Dual land usage for PV plants − Agrivoltaic approach

Graduate

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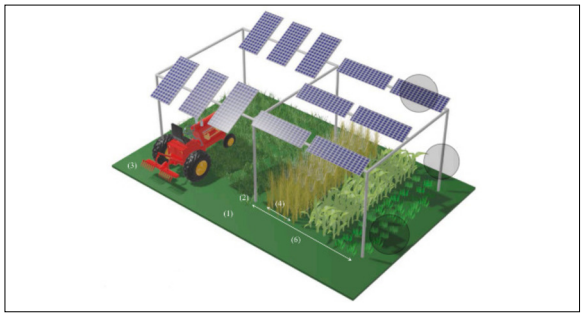
Introduction: The world is facing various difficulties in the ongoing transition to renewable energy. One of the most popular renewable technology is photovoltaics. It requires a large amount of land to produce electricity and the construction of solar farms competes with agriculture. One possible solution to this problem is agrivoltaics. In Evora the chair of renewable energies wants to implement an agrivoltaic pilot plant within their research facilities. To help with this ongoing project 3 major topics were researched and developed:

- Agrivoltaic potential in Portugal and Switzerland
- Designing and calculating possible variants for the agrivoltaic pilot plant
- Implementing a measurement system and analysing data

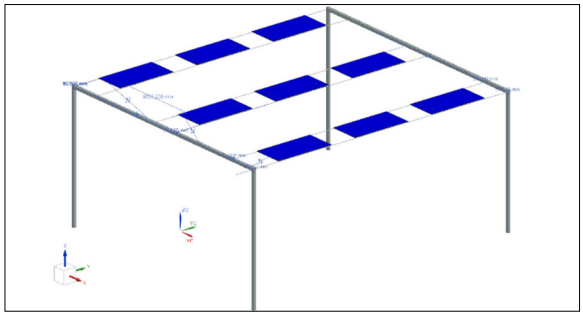
Result: Potential:
With the agricultural statistics for potato, tomato and lettuce fields and the estimations of an agrivoltaic system the energy yield for Portugal and Switzerland was calculated. A LER of 1.54 for potato, a LER of 1.14 for tomato and a LER of 1.35 for lettuce was calculated by reviewing case studies.
For Switzerland covering 20 % of the potato fields results in covering 2.90 % of the electricity demand 2022, covering 20 % of tomato fields results in covering 0.06 % of the electricity demand 2022 and covering 20% of lettuce fields result in covering 0.22 % of the electricity demand 2022.
Pilot:
In the CAD NX Siemens 3 different overhead structures were drawn. A square structure, a cable structure and an arch structure. With these configurations 12 different simulations were done in PVSyst, with different modules, tracking and alignment. The resulting energy yields were compared ranging between 74.36 kWh/year/m^2 and 134.99 kWh/year/m^2 with the version 1.2.1 and 1.2.2 having the highest with 128.66 kWh/year/m^2 and kWh/year/m^2.
An economic analysis was also made, calculating the LCOE of the 12 different configurations. The results were compared ranging between 0.080 €/kWh and 0.0129 €/kWh with the version 1.2.2 and 2.2.2 having the lowest with 0.080 €/kWh and 0.081 €/kWh.

Result: Measurement:
A measurement system was deployed in the open field and beneath an existing PV power plant to compare agricultural and agrivoltaic situations. Temperature, volumetric water content and photosynthetically active radiation were measured and reviewed. They were also compared to data of the local weather station.
The soil temperature in the shaded areas was up to 2.8° C lower than in the open field.

agrivoltaic system
Agrivoltaic system designing for sustainability, Sangik Lee



CAD cable design
Own presentment



measurement system
Own presentment

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Subject Area
Electric solar technology, Construction design