

SOLAR HIGHWAYS

Effect of albedo on solar noise barrier performance

Simona Villa
Minne De Jong

2019 bifiPV Workshop

TNO innovation
for life



SOLAR HIGHWAYS

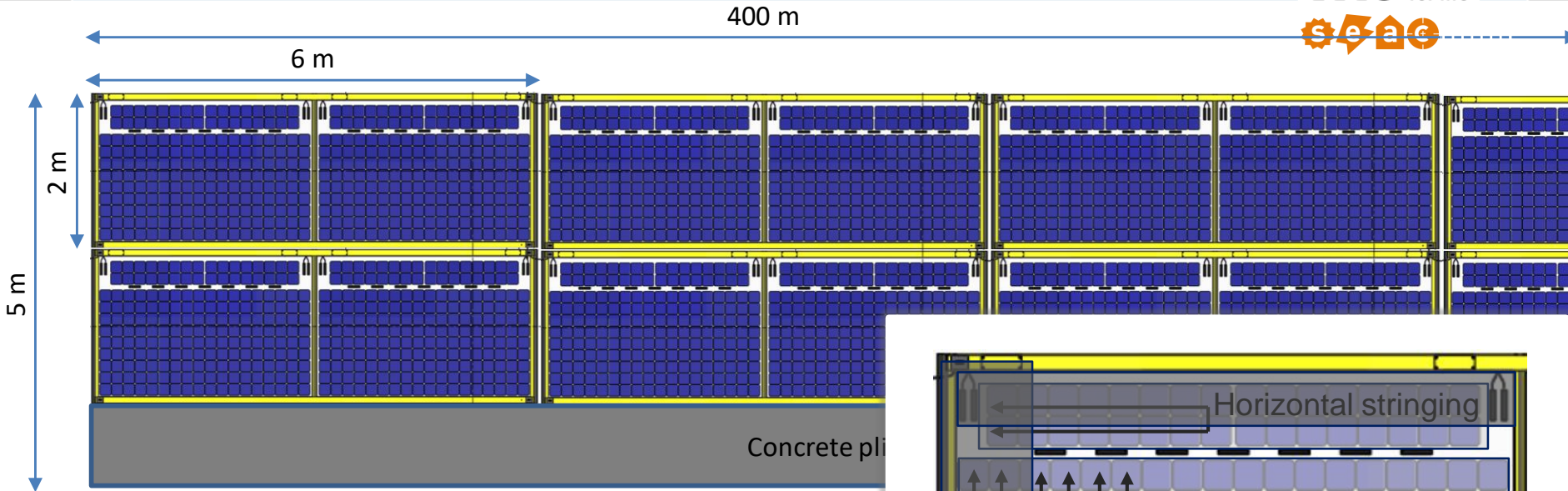
World's Largest Bifacial Solar Noise Barrier



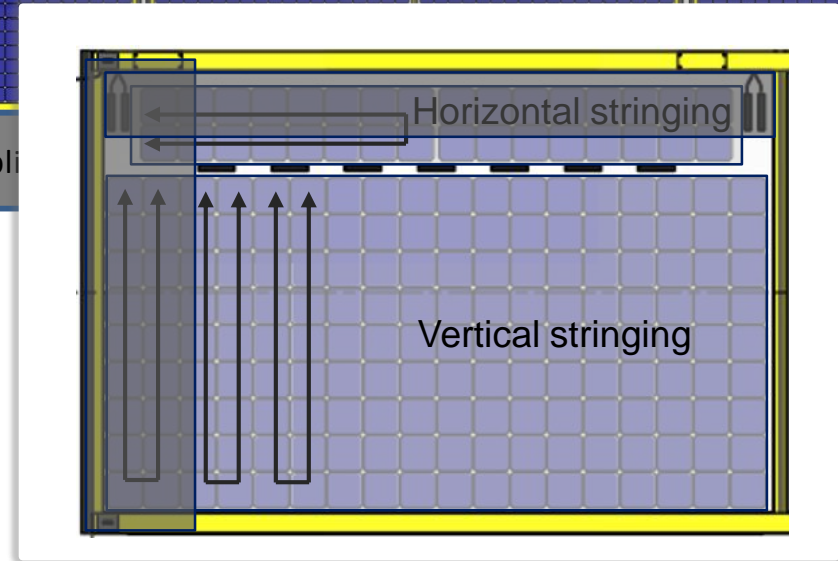
- › 400 m long and 5 m high
- › 1600 m² PV
- › East-West orientation
- › 80° tilt
- › 248 kWp - front side



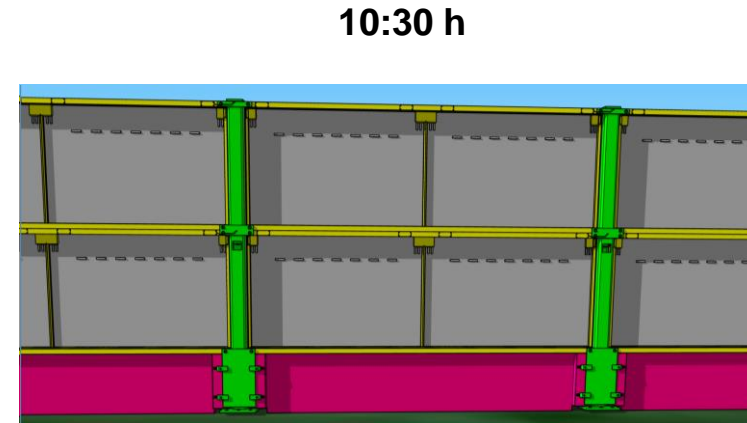
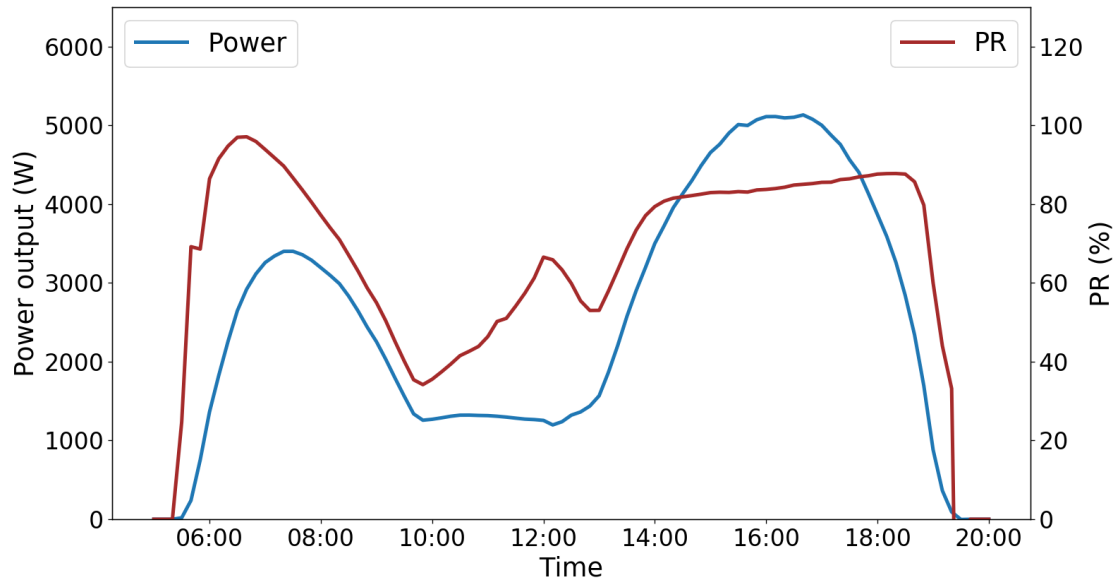
MODULAR DESIGN AND SMART STRINGING



- › 67 sections, each made of 4 PV laminates
- › Full MLPM
- › Optimized for shade mitigation
- › String and bypass-diode design adjusted to shade direction

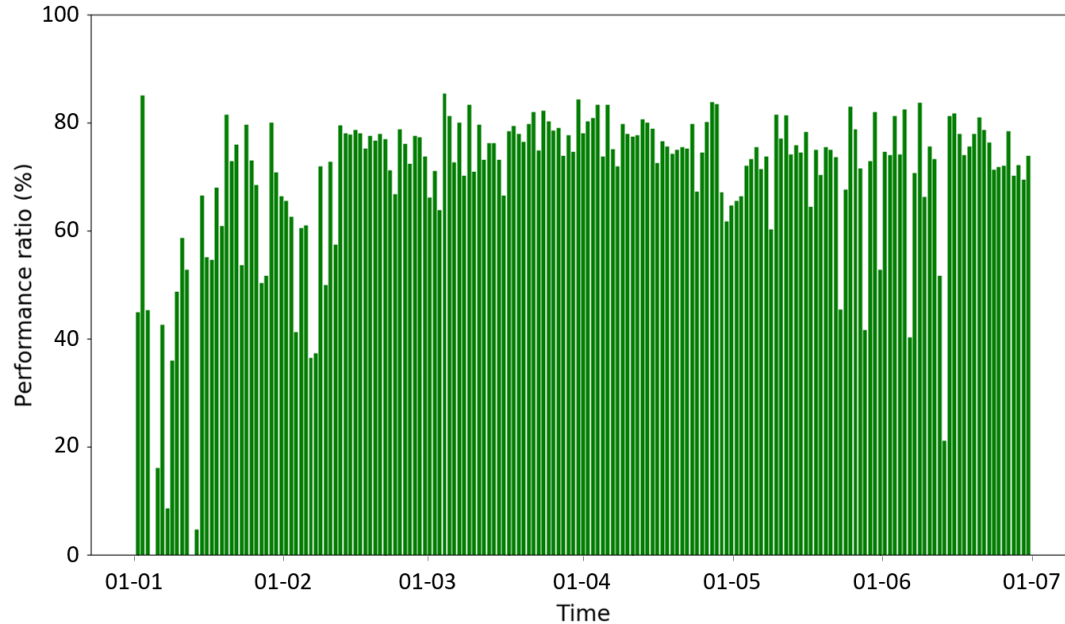


- › Double-peak irradiance and power profile
- › PR drops around noon due to vertical and horizontal supporting structures of the SH



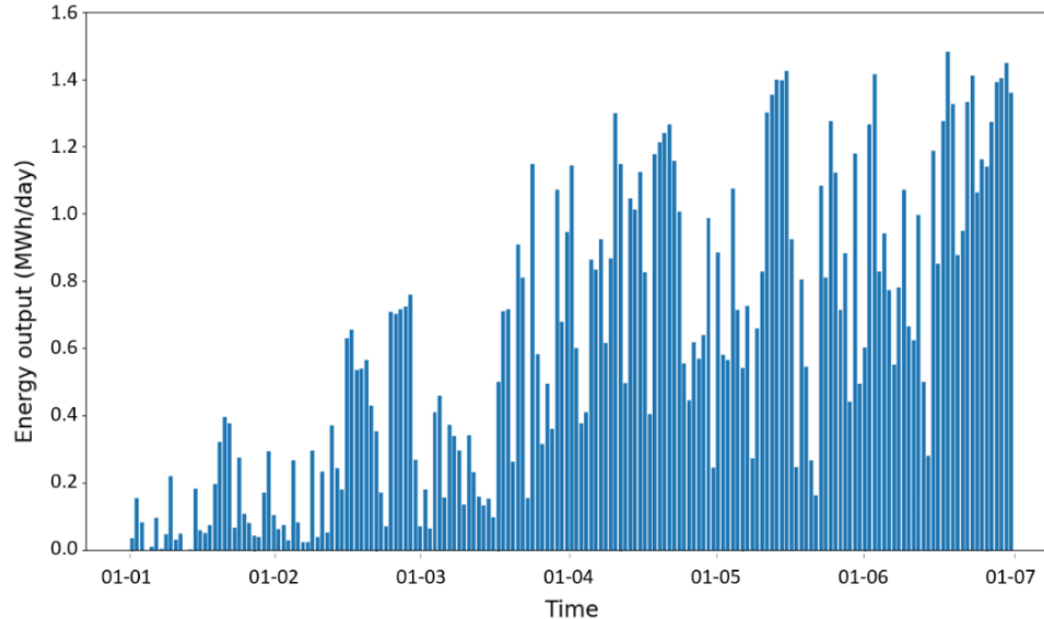
SH PERFORMANCE AND PRODUCTION

- › Average performance ratio 75%



SH PERFORMANCE AND PRODUCTION

- › Average performance ratio 75%
- › Total energy produced form January to August 2019: **163 MWh**

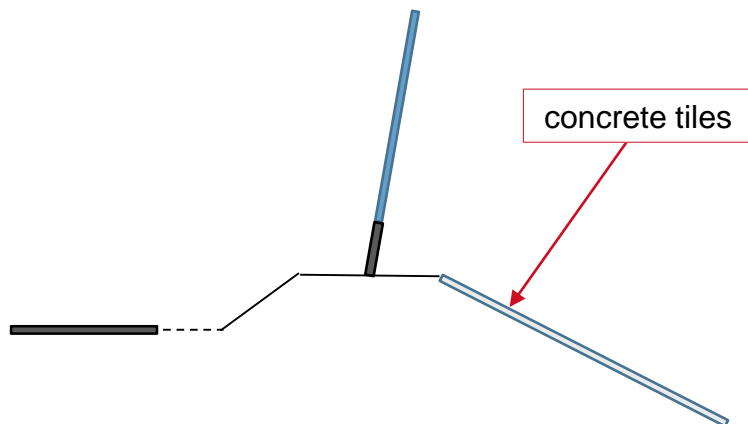


ALBEDO EFFECT

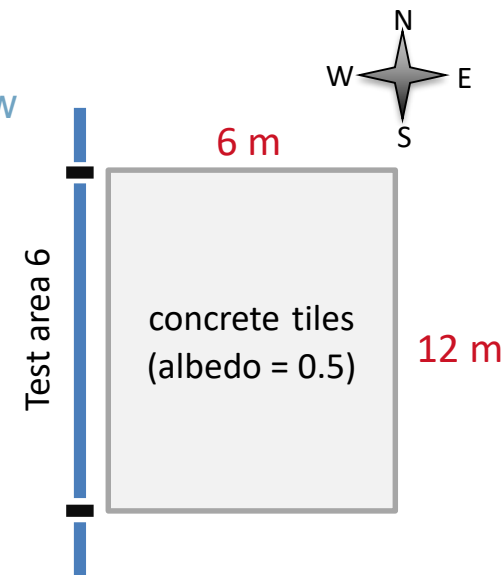
EXPERIMENTAL SET-UP

- › On 29/05/2019 white concrete tiles (albedo 0.5) are installed on the rear east side of test area 6
- › The tiles follow the ground slope (27° tilt)
- › Covered area of 12 m x 6 m

Lateral view



Top view

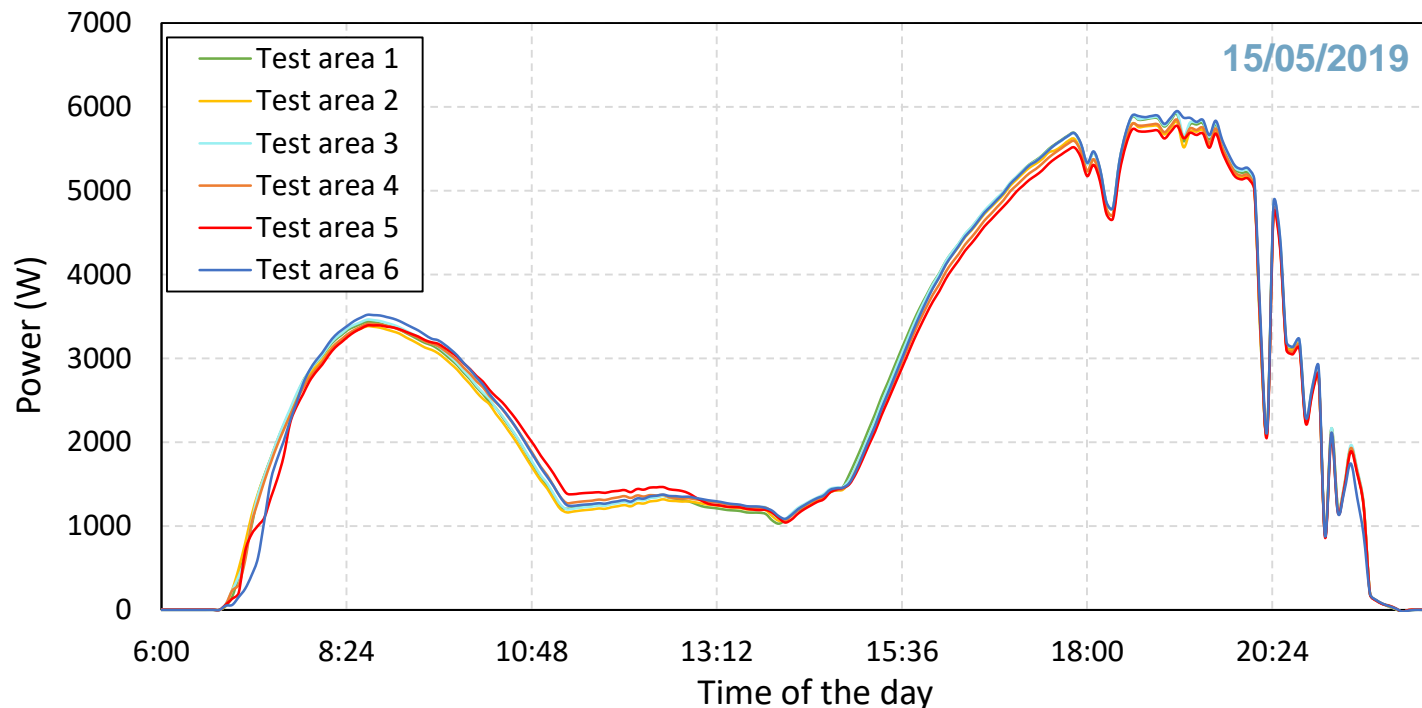


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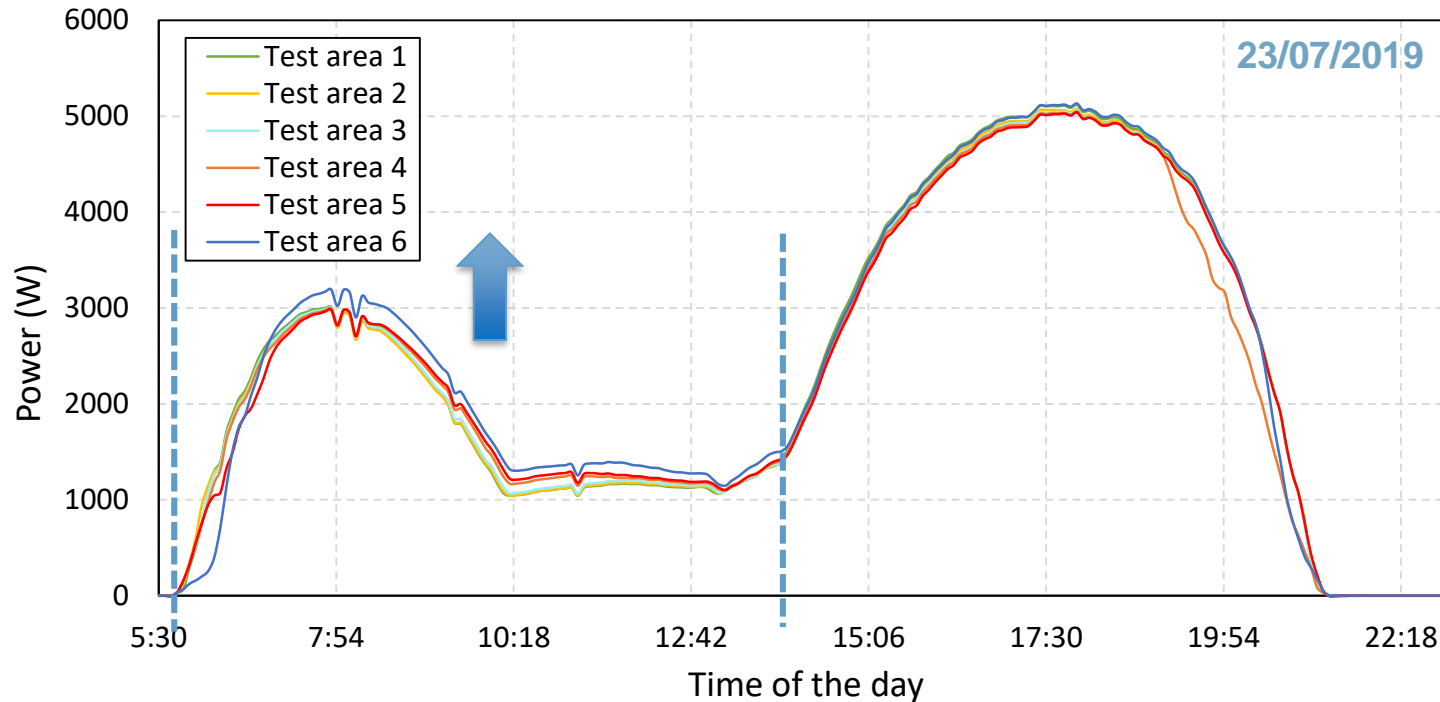


BEFORE INSTALLATION...



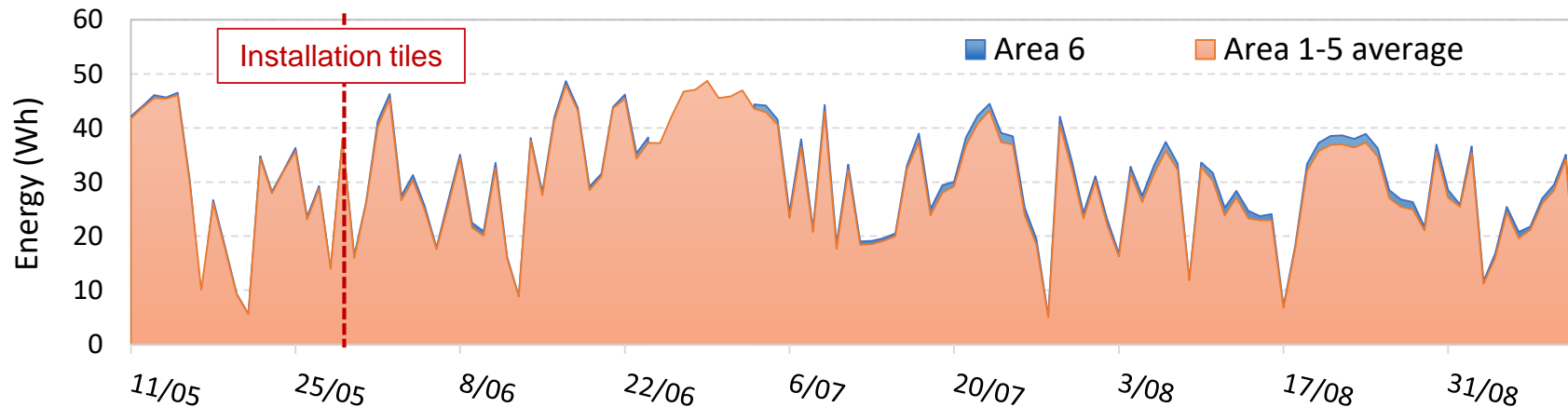
- › All test areas show similar power profiles

...AFTER INSTALLATION

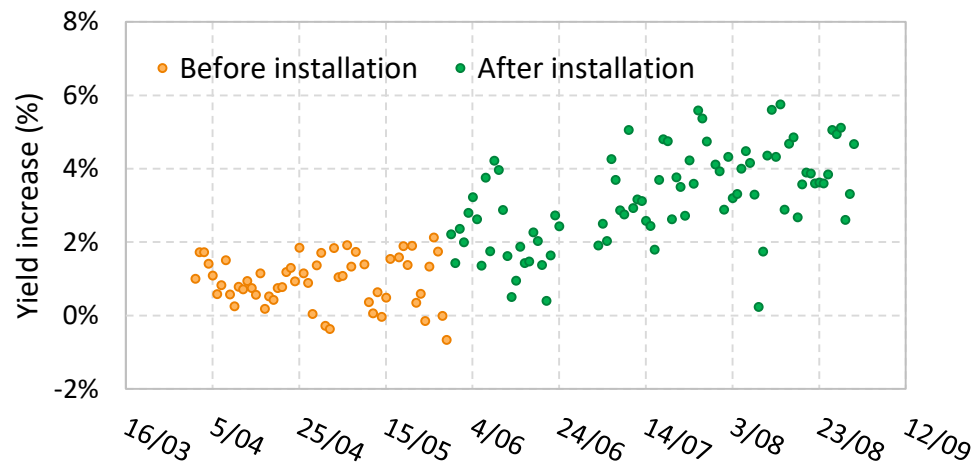


- ▶ Test area 6 shows enhanced power generation especially during morning hours

DAILY YIELD INCREASE



- › On sunny days:
 - › **+7.5%** in the morning (peaks of +20%)
 - › **+3%** during the whole day (up to 6%)
- › On cloudy days:
 - › +2% in the morning
 - › +1.5% during the whole day



SIMULATIONS FEATURES

› Elements:

- PV panels
- Base, vertical and horizontal supports (dummies)
→ self-shading
- Diffuse reflector

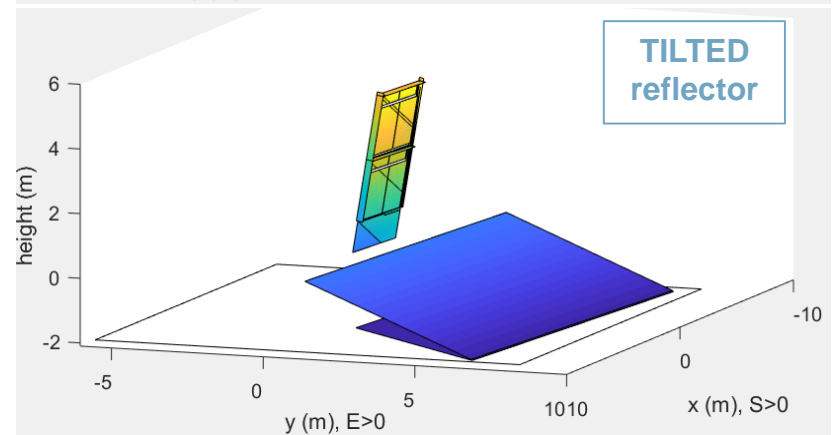
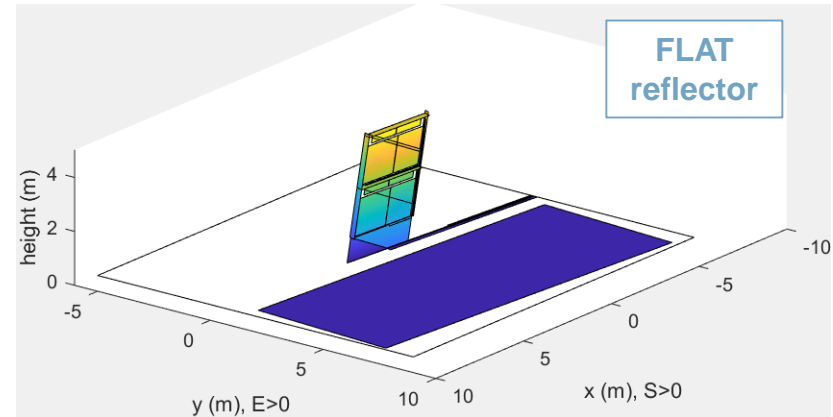
› Changing Reflector tilt:

0° (flat), 10° , 30°

› Changing Reflector albedo:

0.2 (as ground = no reflector), 0.5, 0.8

- ## › Output: contribution of diffused irradiance reflected from reflector towards PV elements
- enhanced energy yield



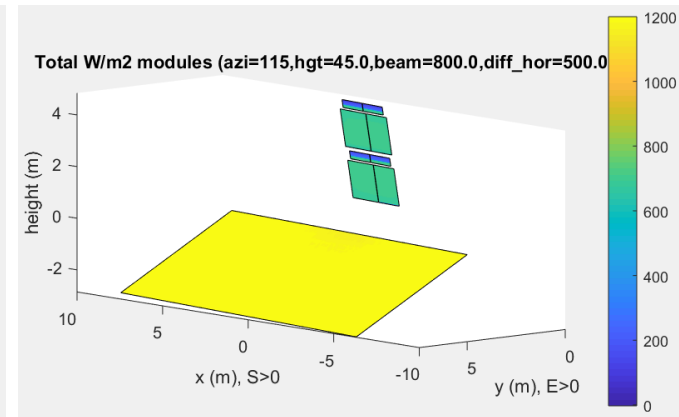
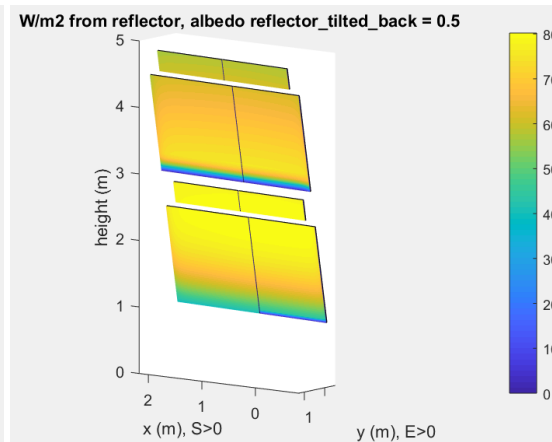
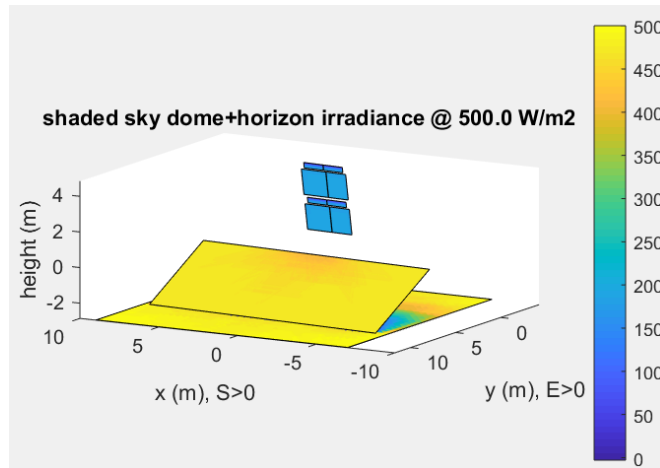
EXAMPLES BIGEYE RESULTS

@ Reflector tilt 27° , albedo 0.5, Sun (azi, hgt) = (115° , 45°)

Sky irradiance on PV modules and reflector (with shading)

Irradiance contribution from reflector

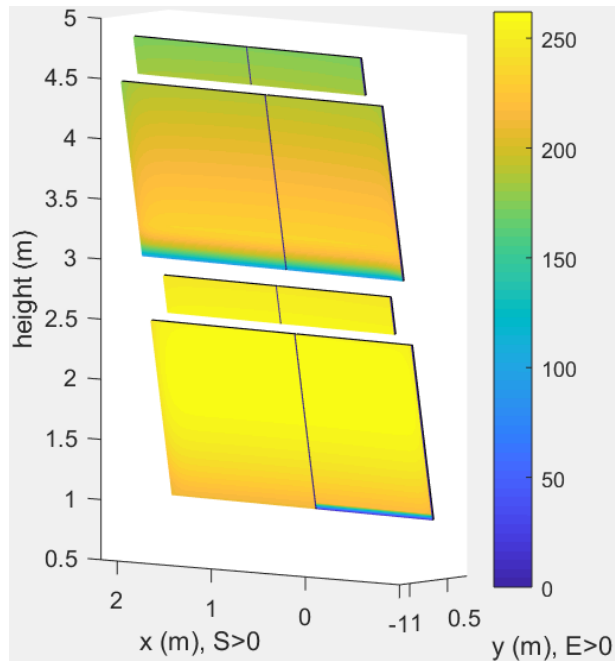
Total irradiance on PV modules and reflector



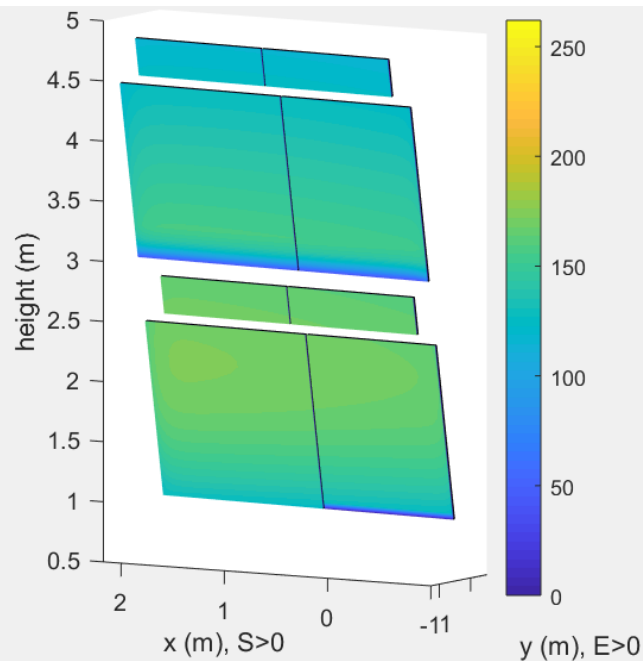
IRRADIANCE FROM REFLECTOR

@ Fixed albedo (0.8), changing reflector tilt

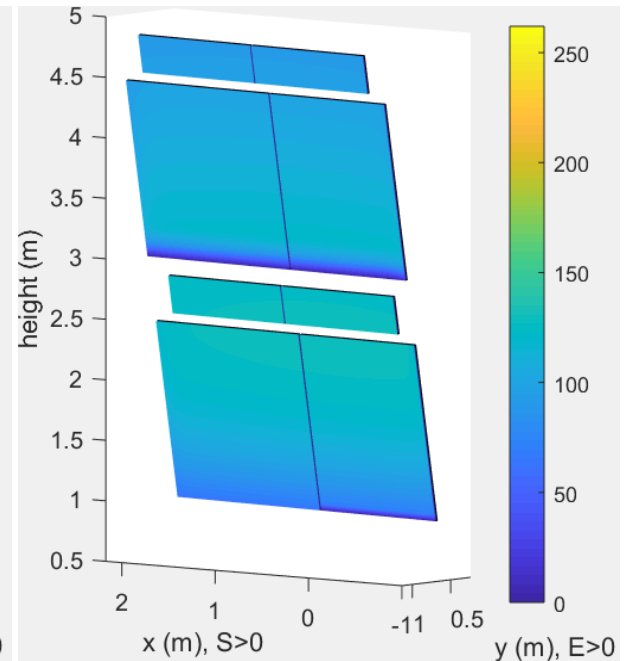
FLAT reflector



10° tilt



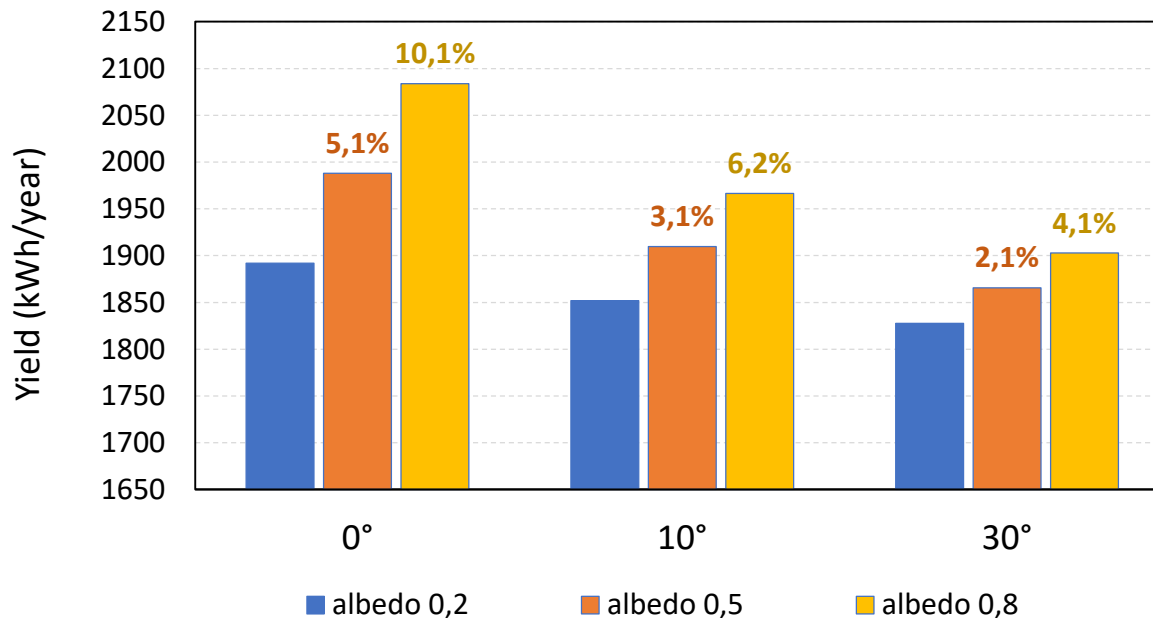
30° tilt



SIMULATION RESULTS

Yearly energy gain

Meteo data: Typical year (Meteonorm)



CONCLUSIONS

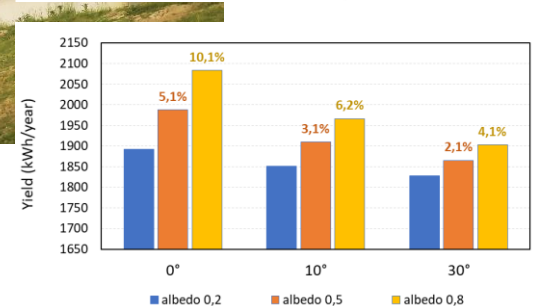
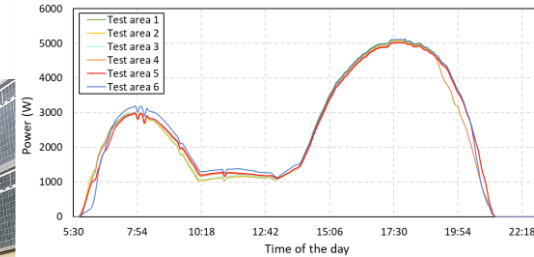
Solar Highways

Successful integration of bifacial vertical PV as solar noise barrier



Albedo effect

Significant energy gain thanks to high-albedo materials on the surroundings of bifacial PVNB



› **THANK YOU FOR YOUR
ATTENTION**

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simona.villa@tno.nl
www.solarhighways.eu