extra energy gains

Webinar

July 8, 2020

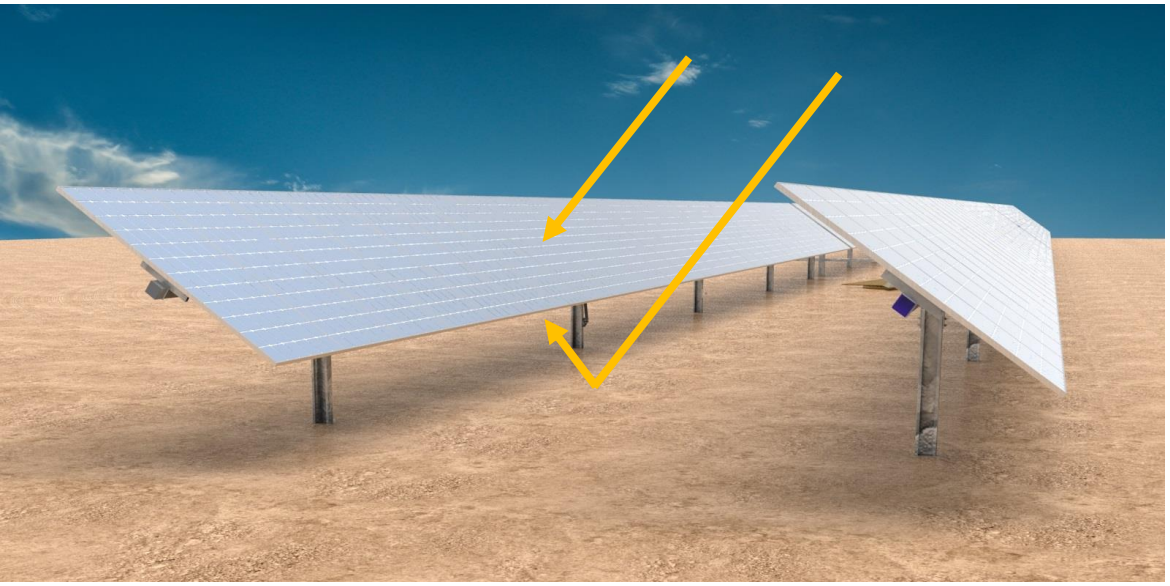
Speaker
Javier Tamayo
Civil Engineer

STI Norland's experience

>1 GW bifacial track-record

Project	Location	Country	Power	Product	Year
Sol do Sertão	Bahia	BR	475 MWp	STI-H250™	2020
Pereira Barreto	São Paulo	BR	252 MWp	STI-H250™	2020
Antofagasta	Antofagasta	CL	163 MWp	STI-H250™	2020
Jaíba	Minas Gerais	BR	156 MWp	STI-H250™	2020
Salgueiro	Pernambuco	BR	115 MWp	STI-H250™	2019
Saint-Pargoire	Occitanie	FR	11 MWp	STI-F5™	2019
Nova Xavantina	Mato Grosso	BR	6 MWp	STI-H250™	2020
Ribeiro	Pernambuco	BR	6 MWp	STI-H250™	2019
Aramon	Occitanie	FR	5 MWp	STI-F5™	2019

Bifaciality in solar energy



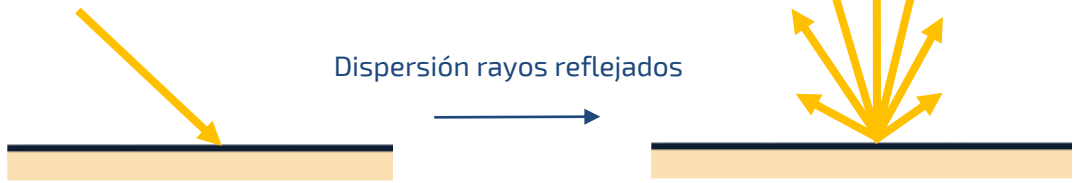
Main bifacial parameters

Depends on

- Irradiance → Location
- Albedo → Soil
- **View Factor (MM + SF)** → **Solar tracker**

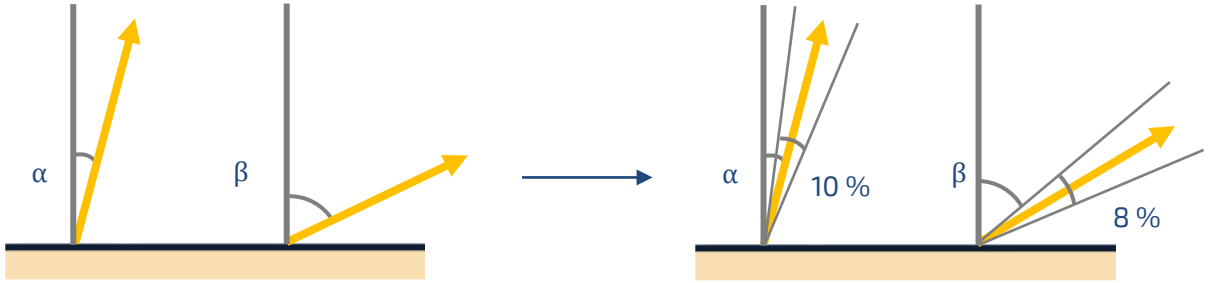
$$\frac{\text{Solar generation with bifacial module}}{\text{Solar generation with monofacial module}} = \textbf{Bifacial Gain (BG \%)}$$

1 View factor definition

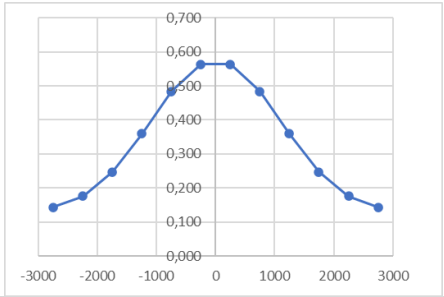


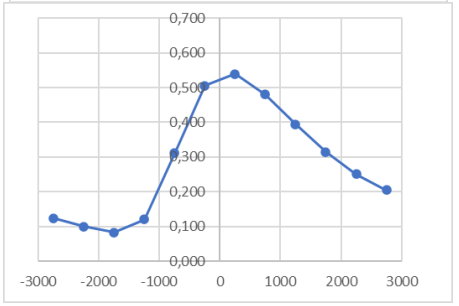
Irradiance-emitting surface

Lambert's cosine law

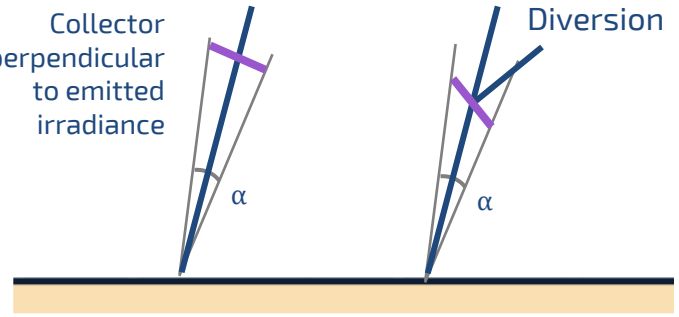


Theorical View Factor

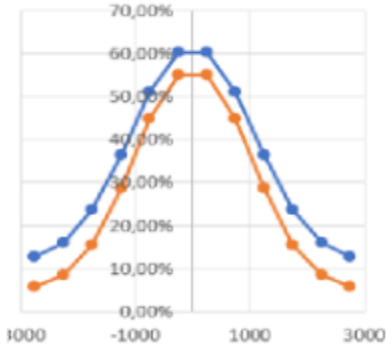




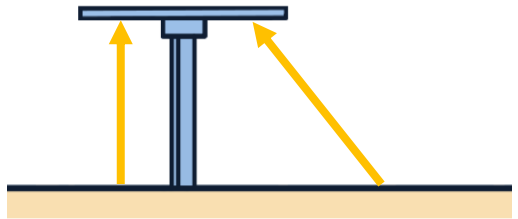
2 Collector capture angle



Adjusted View Factor



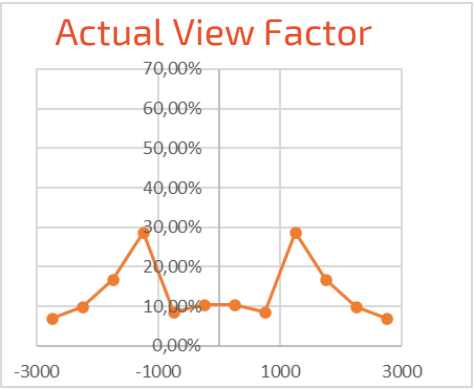
3



Ground point in the shaded area

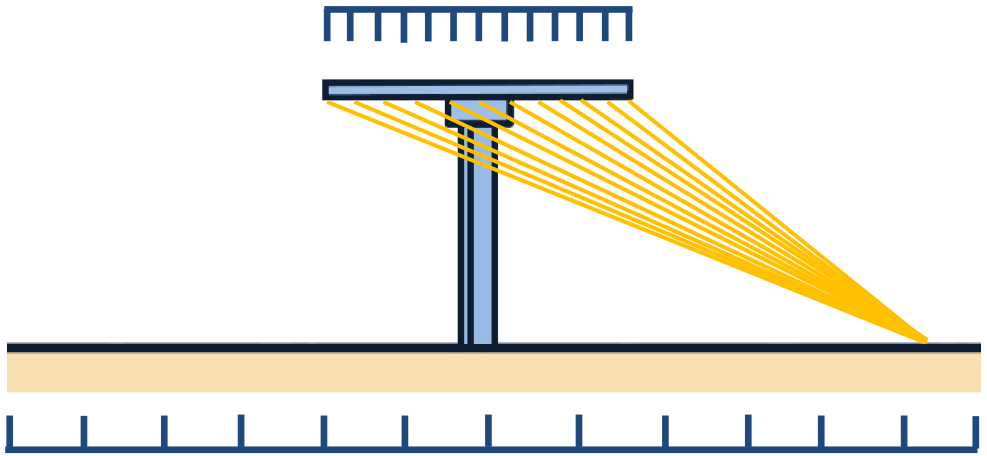
Ground point in the sunligthed area

Actual View Factor



View factor

Collector surface divided in 12 equal parts



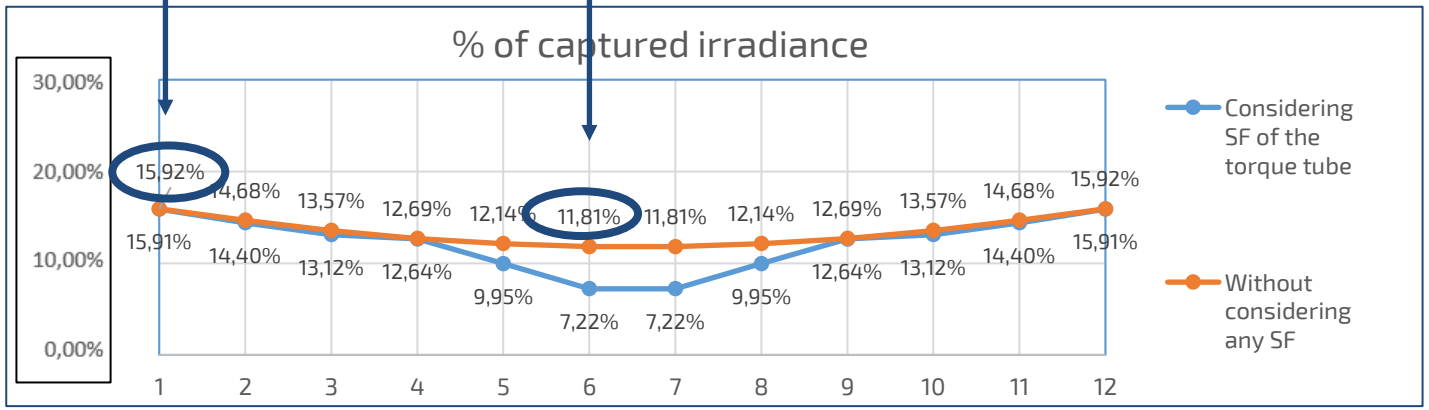
Pitch divided in 12 equal parts

12 collectors

% of reflected irradiance that each PV cell captures

0,89%	0,72%	0,58%	0,47%	0,39%	0,32%	0,15%	0,00%	0,09%	0,16%	0,13%	0,11%
1,73%	1,39%	1,11%	0,89%	0,72%	0,58%	0,19%	0,00%	0,28%	0,27%	0,22%	0,19%
3,24%	2,67%	2,16%	1,73%	1,39%	1,11%	0,22%	0,20%	0,58%	0,47%	0,39%	0,32%
5,04%	4,50%	3,88%	3,24%	2,67%	2,16%	0,20%	0,94%	1,11%	0,89%	0,72%	0,58%
1,08%	1,11%	1,08%	1,01%	0,90%	0,68%	0,02%	0,53%	0,43%	0,35%	0,28%	0,22%
0,78%	0,90%	1,01%	1,08%	1,11%	0,70%	0,37%	0,90%	0,78%	0,65%	0,53%	0,43%
0,43%	0,53%	0,65%	0,78%	0,90%	0,39%	0,73%	1,11%	1,08%	1,01%	0,90%	0,78%
0,22%	0,28%	0,35%	0,43%	0,53%	0,03%	0,71%	0,90%	1,01%	1,08%	1,11%	1,08%
0,58%	0,72%	0,89%	1,11%	0,94%	0,20%	2,16%	2,67%	3,24%	3,88%	4,50%	5,04%
0,32%	0,39%	0,47%	0,58%	0,20%	0,26%	1,11%	1,39%	1,73%	2,16%	2,67%	3,24%
0,19%	0,22%	0,27%	0,28%	0,00%	0,22%	0,58%	0,72%	0,89%	1,11%	1,39%	1,73%
0,11%	0,13%	0,16%	0,08%	0,00%	0,16%	0,32%	0,39%	0,47%	0,58%	0,72%	0,89%

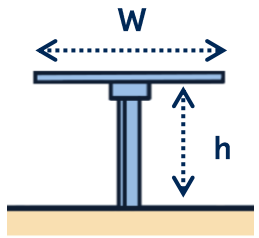
12 reflecting soil parts



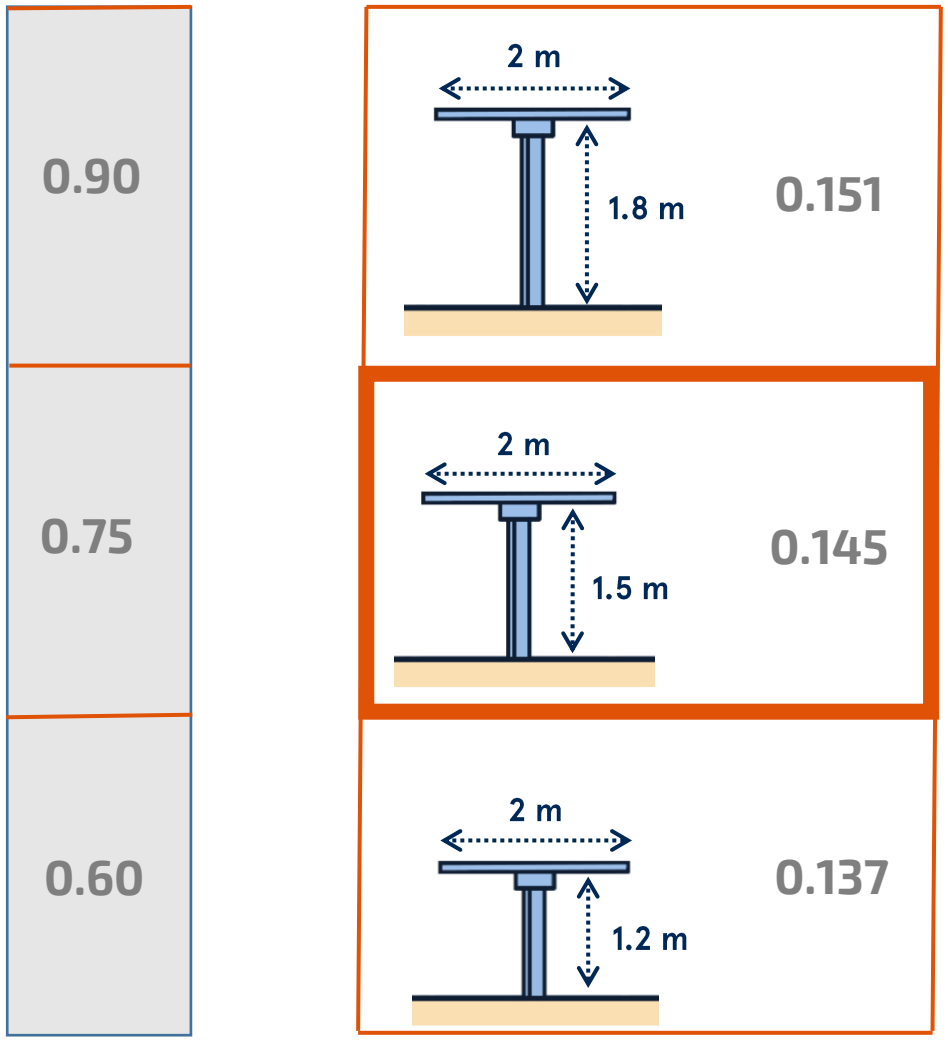
Collected irradiance comes from 144 different rays → 4 main bifacial parameters { - View Factor (VF) - Shading Factor (SF) - Mismatch (MM) - Bifacial Gain (BG)

View factor

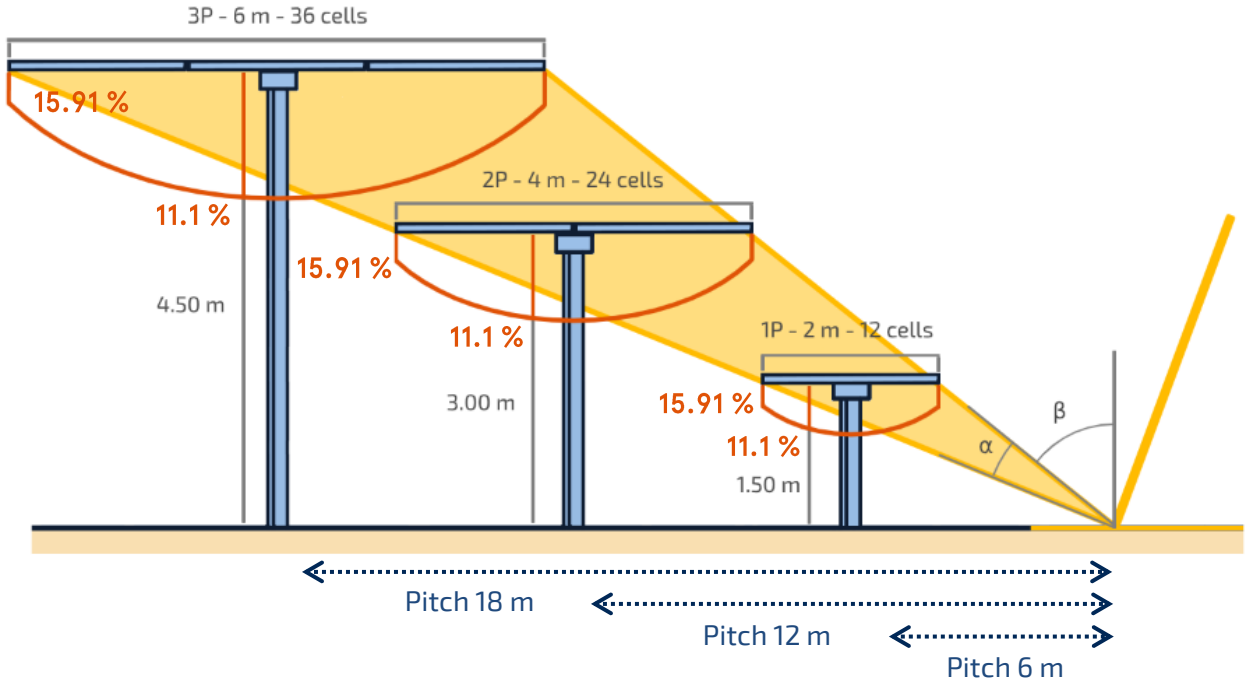
Same GCR value considered for both configurations.



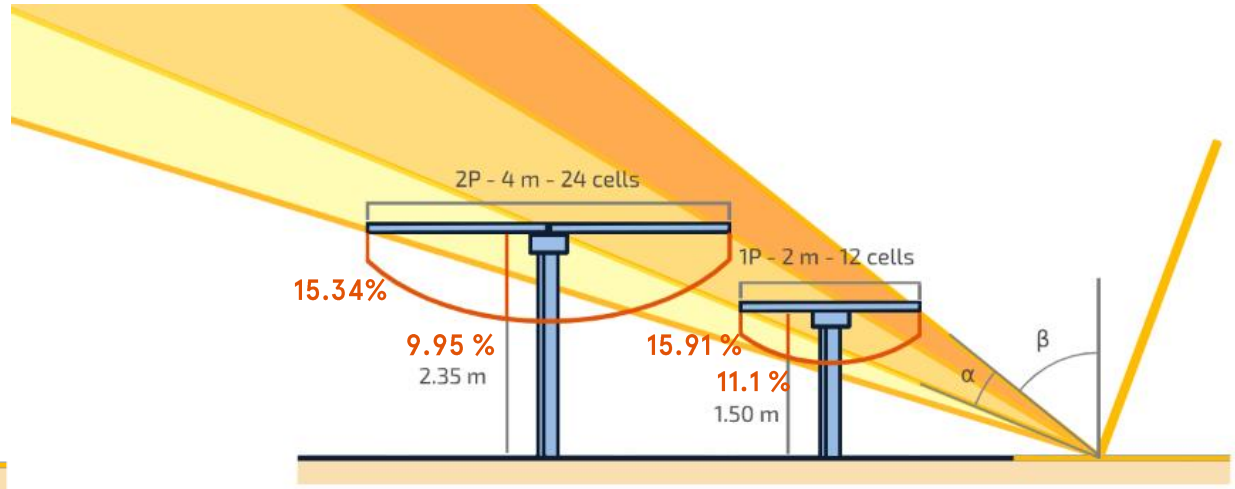
$$\text{Normalized Height, H} = \frac{h}{W}$$



Normalized height



Theorical equivalent normalized height



β = Reflected ray strength
α = Irradiance captured by collector

Reflecting ground (ω/m²)

Real-case height

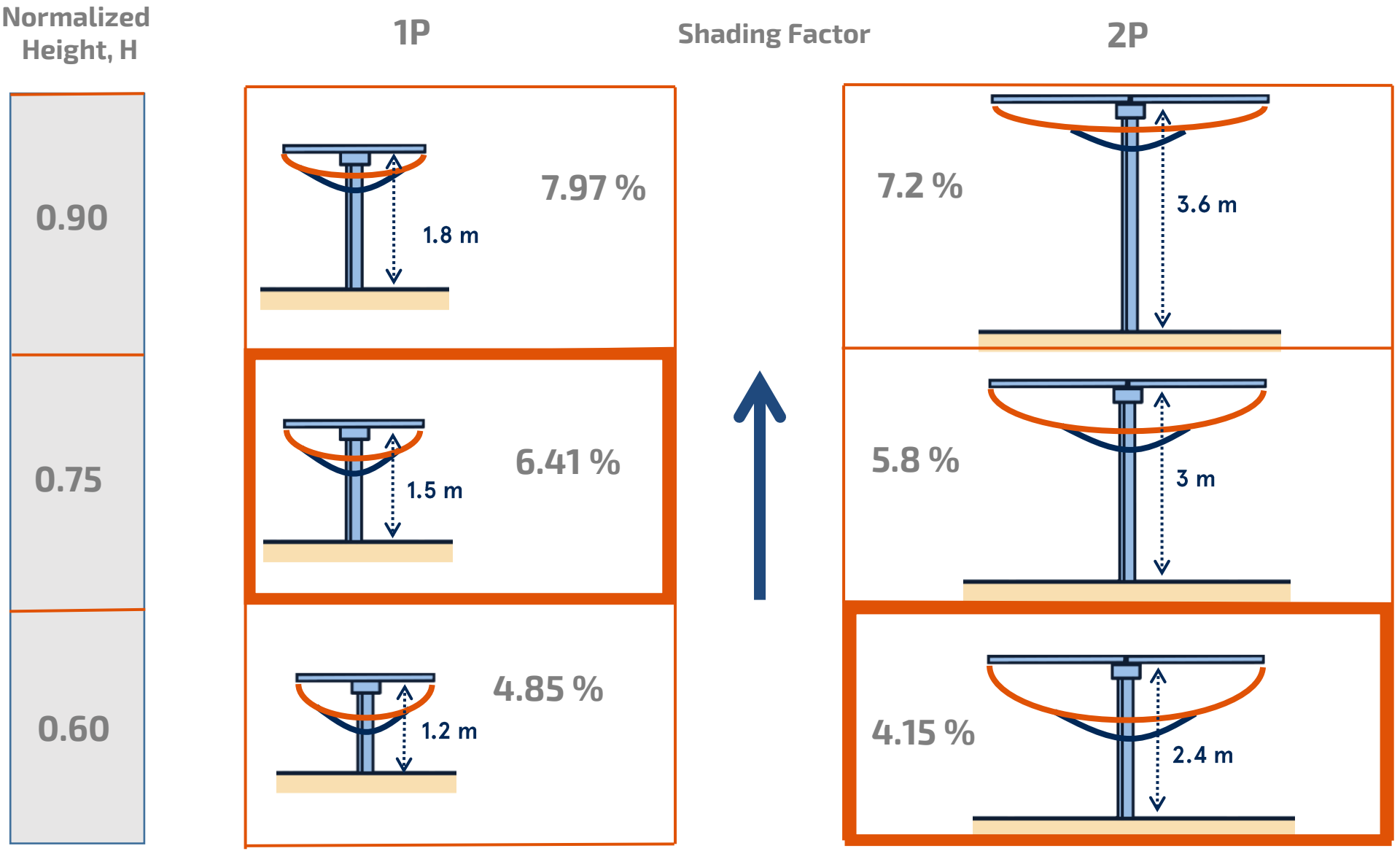
Mismatch

Normalized Height, H	1P	Mismatch	2P
0.90	15.9 % / 14.1 % / 1.8 m — 0.66%		15.9 % / 14.1 % / 3.6 m — 0.66%
0.75	15.2 % / 13.5 % / 1.5 m — 0.98%		15.2 % / 13.5 % / 3 m — 0.98%
0.60	14.5 % / 11.7 % / 1.2 m — 1.45%		14.5 % / 11.7 % / 2.4 m — 1.45%

Shading factor

$$\frac{\sum_{n=0}^{N} G_{rear}\ (no\ tube)}{\sum_{n=0}^{N} G_{rear}\ (with\ tube)}$$

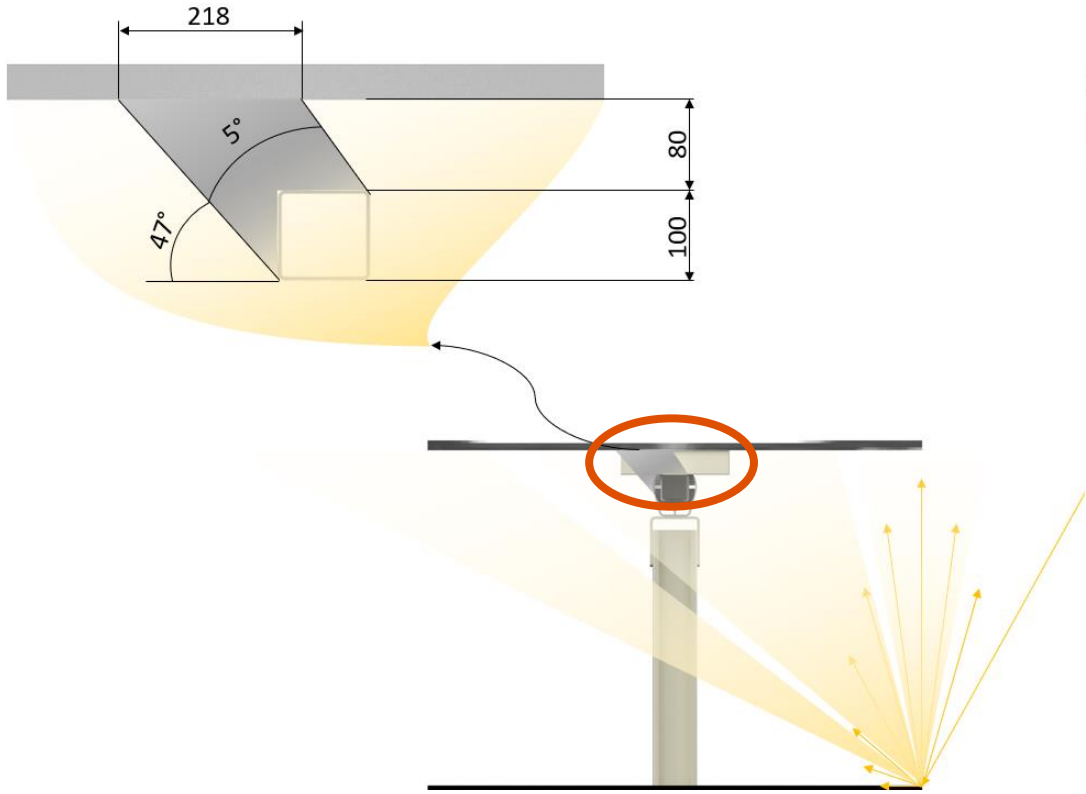
Square torque tube of 100 mm considered for the 1V configuration, and of 150 mm for the 2V.



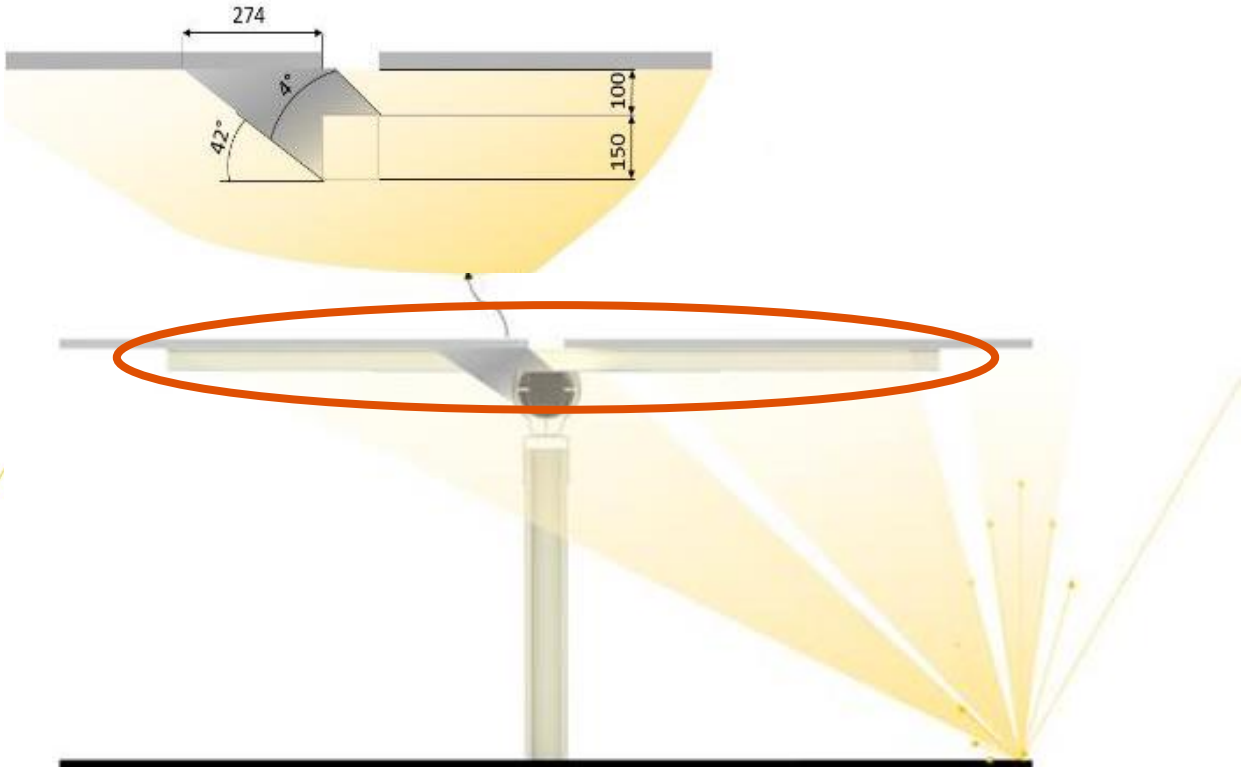
Shading factor

Torque tube shading

Maximum irradiance (direct and diffuse) of a reflected ray with panels in 0º position



1P



2P

Bifacial gain

A natural common albedo of 0.25 is considered for the analysis.

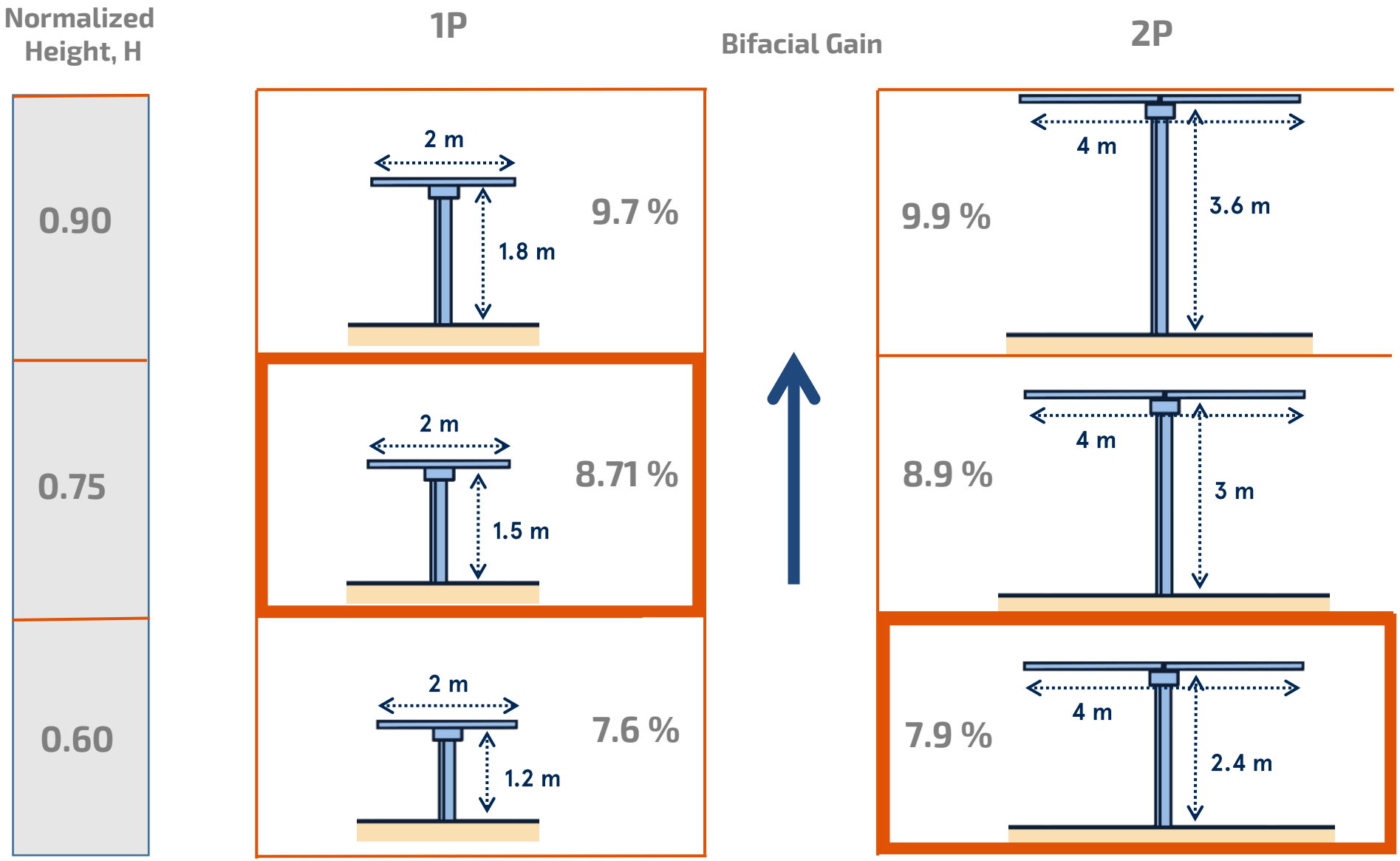
View Factor

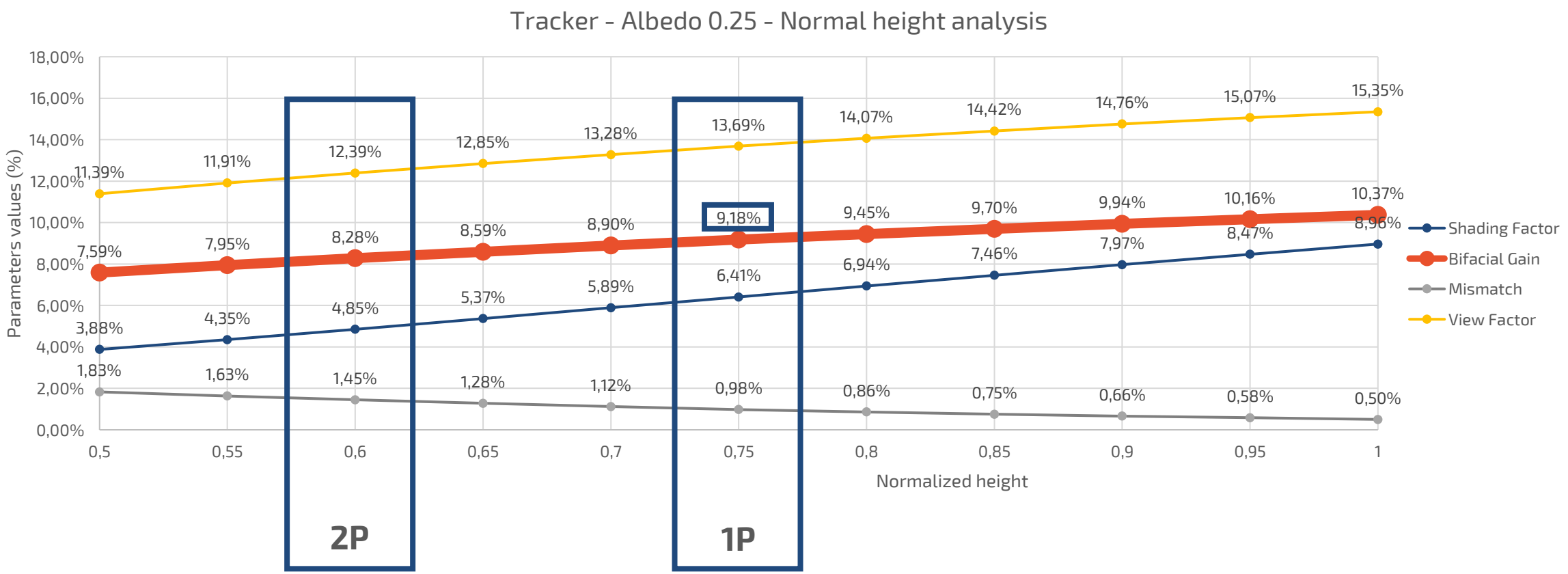
↓

Shading Factor Mismatch

↓

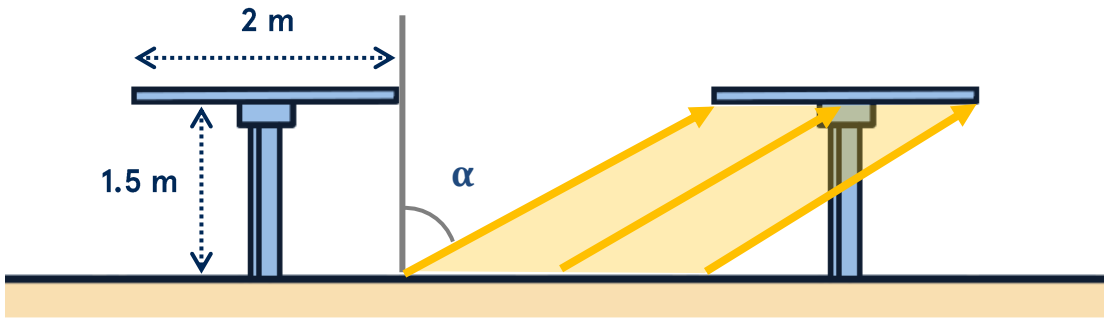
Bifacial Gain





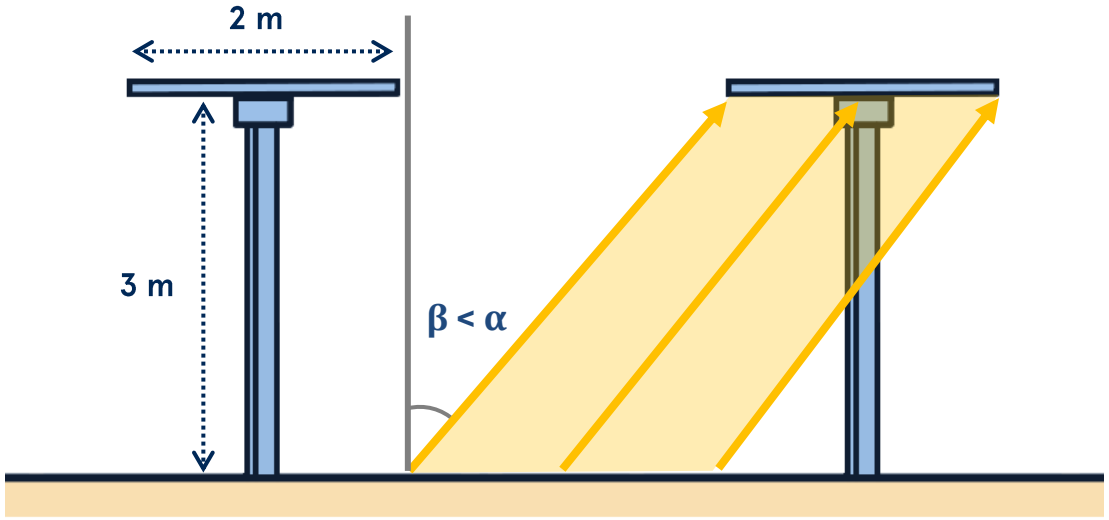
View Factor { Shading Factor, Mismatch → **Bifacial Gain**

Bifaciality rewards greater values of normalized height → where is the optimum point?



H = 0.75

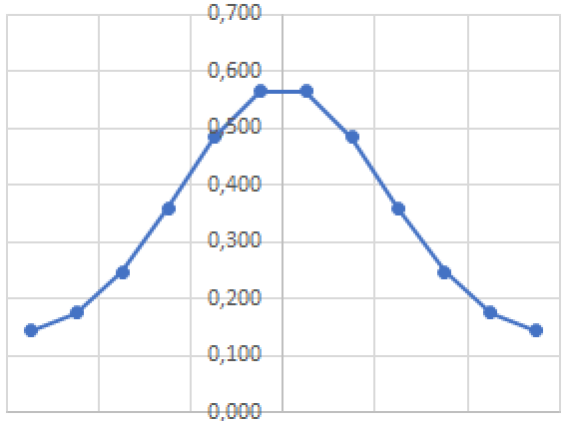
Back irradiance captured: 13.47%

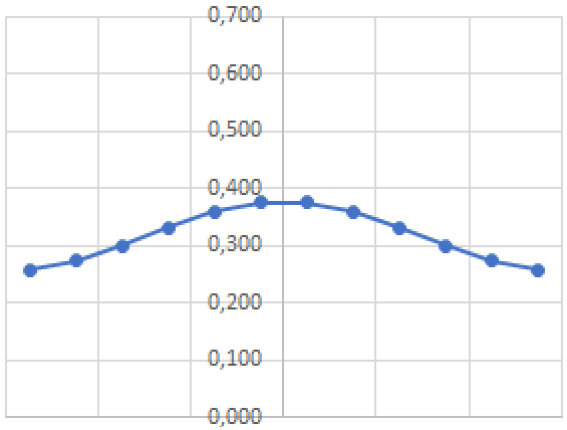


H = 1.50

Back irradiance captured: 17.04 %

Theorical View Factor





STI-H250™ dual-row analysis

LCOE concept

$$LCOE = \frac{CAPEX + \sum_{n=1}^{N} \frac{OPEX - RV}{(1+r)^n}}{\sum_{n=1}^{N} \frac{Y_0(1+D)^n}{(1+r)^n}}$$

Election list criteria

- ✓ Manufacture
- ✓ Safety
- ✓ CapEx
- ✓ OpEx
- ✓ Construction
- ✓ Engineering
- ✓ Logistics
- ✓ Energy

STI Norland bifacial election scheme

Tracker type	Configuration	Module height	Total length	Energy input
Single row	**1P**	1.4 m	30 m	**Self-powered**
Dual row	2P	**1.5 m**	45 m	Wired
Multi row	2H	1.6 m	**65 m**	
	3H	1.7 m	90 m	
	4H	1.8 m		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