Sun'Agri

Benefit of bifacial PV panels for agrivoltaics

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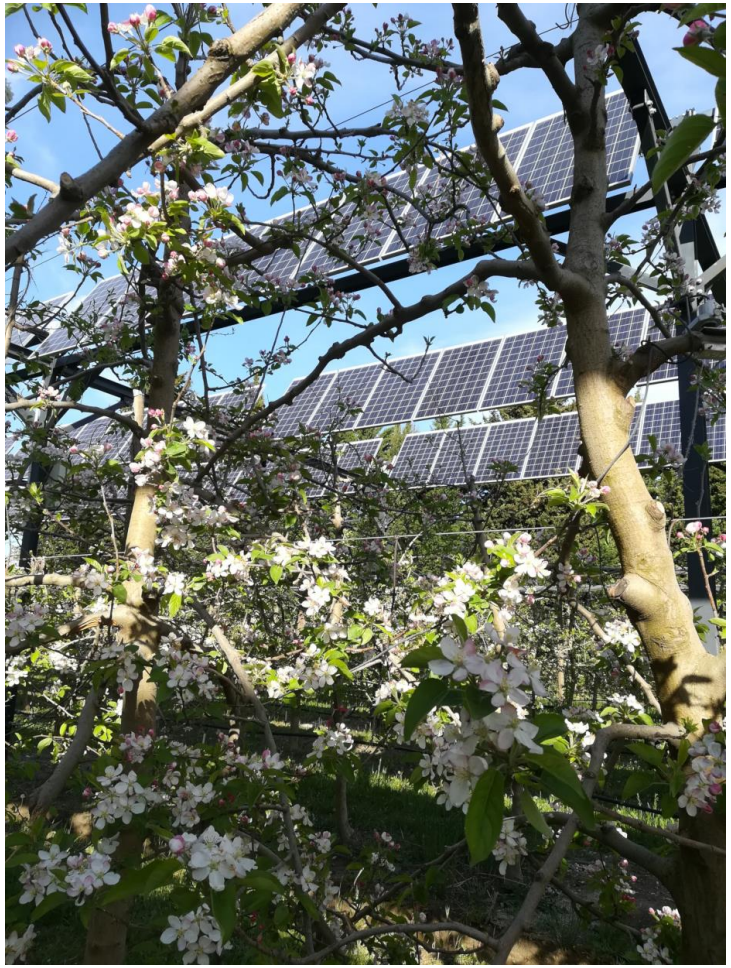

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Motivations of dynamic agrivoltaics

Worldwide food production must be increased by 56% by 2050 to meet the needs of the population while adapting to climate change

PV development requires large surfaces but without land artificialization

In France, fixed south-pointing panels would create inhomogeneity in ground incoming radiation while causing too much shade around wintertime

Dynamic agrivoltaics

A breakthrough solution combining crops and electricity production over one surface, without being detrimental to the crops

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Sun'Agri project

Benefit of bifacial PV panels for agrivoltaics

5 research facilities

Apple trees

Grapevines

Vegetables (starting in 2020)

Field crops
Grapevines (fixed panels)

1 large scale demonstrator

- 4,5 hectares with grapevines and PV panels
- 2,1 MWp
- 3 hectares of control plot without PV
- Agronomical follow-up and real-time microclimate monitoring

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System overview

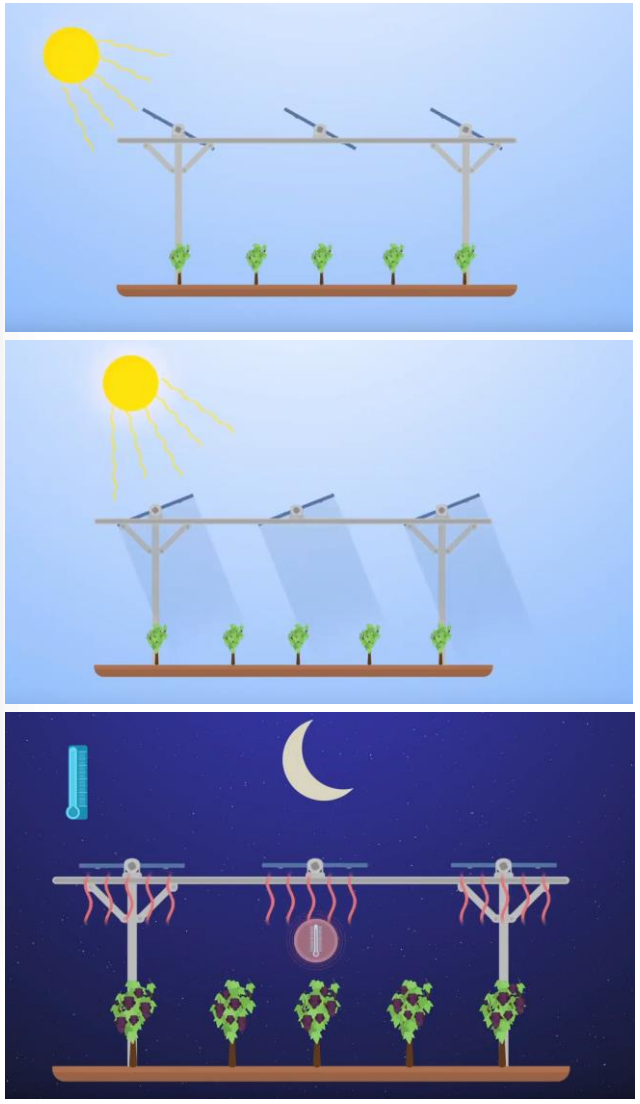
Benefit of bifacial PV panels for agrivoltaics

PV specificities

- Panel steering will follow agronomic purposes and differ from pure solar tracking, inducing electricity production losses.
- Independency of panel steering with respect to the power producer is needed to ensure priority to the crop
- On each present and future demonstrator, a control area without PV is needed to attest the impact of the system on crop growth

Impact on microclimate

- 1-axis rotating panels can avoid shade or rain interception at any time of day (with an extended angle range compared to traditional trackers)
- Shading limits hydric stress and reduces crop temperature
- Flat panels during night reduce thermal losses and therefore frost impact



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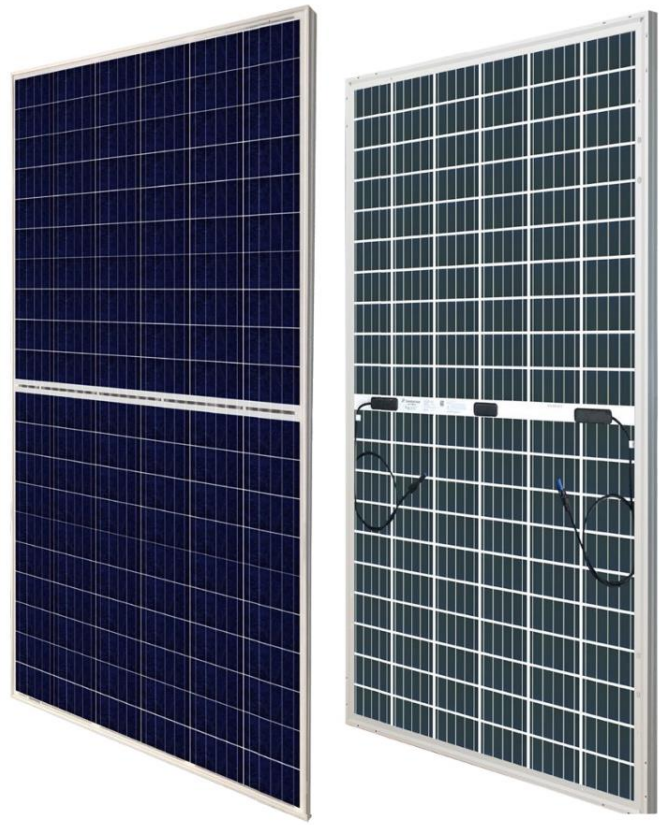
System specificities for bifacial panels

- Panel height ≈ 5 m → less self shading
- More light arrives on the ground
  - GCR is lower than traditional PV plant
  - Panel steering is not pure solar tracking
- Panel transparency → more light for crops
- Albedo is low
- Structure is difficult to adapt

Research and development

Benefit of bifacial PV panels for agrivoltaics

- Bifacial modules have been developed by Photowatt, partner in Sun'Agri 3
- On-site tests are planned on our demonstrator
- Future demonstrators will all be equipped with bifacial PV
- An in-house software was developed to steer the panels and simulate electricity production and incoming light on the crops



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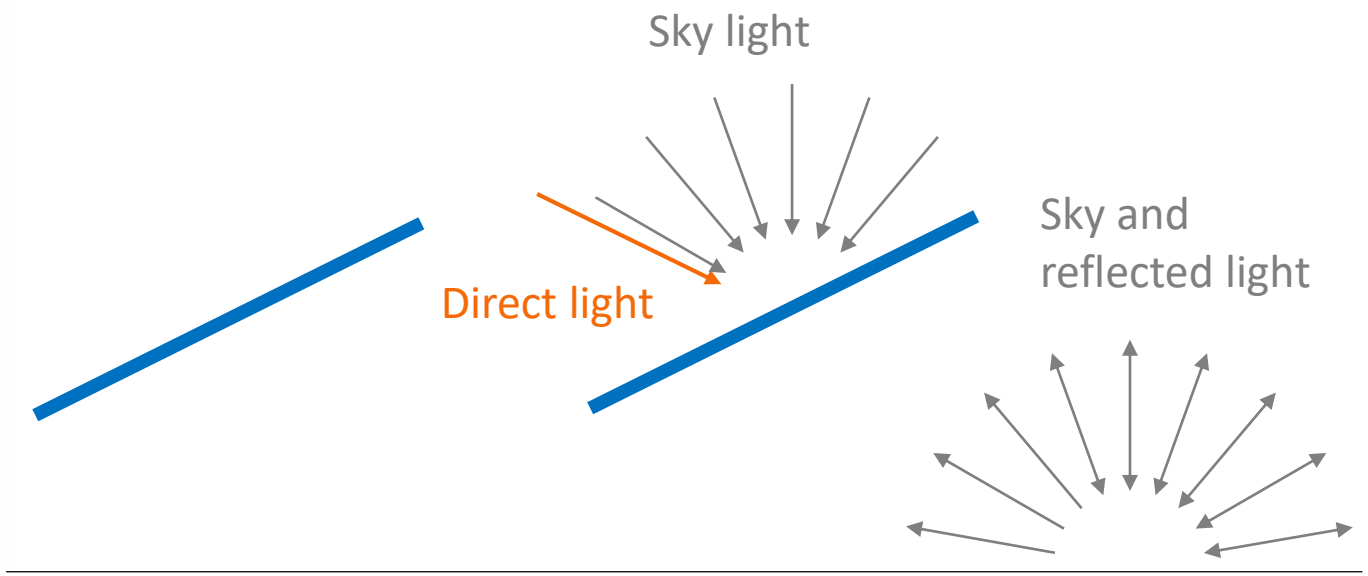
AV-Studio

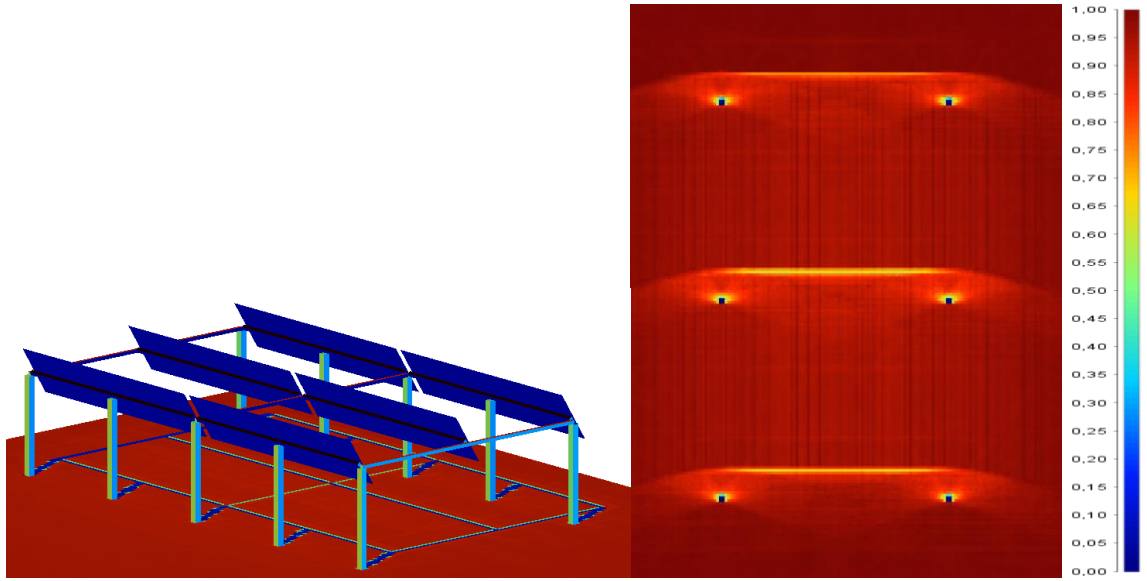
Principles

- Sky is discretized in a finite number of direction
- Incoming radiation is calculated for every direction and shades are projected
- Light is reflected on the ground in the same finite set of directions in an isotropic way
- Mean incoming radiation is calculated for each cell
- One diode model determines the power of each cell
- Total power is calculated with electrical architecture at module and plant level

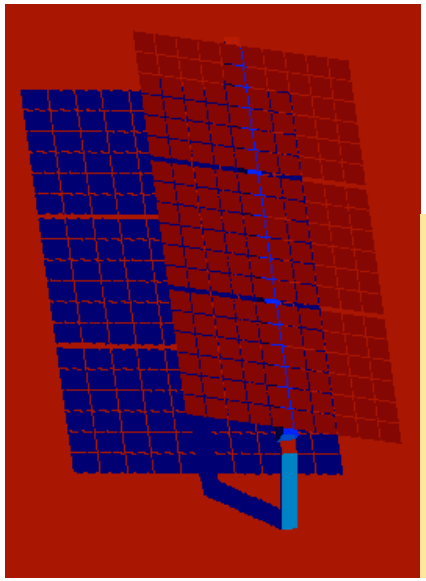


AV-Studio : outputs

Incoming radiation cartography



Bifacial production with structure shade



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1031	1031	1033	1028	1015	985	996	1023	1024	1027	1027	1026

AV-Studio : results

- Bifacial gain is around 5 % with pure solar tracking (height ≈ 5 m, GCR ≈ 0.4, albedo ≈ 0.2)
- Tube shade on the rear side represents about 1 % loss (mainly due to radiation loss rather than inhomogeneity)
- Putting the tube between the panels (in 2H for example) doesn't improve production significantly for this level of albedo
- Steering optimization (less steep when cloudy) doesn't change significantly with bifacial, but gain is lower

QUESTIONS AND ANSWERS

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