



# Advance Tracking Simulations

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hybrid  
**bifi PV** **2022**  
**workshop**

## Soltec Bifacial Tracker Track Record

# 16.4 GW

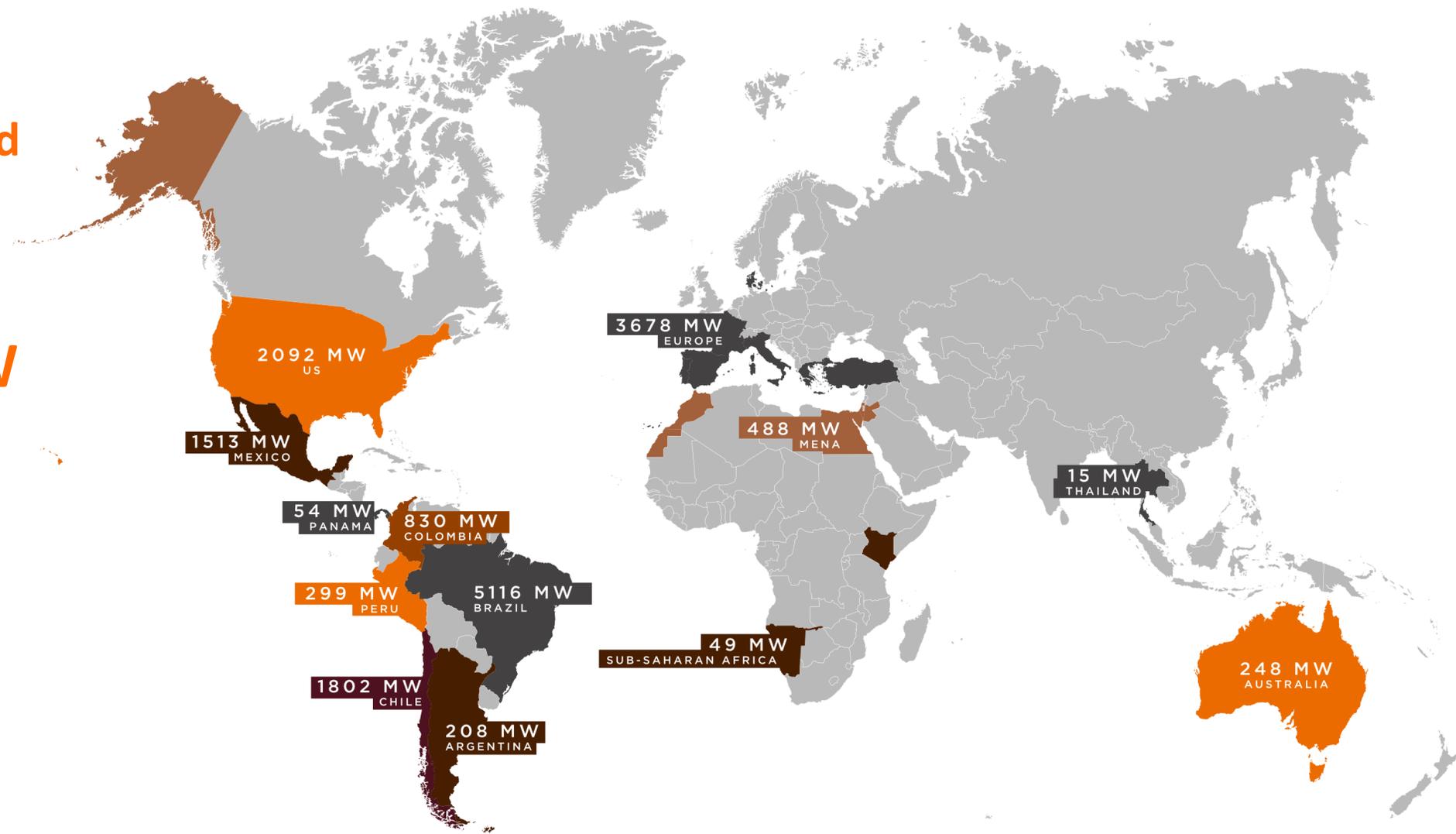
GLOBAL PROJECTS\*

# 7.2 GW

BIFACIAL PROJECTS\*

With contracted and ongoing projects

18 years of industry experience  
more than 1,300 people

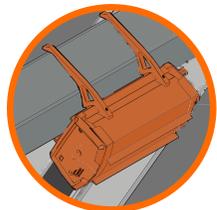


# Innovation

## BEST IN CLASS PRODUCTS AND DIFFERENTIATED SOLUTIONS

Implementing all the products and processes to each project through its R&D team dedicated Patent Box:

Soltec Innovations, with **146 Active Patents**



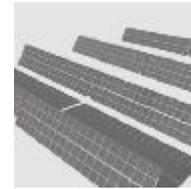
Full Wireless



Dy-WIND



SF ONE  
2021



Solarfighter  
(Gen 2-DG)  
2021



SF8  
2020



SF7 Tandem  
2020

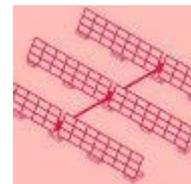


SF7 Bifacial  
2018

## Bifacials



10K5  
2007



SA Series  
2010



Solarfighter  
(Gen 1)  
2011



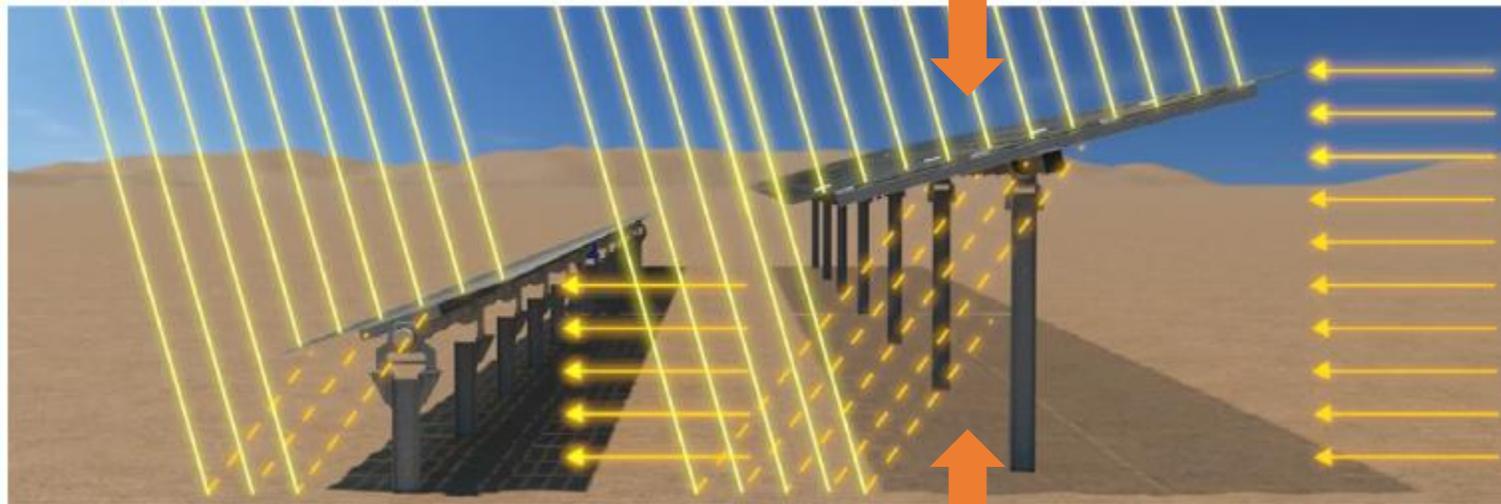
SF Utility  
2013



SF7  
2017

# Bifacial Energy Yield Estimation

$$\text{Bifacial Energy} = \eta (G_{\text{front}} + G_{\text{rear}} \times \text{Bifaciality})$$



*G<sub>rear</sub>*

Diffuse

Albedo

Reflections

Rear Shading

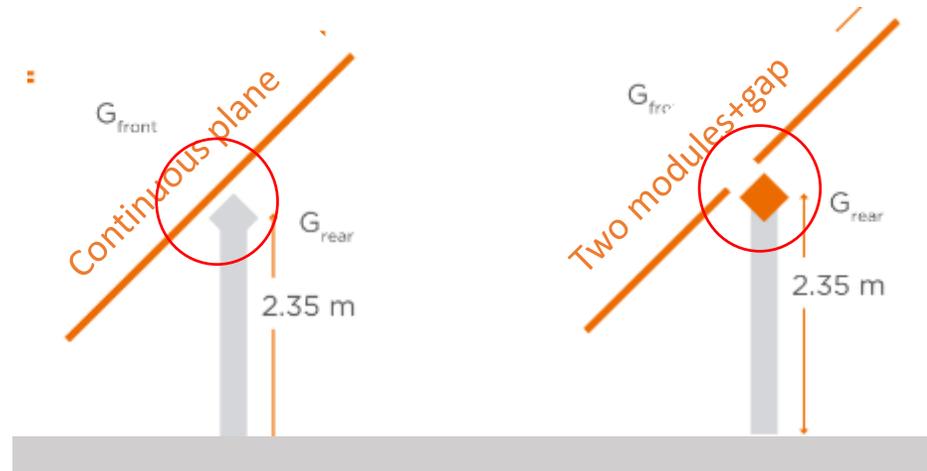
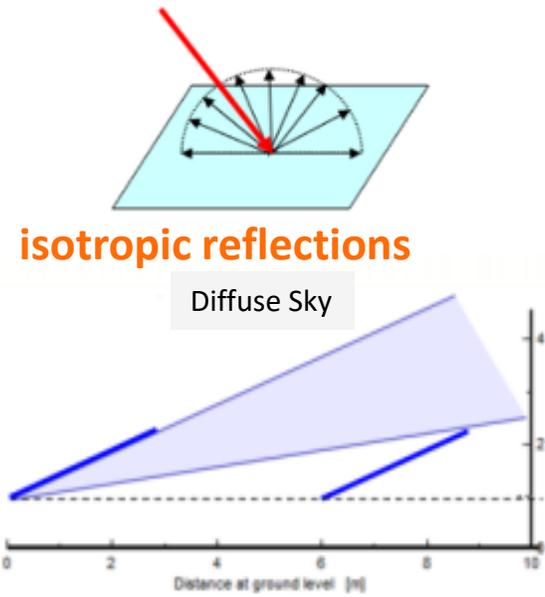
*Geometry properties*

# Rear Irradiance simulation

- PVsyst View Factor: Simplified simulations
  - Quick simulations
- Parameter approximation

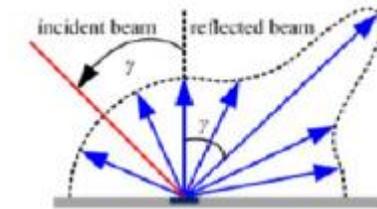


Transparency fraction  
 Rear Shading factor  
 Rear Mismatch Loss factor

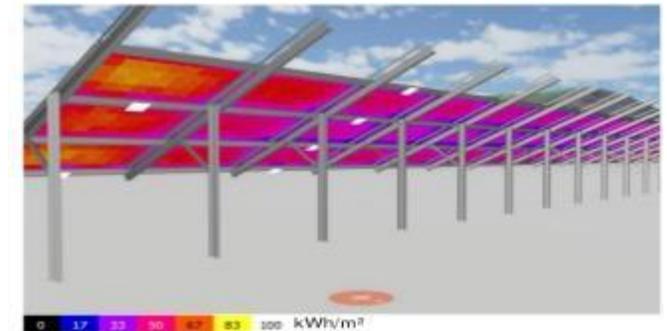


From Simplified to Realistic

- Accurated Simulations
- Comprehensive modelling
- High Computational cost

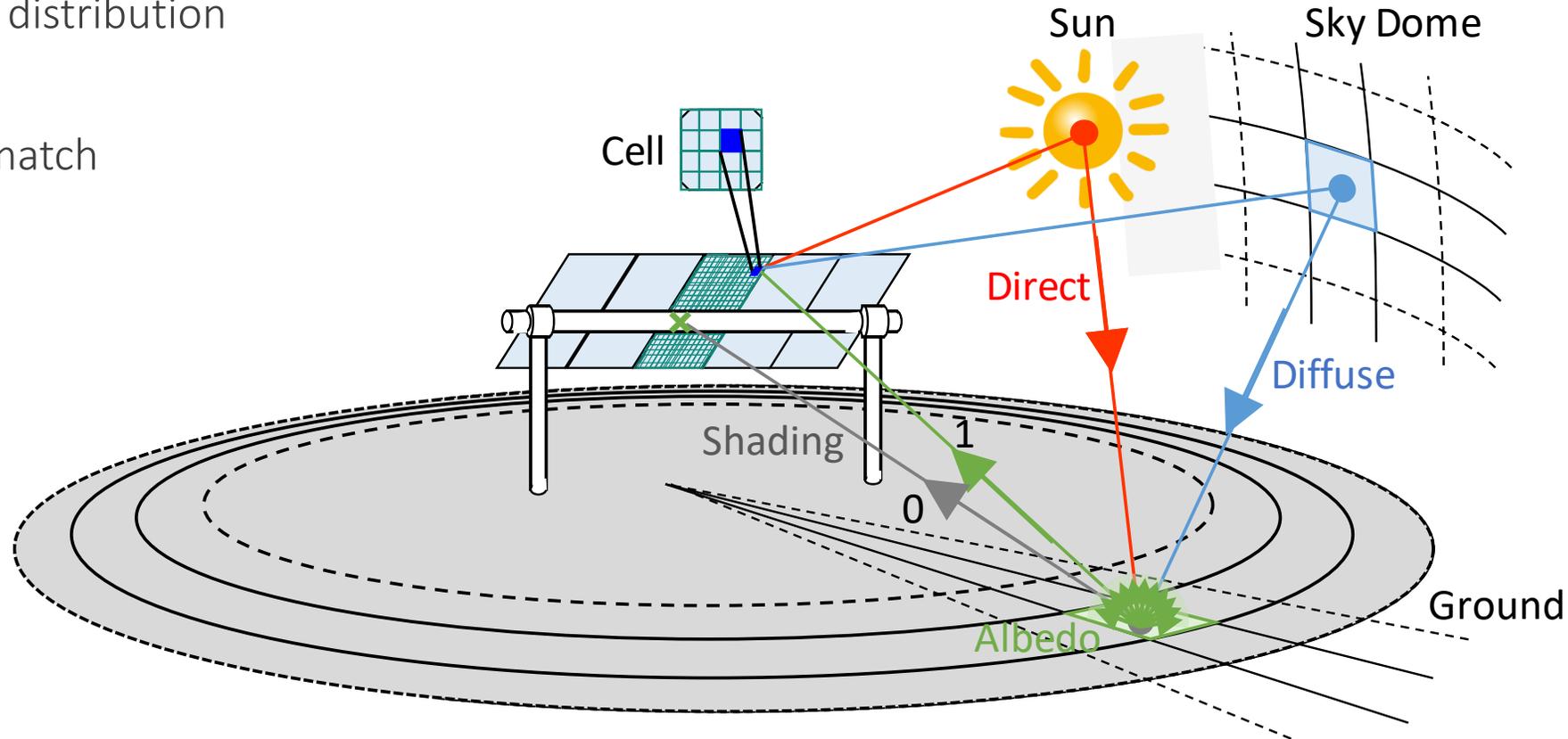
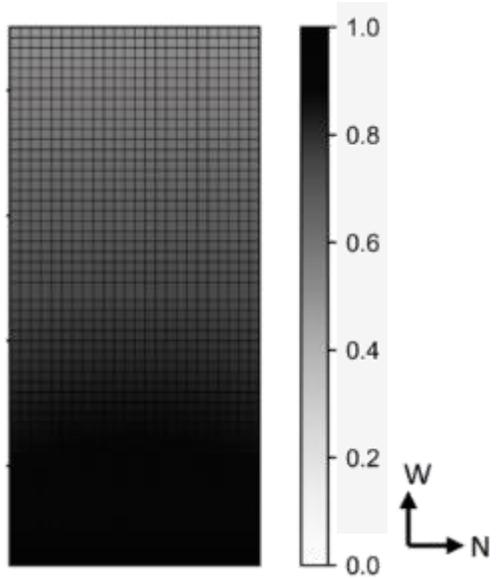


Non-isotropic reflections



# Comprehensive Simulation: DUET

- 3D view factor – front and rear
- Heterogeneous irradiance distribution
- Rear shading elements
- Optical and electrical mismatch



SPAIN: 38°

Albedo 30%.

| PVSYST PARAMETERS           |   |        |
|-----------------------------|---|--------|
| Shading factor              | Shading of Piles Module Support Torque Tube Cabling | 12,01% |
| Total Transparency Fraction |   | 1,33%  |
| Thermal Factor              | Uc  | 25,0   |
| Thermal Factor              | Uv  | 1,2    |
| Rear Mismatch factor        |   | 1,82%  |

1P: Piles 0,41% Module support 0,81% Torque tube 9,57% cabling 1,5%

#### Output

| PVSYST PARAMETERS           |   |       |
|-----------------------------|---|-------|
| Shading factor              | Shading of Piles Module Support Torque Tube Cabling | 8,35% |
| Total Transparency Fraction |   | 0,94% |
| Thermal Factor              | Uc  | 31,3  |
| Thermal Factor              | Uv  | 2,3   |
| Rear Mismatch factor        |   | 1,04% |

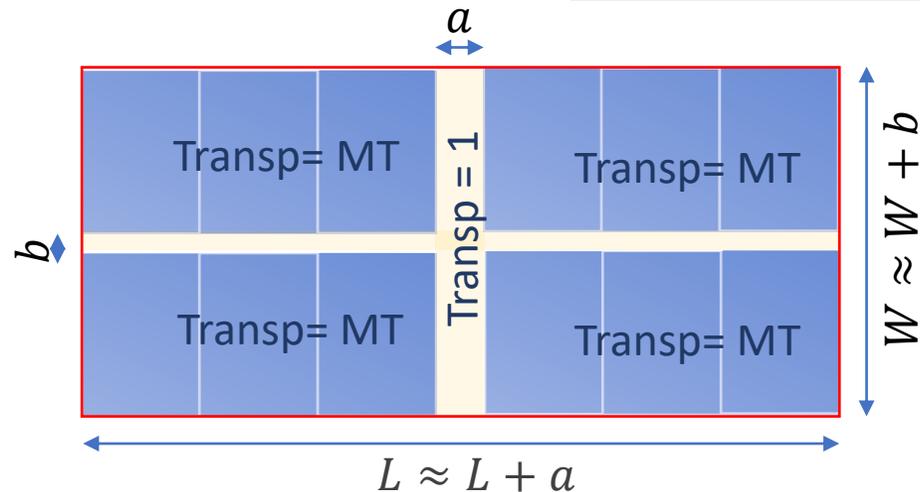
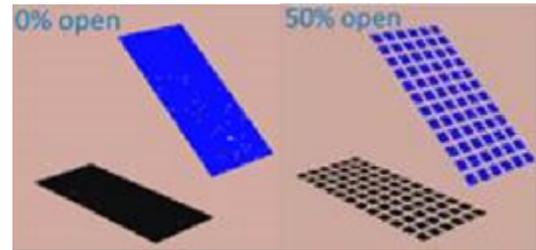
2P Shading: Module support 4,1%, Piles 0,43%, Torque tube 2,565, cabling 1,5%

# Transparency Fraction

$$\text{Transparency fraction} \approx \left( MT + \frac{a}{L} + \frac{b}{W} \right)$$

*MT = Module Transparency*

$$MT \approx 1 - \frac{n_{\text{cells}} \cdot A_{\text{cell}}}{A_{\text{module}}}$$



From continuous plane to open realistic plane

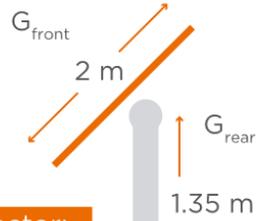


$$\text{Transparency} = \frac{MT \cdot L \cdot W + 1 \cdot a \cdot W + 1 \cdot b \cdot L}{(L + a)(W + b)}$$

2P Soltec Transparency  $\approx$  MT +3.75%

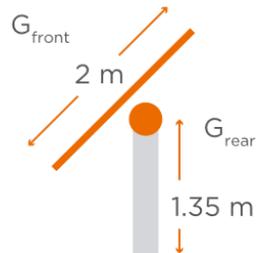
# Shading Factor Torque Tube

Module 1 = continuous plane  
No torque tube

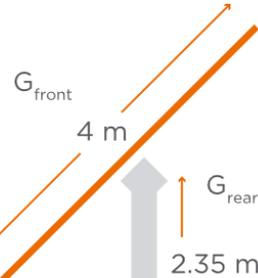


Shading factor:  
**-5.6%**

Module 1 = continuous plane  
With torque tube



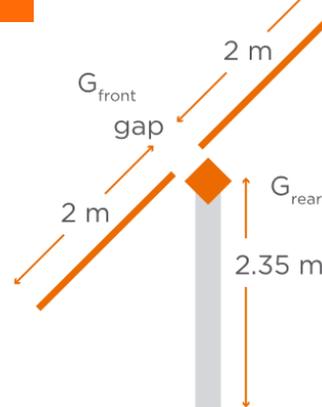
Module 1 + Module 2 =  
continuous plane  
No torque tube



Simplified-PVsyst

Gain reflection  
 $\Delta = +8.5\%$

Module 1 + Gap  
+ Module 2  
With torque tube

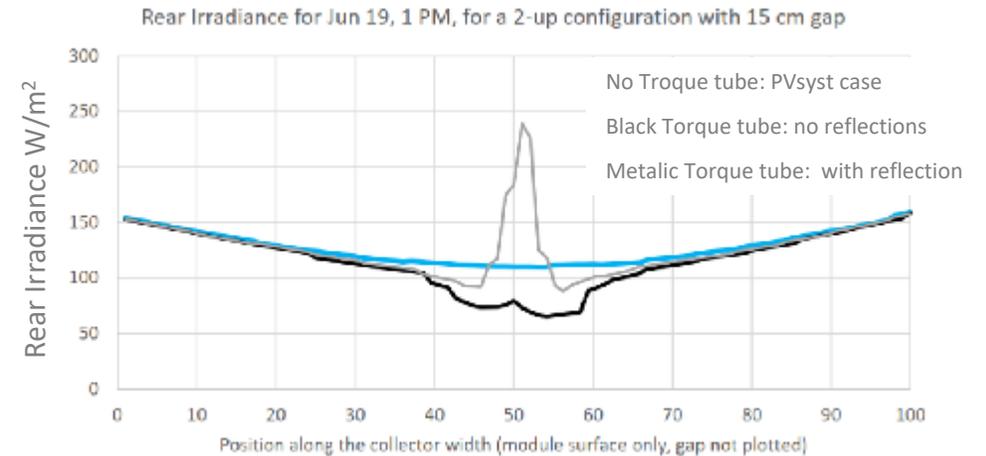


Comprehensive

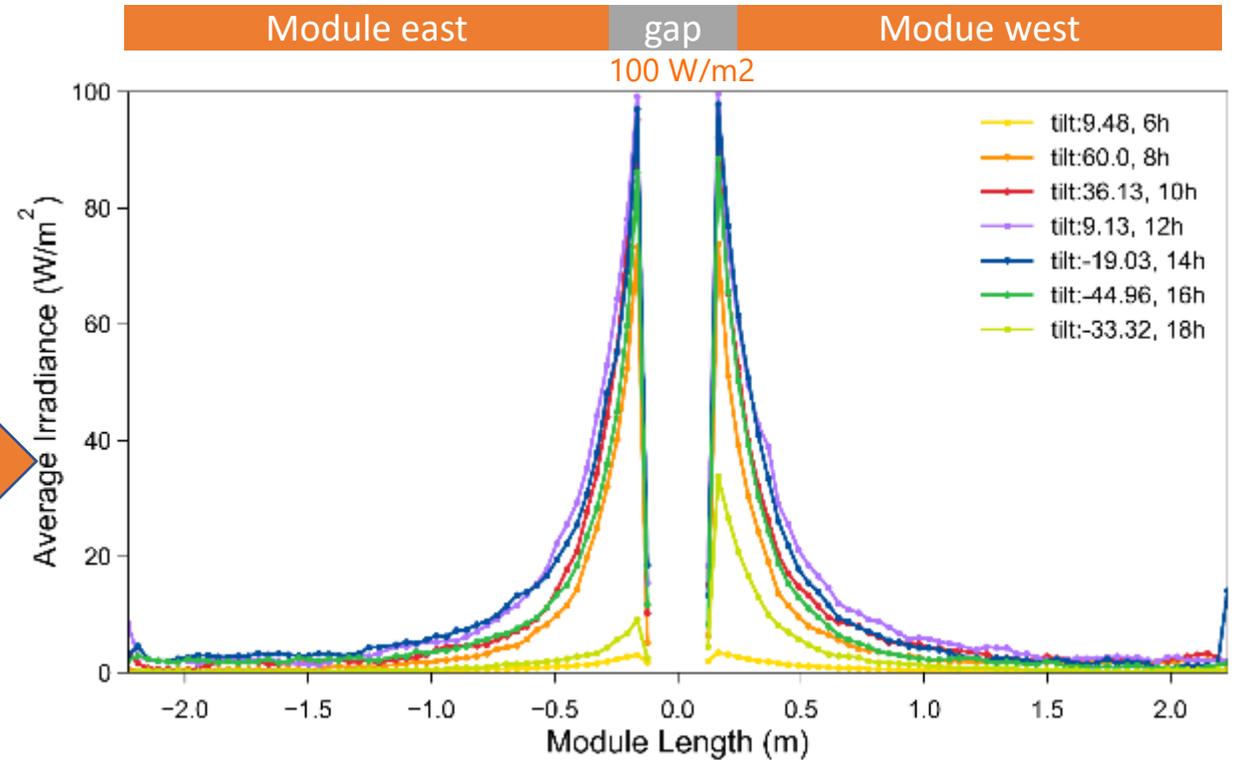
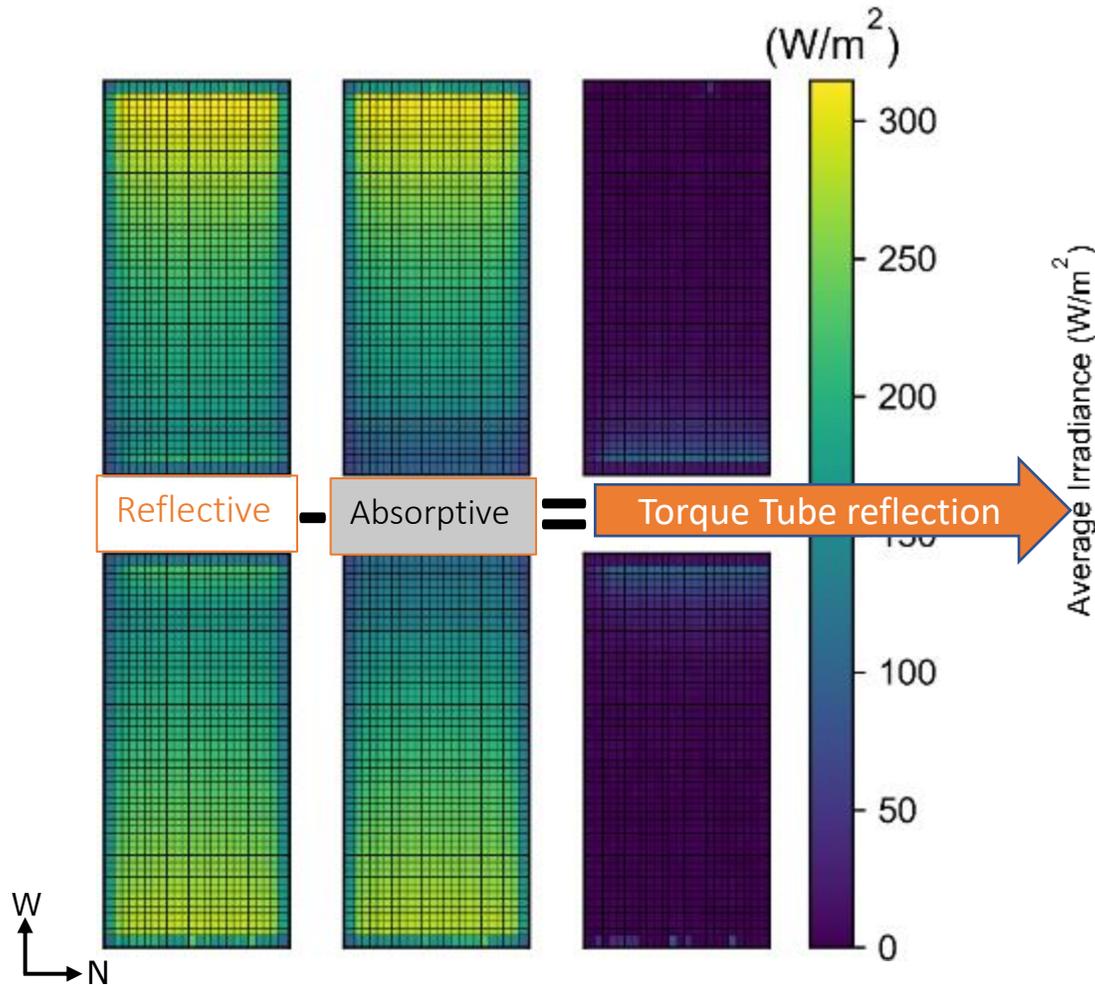
Example of central row. Simulations count with my rows.



Torque Tube gap

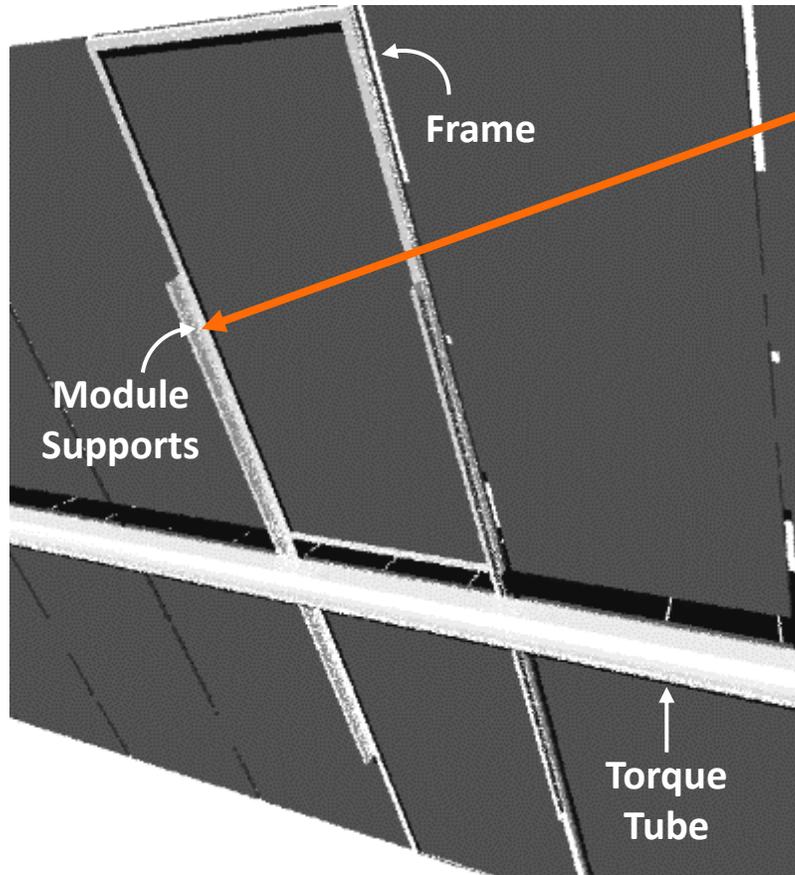


# Torque Tube + Module Frame Shading



more irradiance in central area

## Rear Shading module frame + module support

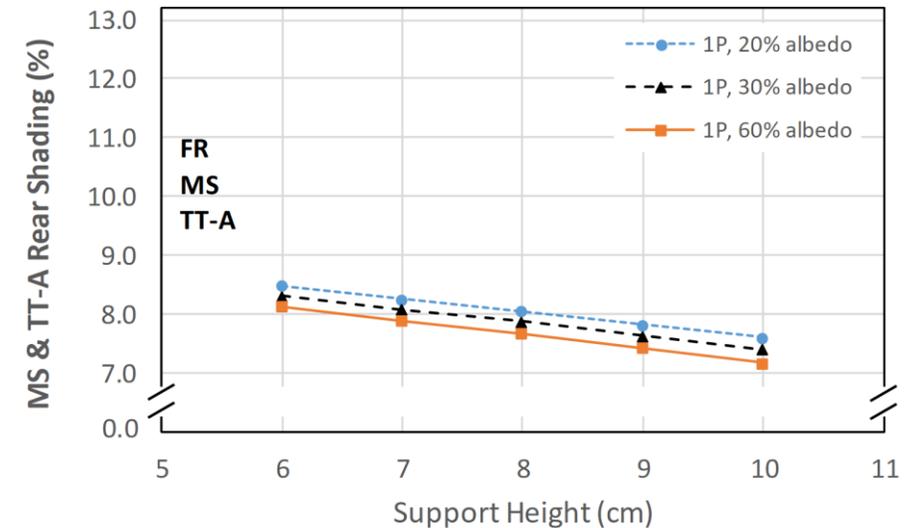
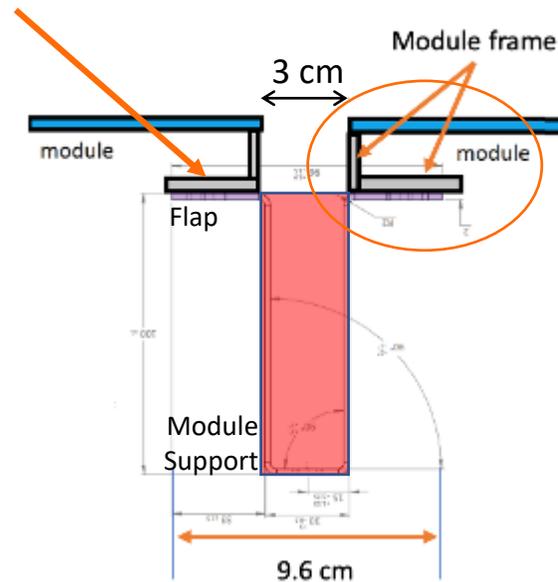


Rear view of module under test

Module Frame  $\zeta$  include in .pan file through bifacility factor ?

Module support height has decreasing impact in 1P rear shading fraction

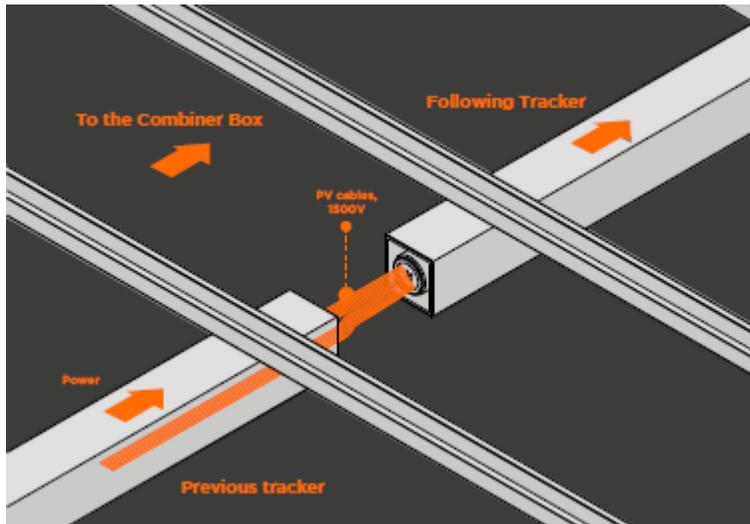
Module support flap does not generate additional shading on cell (due to module frame)



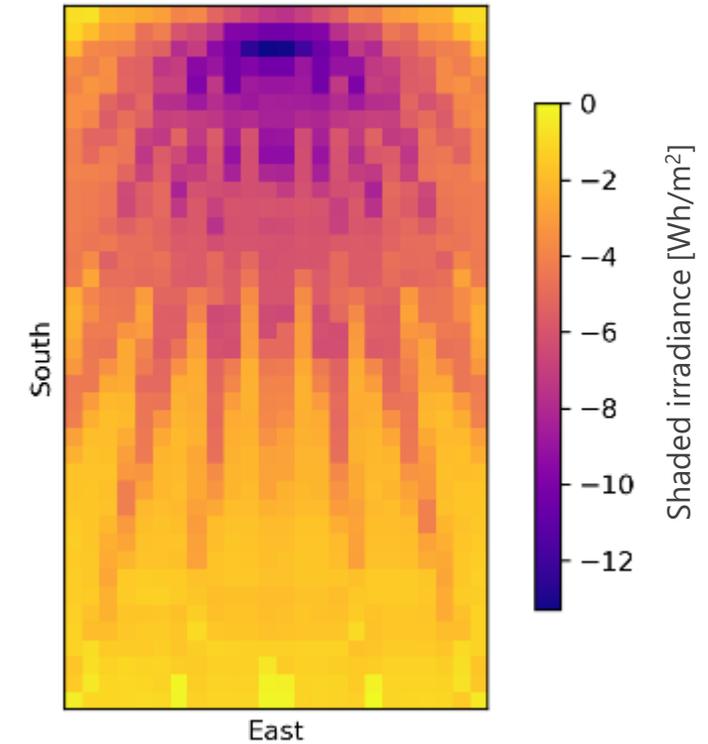
# Bifacial Energy Factors: Piles & Cabling Shading

Piles\* – 0.4-0.7% in module in front  
 Shading factor contribution <0.02%)

|                            |                 |      |
|----------------------------|-----------------|------|
| Cabling: Module connection | up to 4 cables  | 1%   |
| String cables              | up to 16 cables | 4.3% |



Pile Shading\* (Single TimeStamp)  
 Rear of Eastern 2P Module in Morning



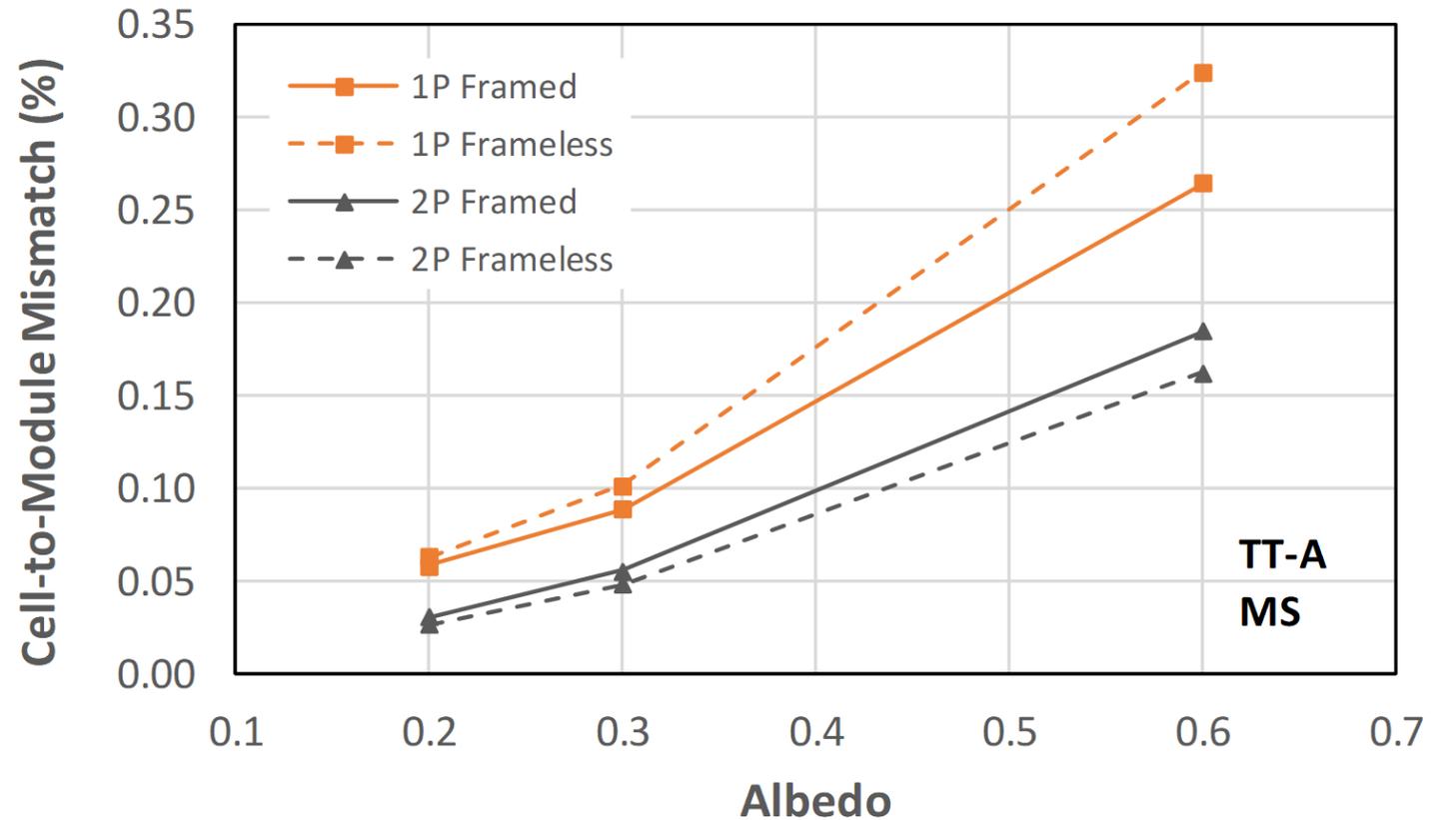
\*Effect of module supports  
 & torque tube not shown

\*Annie Russell et al. Modelling Bifacial Solar Energy Yield for Single-Axis Tracked Systems with Racking . <https://www.nusod.org/2019/nusod19paper31.pdf>

# Rear Mismatch Factor

-  Heterogeneous distribution
-  Torque Tube
-  Torque Tube gap
-  Module frame
-  Cabling
-  Piles

| Albedo | PV Syst Factor |       | Energy Loss |       |
|--------|----------------|-------|-------------|-------|
|        | 1P             | 2P    | 1P          | 2P    |
| 20%    | 1.69%          | 0.96% | 0.10%       | 0.06% |
| 60%    | 2.20%          | 1.27% | 0.32%       | 0.18% |



## Smart Tracking

Tracking algorithms can provide an important advantage

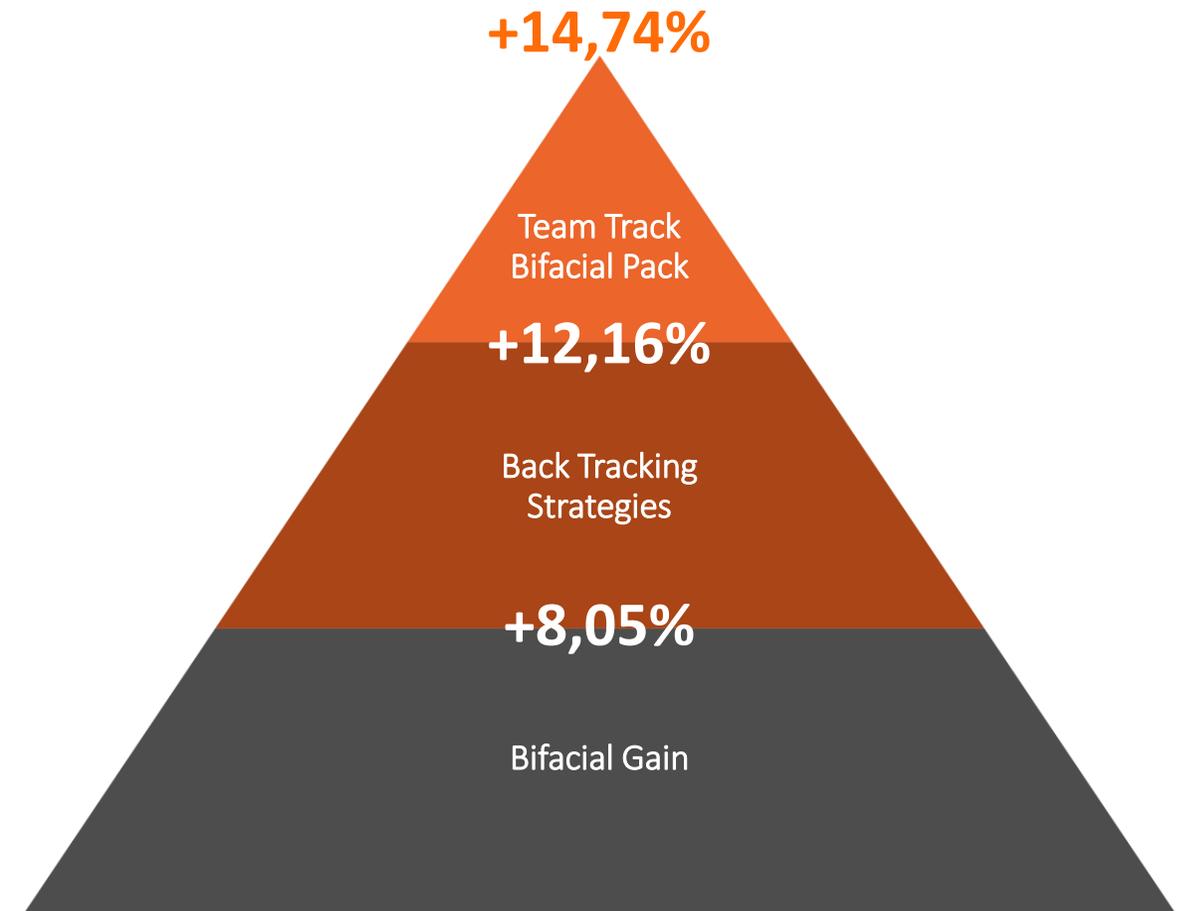
Bifacial gain of an installation with standard tracking (20% albedo): 8,05%.

Including the benefits of a basic Backtracking, we now can reach 12.16%.

If we include advanced algorithms such as the Team Track Bifacial Pack, we achieve an 14.74% ANNUAL BIFACIAL GAIN Extra.

These algorithms optimize the electricity produced as a function of the photon irradiance, back irradiance, albedo, and bifaciality of the module.

With the Team Track Bifacial Pack we can achieve hourly production improvements of up to 6,45% in plants with albedos below 20%.



# Conclusions

1. **Bifacial Energy Simulations** in PVsyst **do not accurately model** tracker geometry and heterogeneous **irradiance distribution**

2. **Shading and Rear Mismatch factors** should be assessed with **comprehensive modelling**

3. **Specific software**

bifacial\_radiance uses ray tracking and non-isotropic reflections

DUET allows to include shading elements and rear irradiance mismatch

4. **Transparency fraction**

5. **Shading Factor** values range

All tracker 8,35 ... 12%

Frame+Module support 7 ... 10%

Torque Tube +6 ... 12%; Torque Tube Gap 1.3% ... 6%

Cabling 1 ... 4%

Piles effect is negligible

6. **PVsyst Mismatch range Rear Mismatch Factor 1 ... 2.2 % Energy Losses (<0.15%)**



**Soltec**

MAKING TRACKS,  
BUILDING TRUST

[soltec.com](http://soltec.com)

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