
AGRIVOLTAIC: PRACTICAL EXPERIENCE AND POTENTIAL IN CHILE



David Jung M.Sc.

Fraunhofer Chile Research (FCR) - Center for Solar Energy Technologies (CSET)

NETwoRk – Distinguished Lectures Program of SERC

5th of October 2021

AGENDA

- 1 Fraunhofer CSET in Chile
- 2 Agrivoltaic as a Dual-Use of Land Concept
- 3 Agrivoltaic in Chile: Research and Potential
- 4 Q&A

The Fraunhofer Model: A bridge between science and industry



Top ranking applied research center in Europe

Fraunhofer Gesellschaft



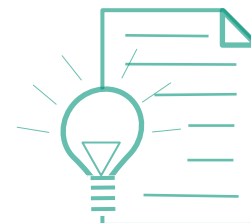
75 Institutes in
Germany



29.000 Researchers
and Engineers

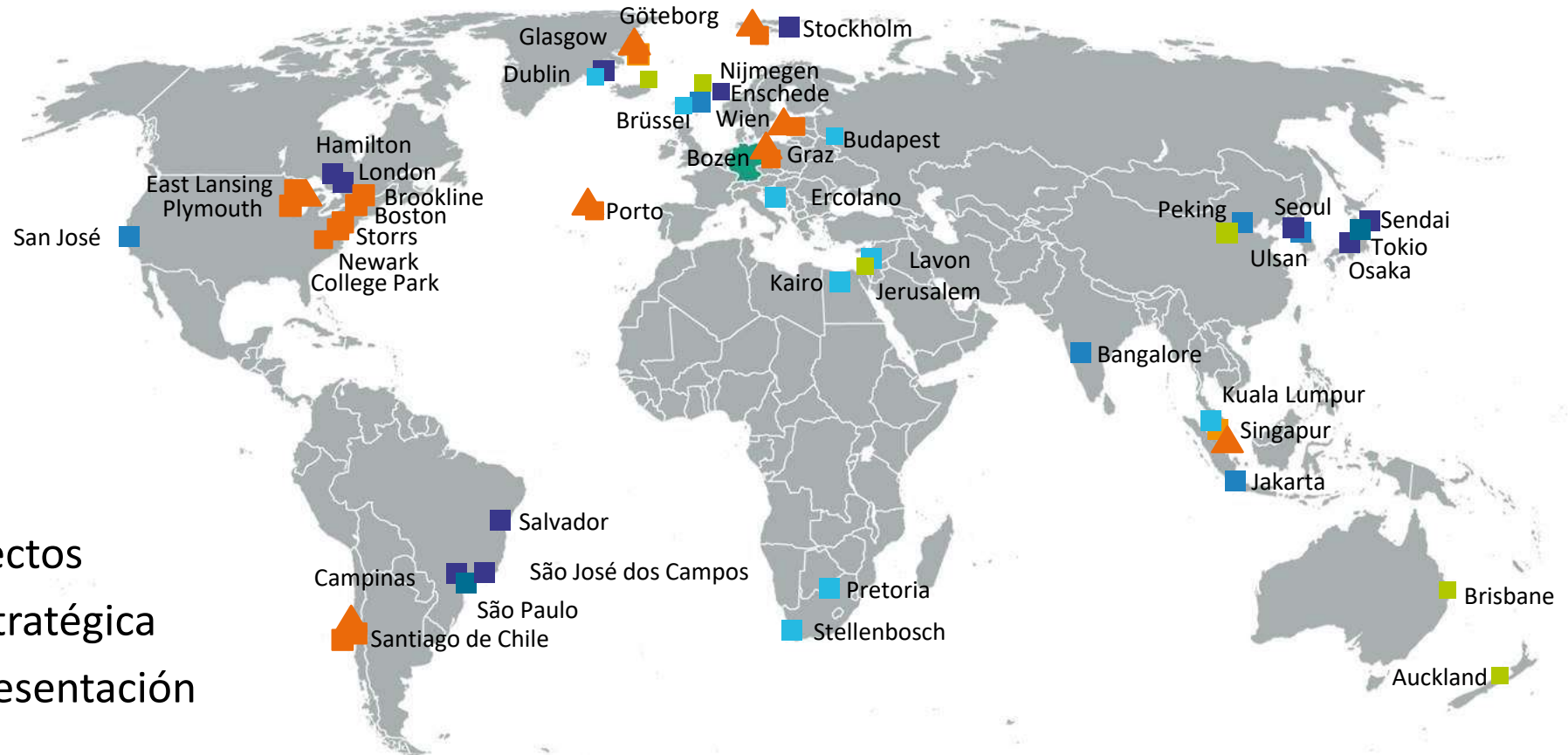


2.800 Millions euros
yearly budget



More than **2** patents per day

Fraunhofer Gesellschaft: Represented worldwide



▲ Branch

■ Center

● Centro de Proyectos

● Cooperación Estratégica

● Oficina de Representación

● Asesoría Senior

Fraunhofer CSET: Solar Energy Pioneer in South America and Chile



- Center for Solar Energy Technologies (CSET) in Chile was founded in 2014
- Applied research in the areas
 - Solar PV
 - Solar Thermal
 - Business Development

AGENDA

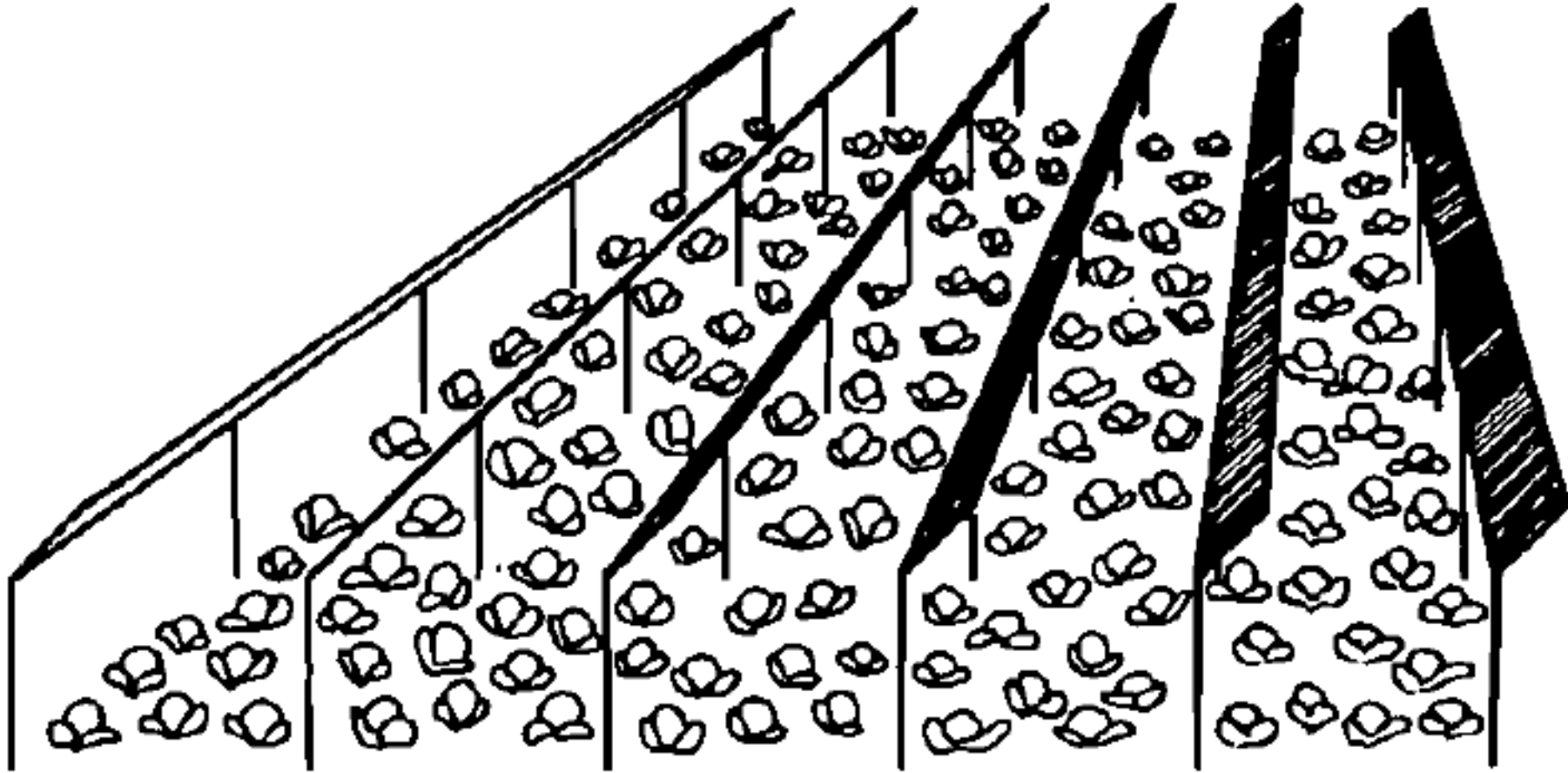
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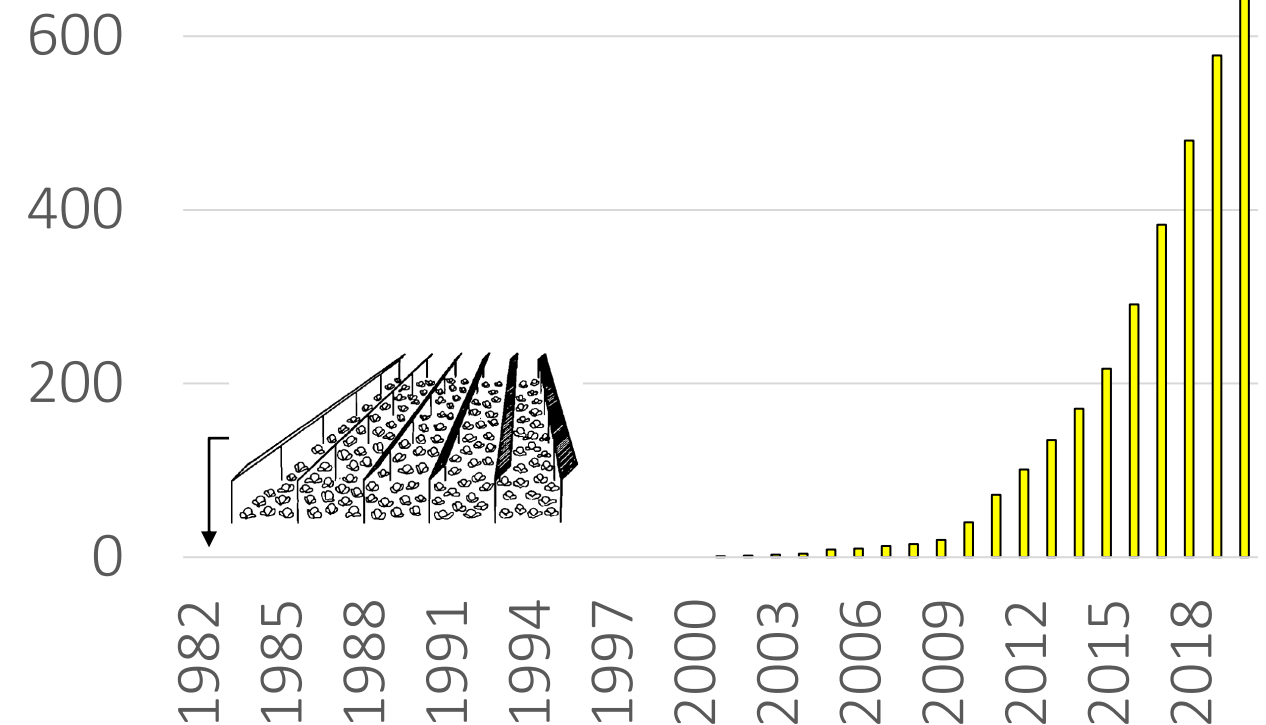
Agrivoltaics was first proposed as a Dual-Use of Land solution in 1981 at Fraunhofer ISE in Germany



The development of solar energy in the last decade has been extraordinary



World wide installed PV capacity (GWp)

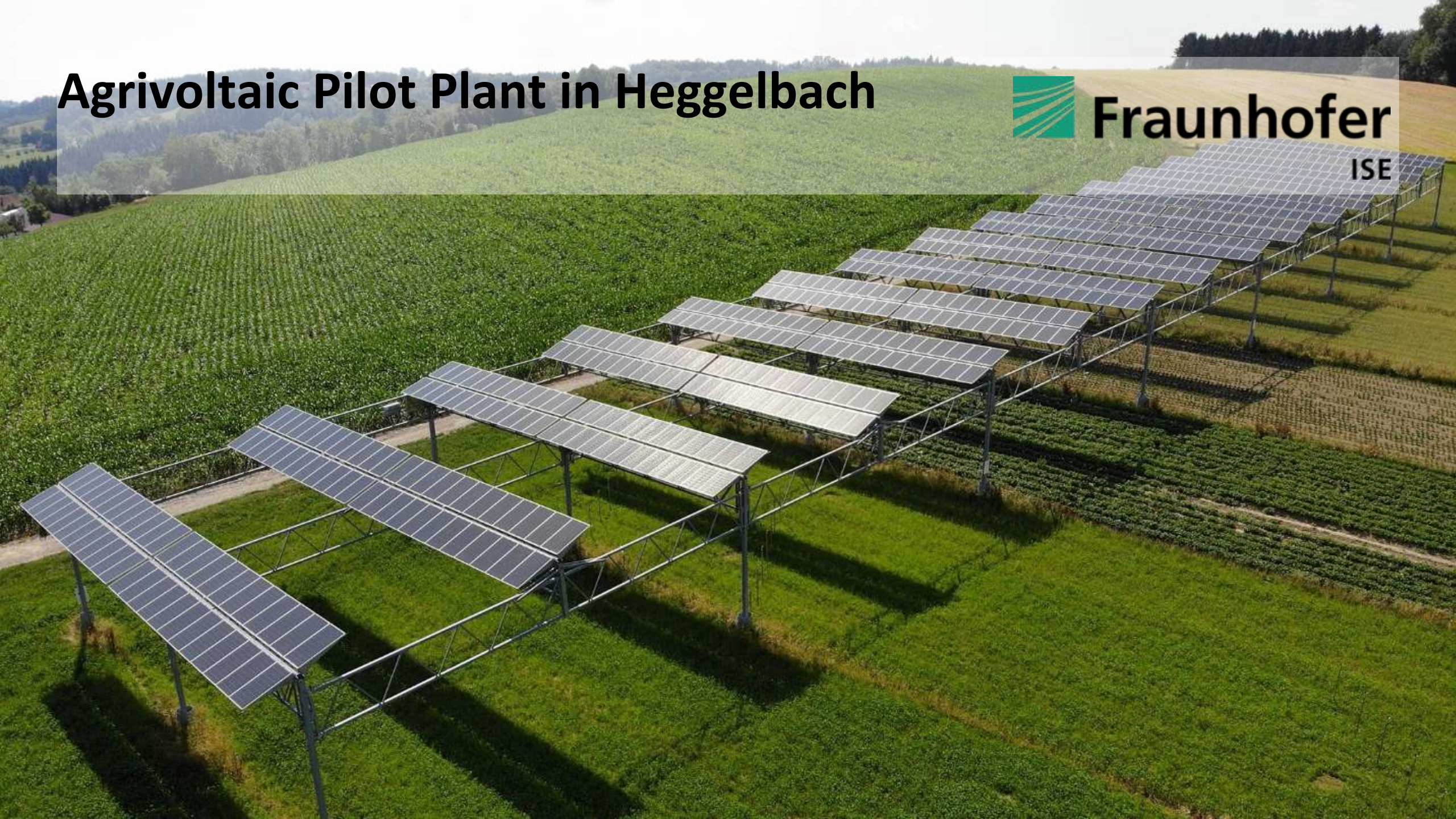


Agrivoltaic Pilot Plant in Heggelbach



Fraunhofer

ISE



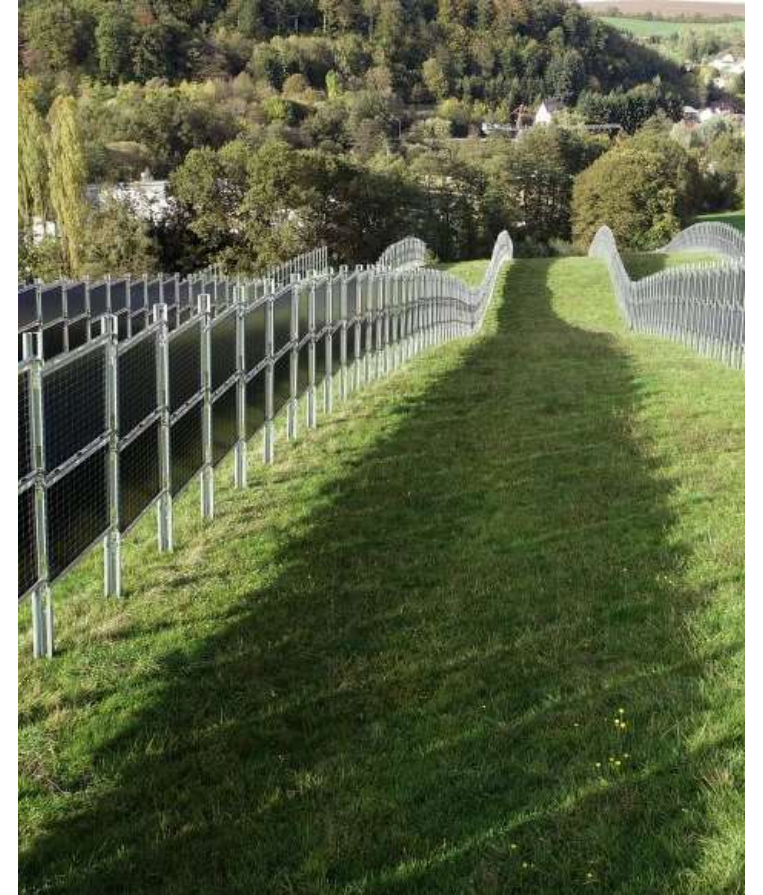
Adaptive shading with PV-panel tracking over wine grapes in France



Moveable arc-shaped PV modules over farmland and livestock



Vertical bifacial PV panels on hay fields in Germany



**Agrivoltaic is as diverse as agriculture itself
and aims at creating a benefit for the farmer**

Semi-transparent PV modules as rain and hail protection in Germany



Rain and wind protection with semitransparent PV-panels over raspberries in the Netherlands



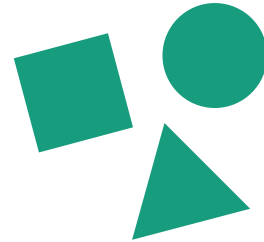
Combination of agrivoltaic systems with (intelligent) plastic cover to protect crops in Italy



2021: Worldwide trends in agrivoltaic



Growing interest



Agrivoltaic is as diverse
as agriculture itself



Focus on providing
benefits for the farmer

AGENDA

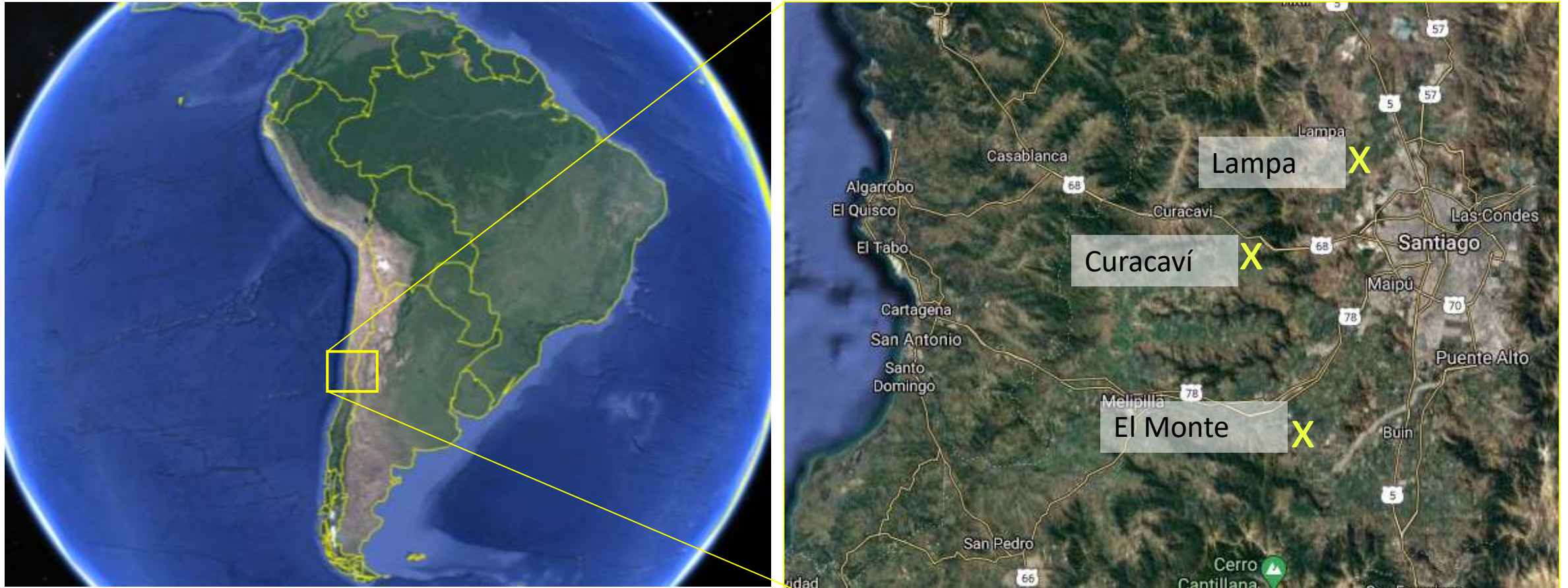
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Fraunhofer CSET operates three agrivoltaic pilot plants in central Chile



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Total Capacity	kWp	12.48 (48 Panels)
PV Panel	-	Jinko Solar JKM260
Technology	-	Poly-crystalline
Capacity PV Panel	Wp	260
Inclination of Panels	°	27 (fixed)
Elevation of Panels	m	3.9
Plant Area	m ²	224 (8m × 28m)








SEMINARIO

AGROPV: ENERGÍA SOLAR PARA UNA AGRICULTURA SUSTENTABLE







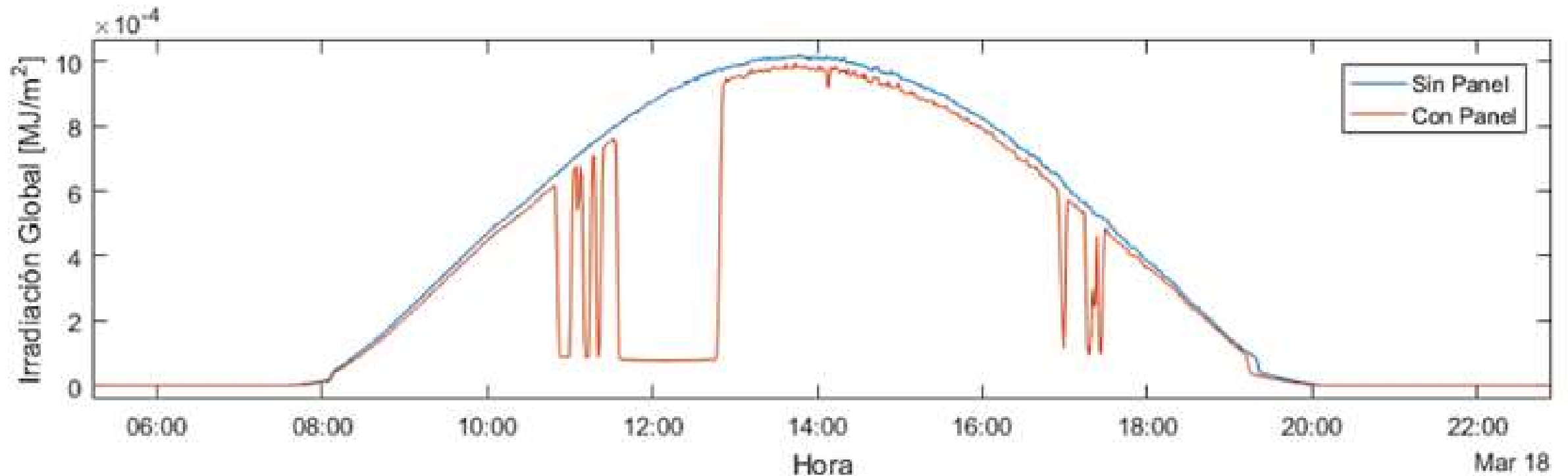
Fraunhofer CSET Agrivoltaic pilot plants: Practical experience



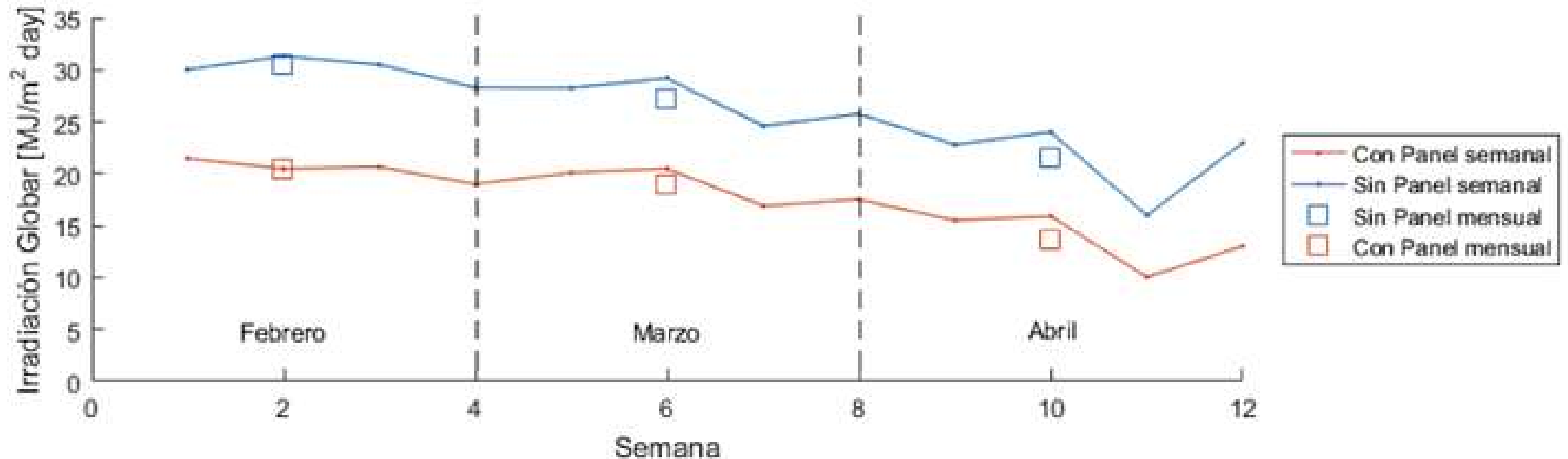
Fraunhofer CSET Agrivoltaic pilot plants: Investigation on the microclimate



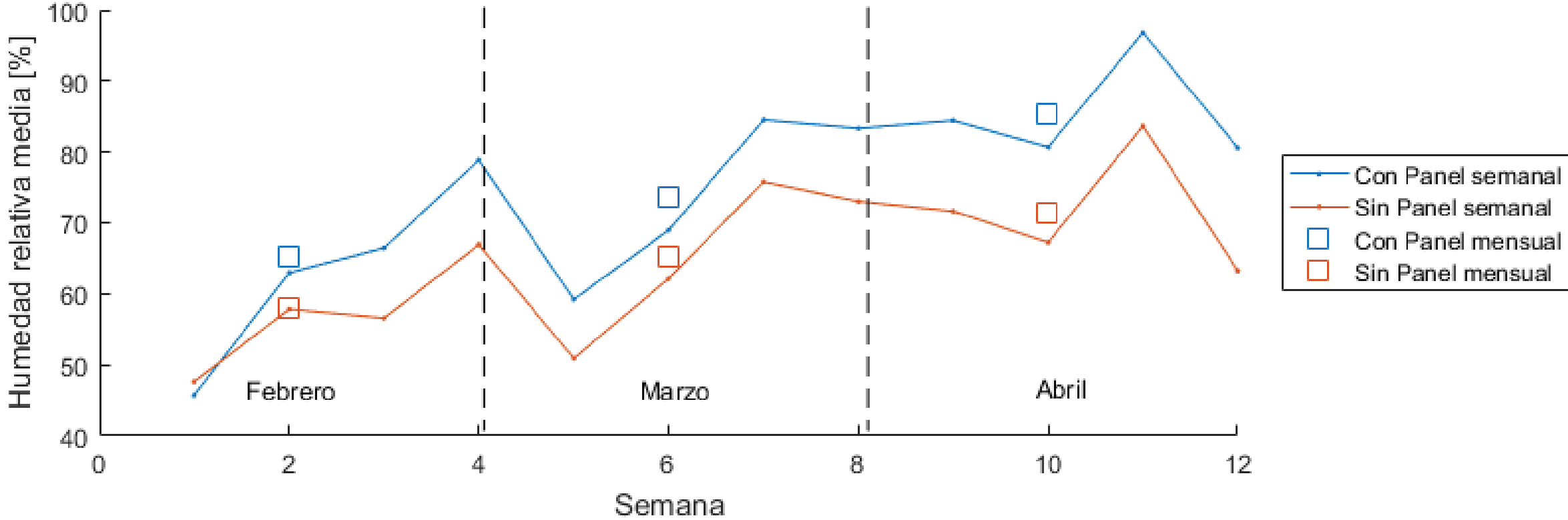
Fraunhofer CSET Agrivoltaic pilot plants: Investigation on the microclimate (preliminary results)



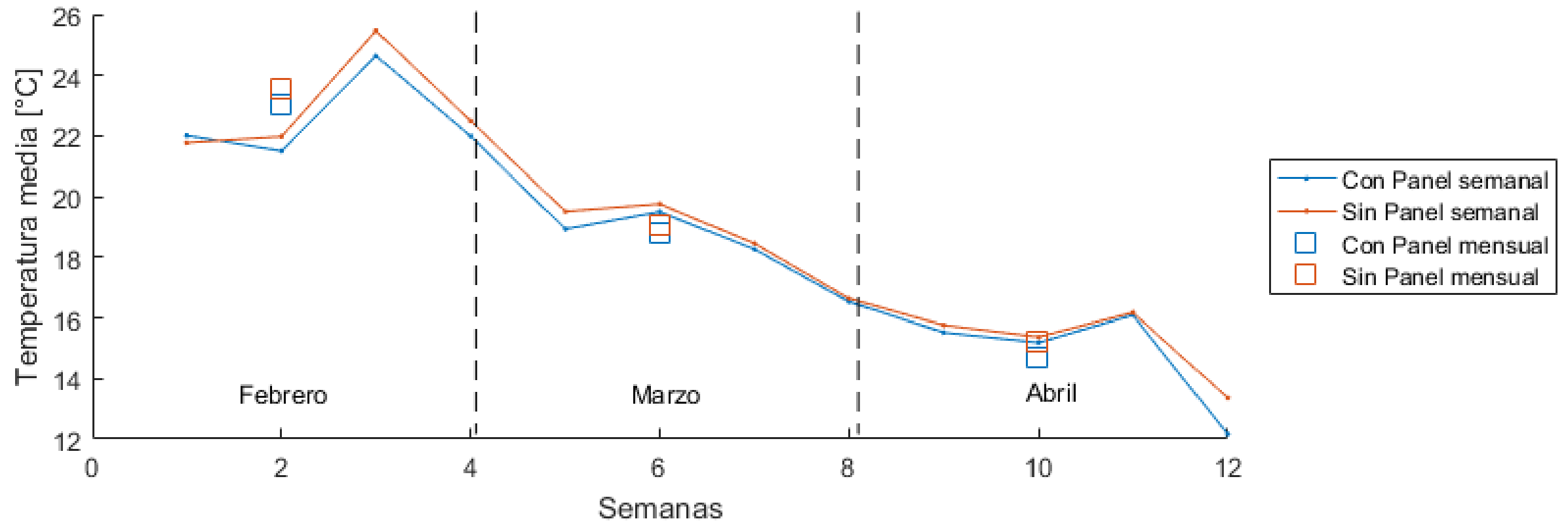
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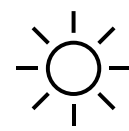
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Fraunhofer CSET Agrivoltaic pilot plants: Investigation on the microclimate (preliminary results)



Microclimate Analysis



Irradiation → 30% reduction registered under the panels.



Humidity → 10% - 20% increase (relative humidity)

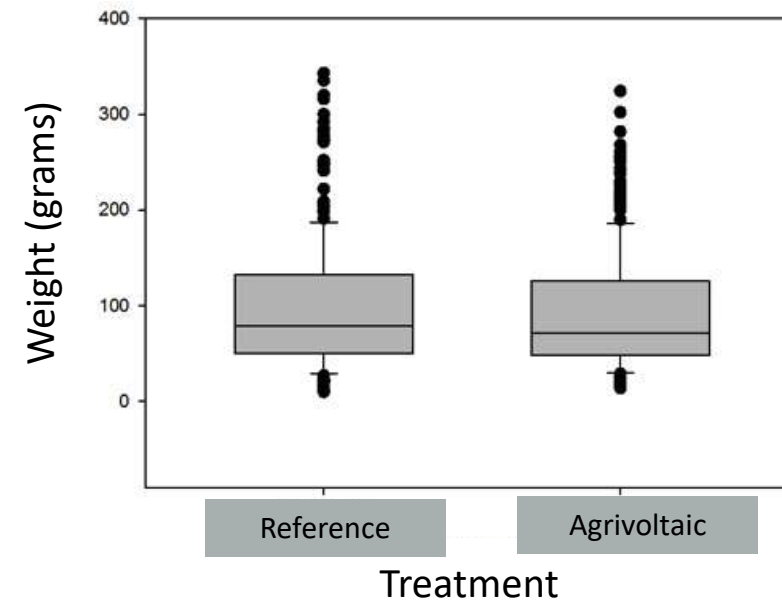


Temperature → no significant difference.

Fraunhofer CSET Agrivoltaic pilot plants: Investigation on plant growth



Lettuce harvest analysis (2019)

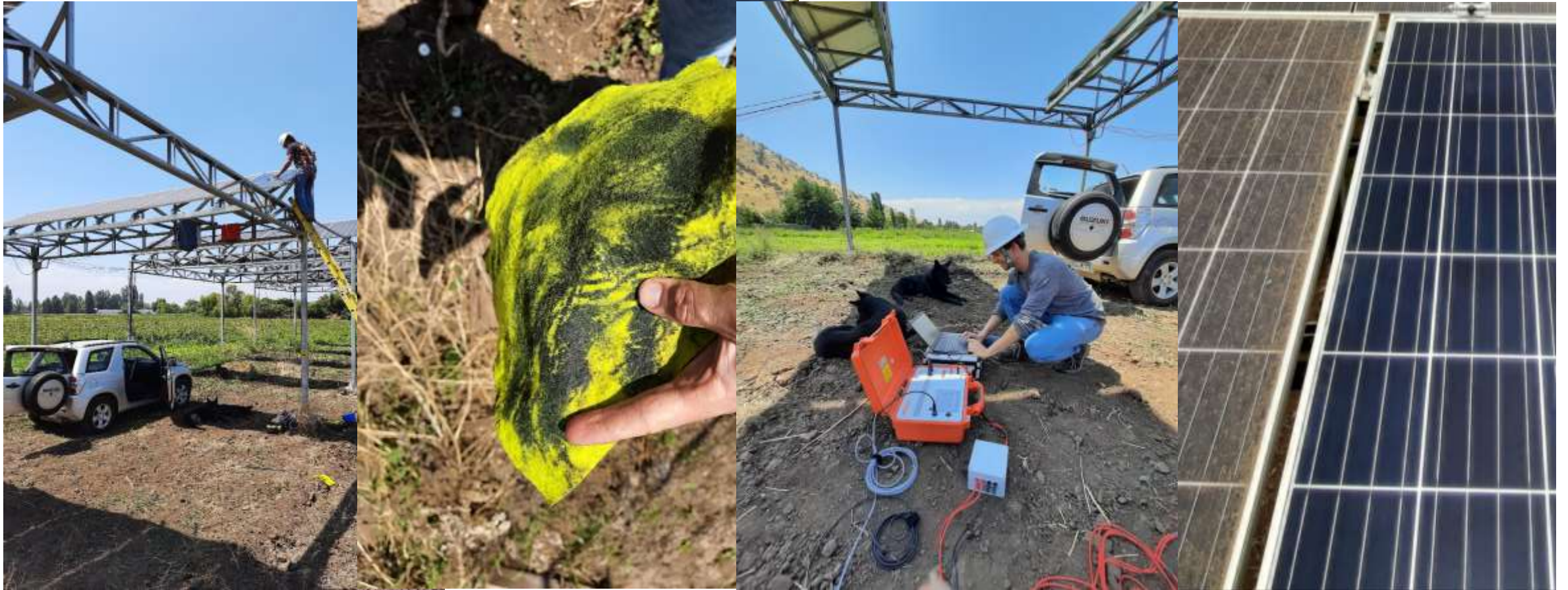


→ no statistical difference between treatments

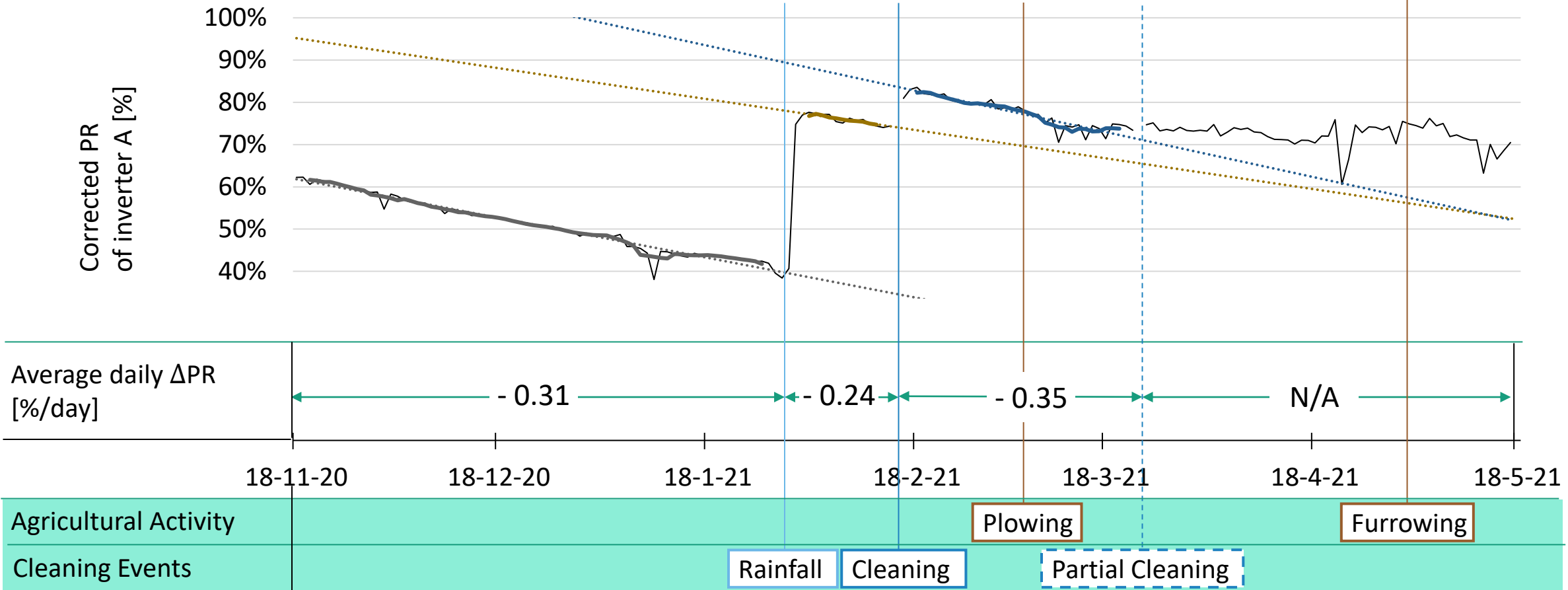
Fraunhofer CSET Agrivoltaic pilot plants: Research on soiling



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High soiling rates of up to 0.35 %/day in summer months require cleaning (solutions)

What is the potential of agrivoltaic in South America?

Potential of Agrivoltaic: Farmers need climatic protection to assure crop quality and efficient water use

Crop Damage because of adverse climate

- Unseasonal heavy rainfalls causes “cracking” and leads to loss of harvest

Chile Fruit Harvest Deeply Affected by Heavy Rains, Rise in Prices Expected

Expected

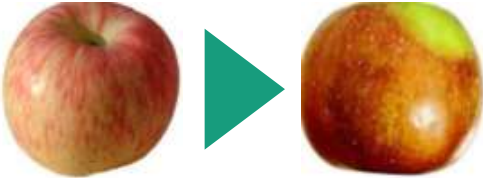
Blueberry Berry Chile  Market

Chile: Weather-related fruit losses pegged at \$150M

Feb 03, 2021

February 05, 2021

- Sun strokes because of intensive sun light



Potential of Agrivoltaic: Farmers use Shading nets to avoid sun burns and to use water more efficiently



Potential of Agrivoltaic: Purposeful Shading with PV Panels

Shading Nets in Agriculture



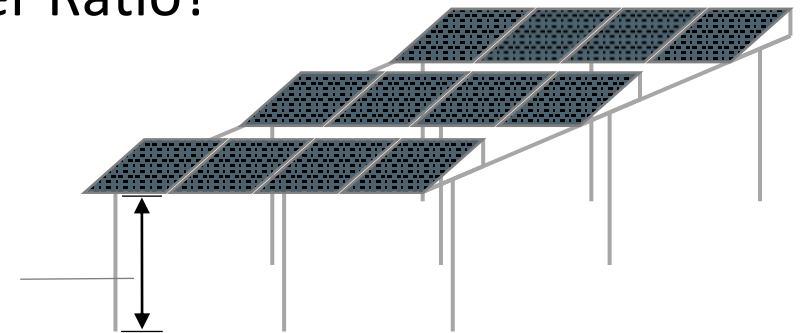
- Increase water use efficiency
- Protection from heat stress, sun strokes and burnings

Conceptual Agrivoltaic Plant Design

Ground Cover Ratio?

Azimuth?

Ground Clearance?

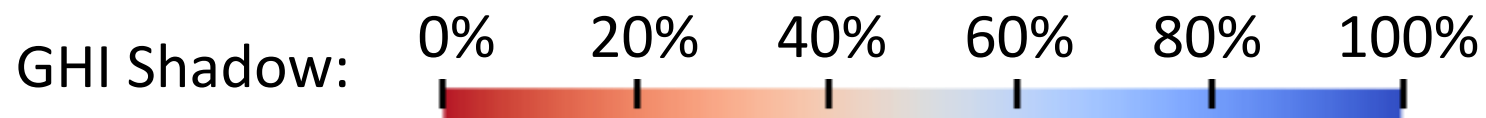
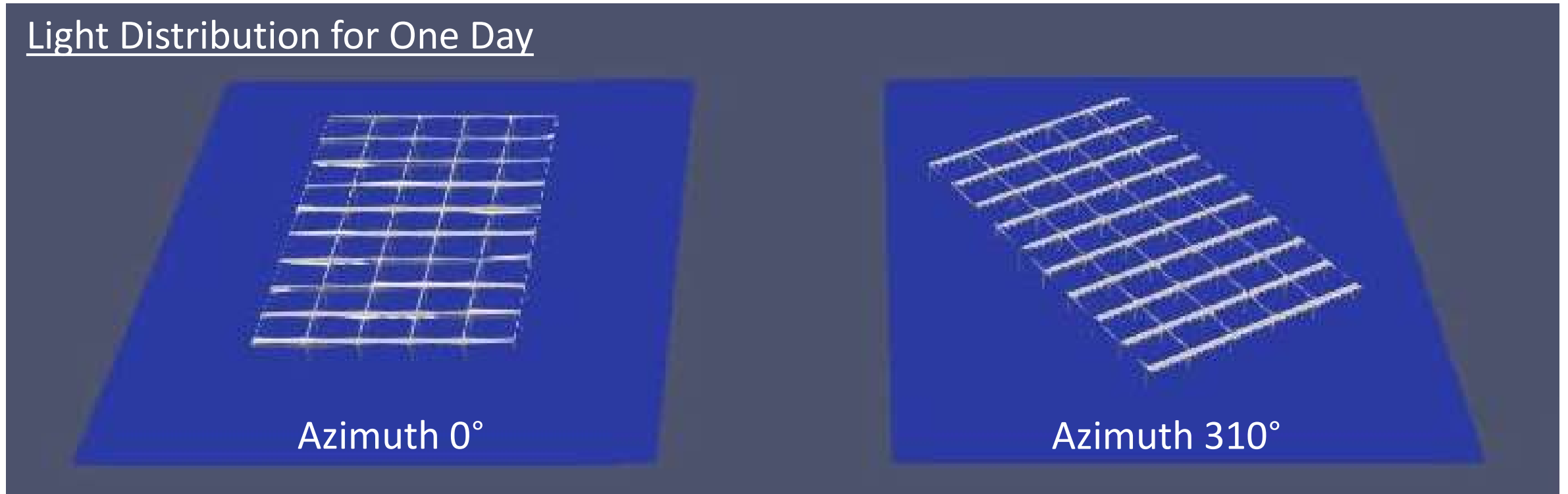


- Allow machinery use
- Provide shading similar to shading nets

Potential of Agrivoltaic: Purposeful Shading with PV Panels

- Simulation of Light Distribution

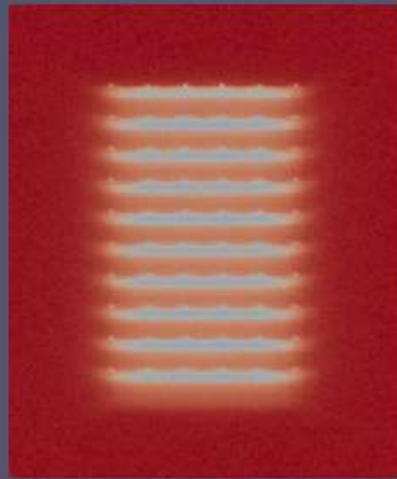
Light Distribution for One Day



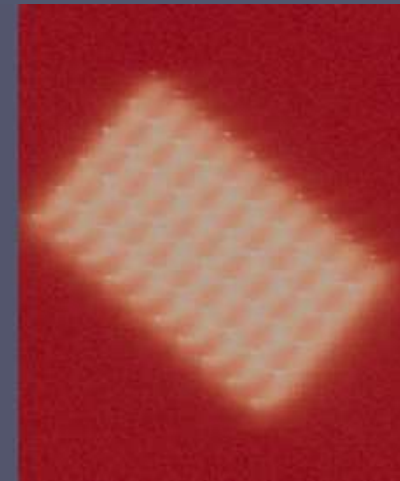
Potential of Agrivoltaic: Purposeful Shading with PV Panels

- Simulation of Light Distribution → Shade Design

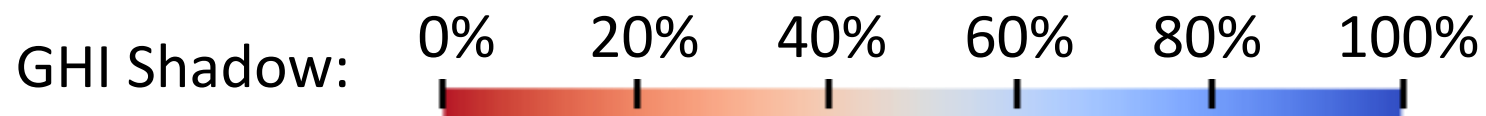
Annual Light Distribution



Azimuth 0°



Azimuth 310°

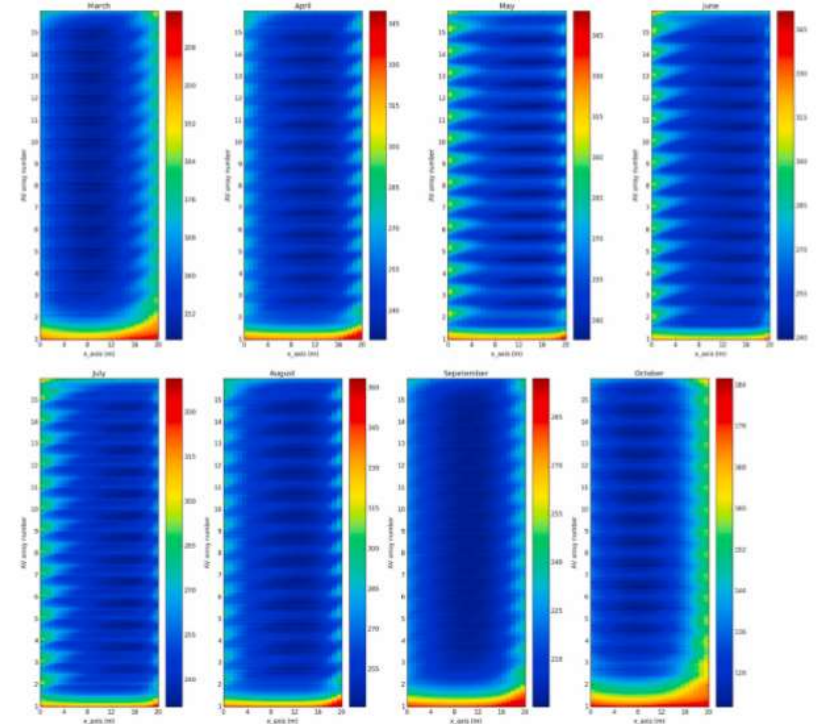


Agrivoltaic could enable resilient agriculture in dry and sunny regions in Chile

Fraunhofer as a leading agrivoltaic pioneer and support for the industry

Ongoing Agrivoltaic Research and Industry Projects at Fraunhofer ISE and Fraunhofer CSET

- Currently 10 agrivoltaic pilot plants in Europe, Africa and South America in operation
- 10 more pilot plants under construction
- Consultancy in ongoing industry projects
 - Biggest site: 350 ha
 - Countries: Italy, Netherlands, Nigeria, Chile
- Covered Services: Design, Light simulation, Crop assessment, scientific monitoring among others



Our Vision

We enable the local industry in Chile and South America to commercialize agrivoltaic as a sustainable solution to protect crops, water and climate with PV panels.



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Thank you for your Attention – Questions?

In case you have any further questions, please contact:

david.jung@fraunhofer.cl

Fraunhofer Chile Research – Center for Solar Energy Technologies

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