SOLARISE project
accelerating solar energy adoption

UNIVERSITY OF PORTSMOUTH

Interreg
EUROPEAN UNION
2 Seas Mers Zeeën
SOLARISE
European Regional Development Fund

CO_2
Low-carbon technologies

TOTAL PROJECT BUDGET:
4.35 M €
INCLUDING AN ERDF BUDGET OF:
2.61 M €

Solar Living Lab – University of Portsmouth

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About living labs

Living labs are defined as user-centred, open innovation facilities integrating research and innovation processes in real-life settings.

A university-based living lab gives the opportunity for staff, students and other stakeholders to analyse the behaviour of real systems as they operate and provides access to live testbeds for innovative scientific research

The Solar Living Lab at Portsmouth

As part of the SOLARISE project co-funded by Interreg 2 Seas and the European Regional Development Fund, a solar living lab has been created consisting of installations at two buildings at the University of Portsmouth.

The Future Technology Centre is a £12m facility opened in 2018 for project-based learning and innovation in engineering and product design

The Port-Eco-House is a research facility consisting of an instrumented 3-bedroom household for research in energy efficiency and building performance

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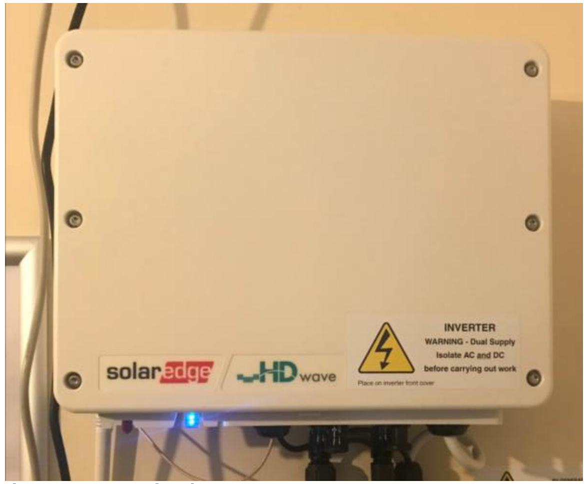
The solar living lab at Portsmouth

- The following items were installed at the Eco-House
  - 15x PV modules, fully monitored, 5 kW in total
  - 15x module optimisers,
  - 1x 5 kW inverter,
  - 1x 13.5 kWh Tesla Powerwall 2 battery
  - 1x Tesla Backup Gateway 2
- Major installation work was completed on 7 May 2021.

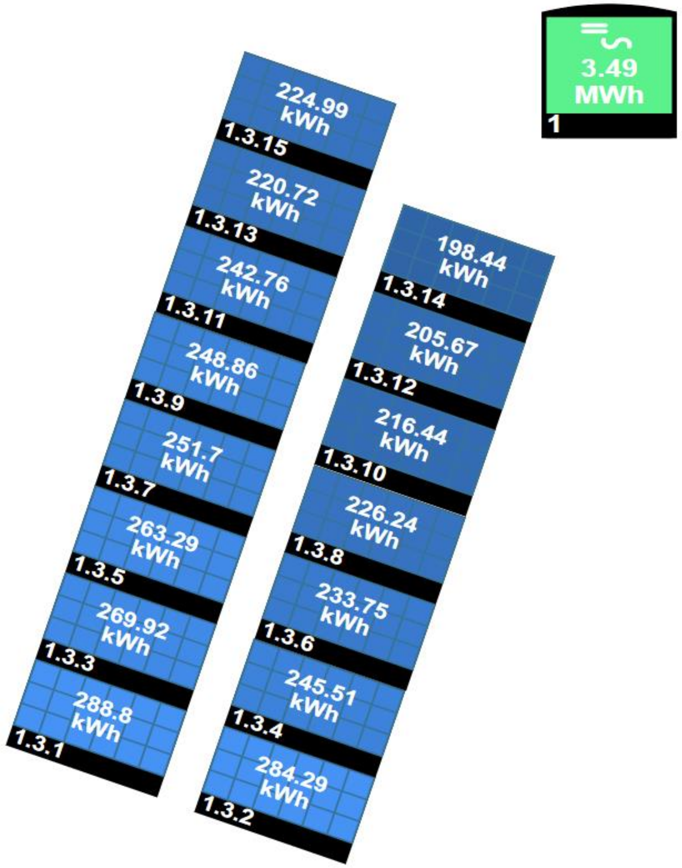


The solar living lab at Portsmouth

- A 40 kWh Tesla battery storage system installed at the three-phase electricity system of Future Technology Centre (FTC) building, to work together with existing 25 kW photovoltaic facility.
- This is complemented by a range of equipment that has been purchased to support UG and PG student projects

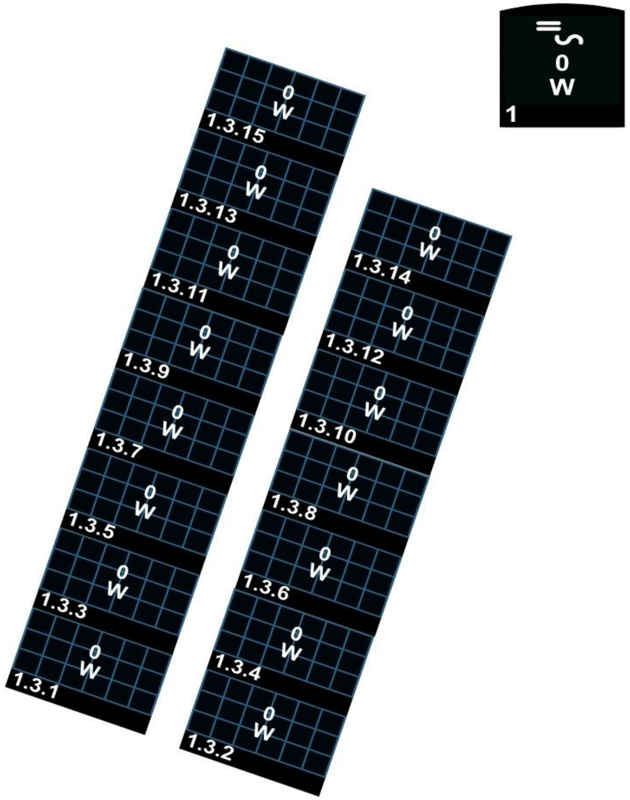
Monitoring data from Eco-House

- Total energy production per module from 5 May 2021 to 5 May 2022
- The differences between modules are due to varying shading



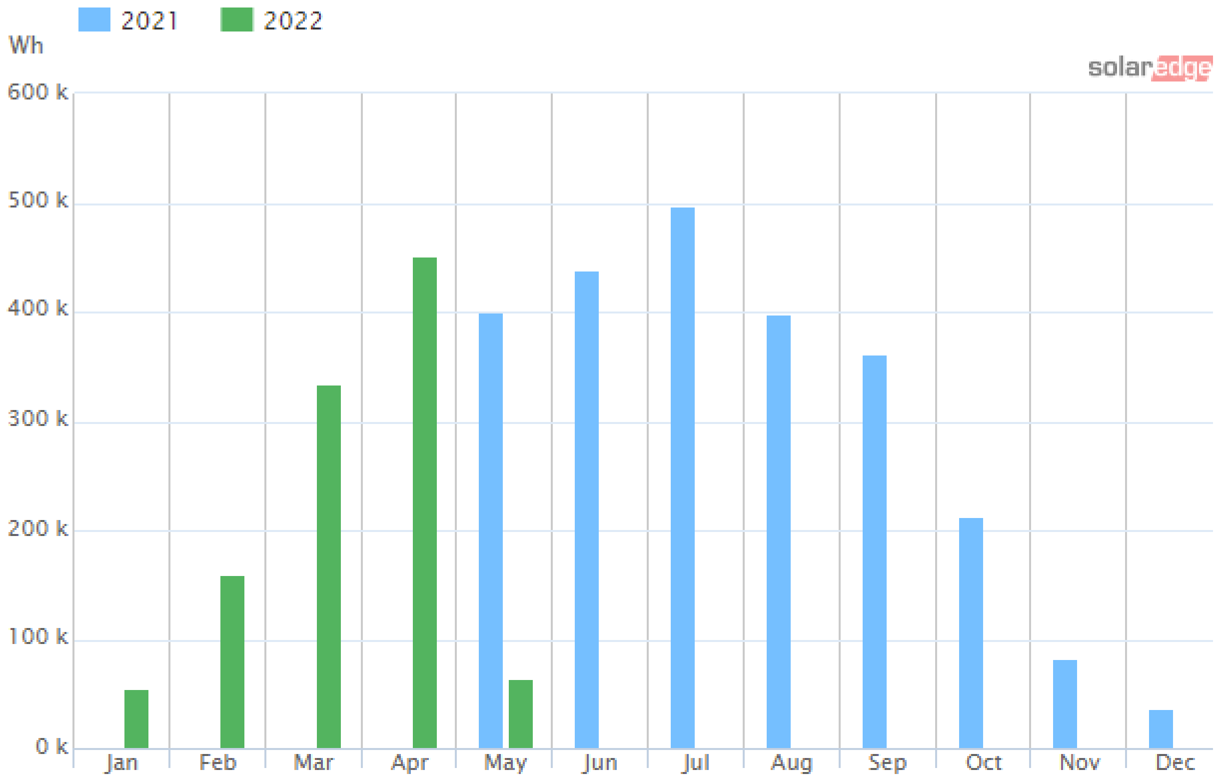
Monitoring data from Eco-House

- The animation shows how power production varies between panels due to differences in shading on a particular day
- The power optimisers on each module ensure that production is the maximum possible, despite differences in shading



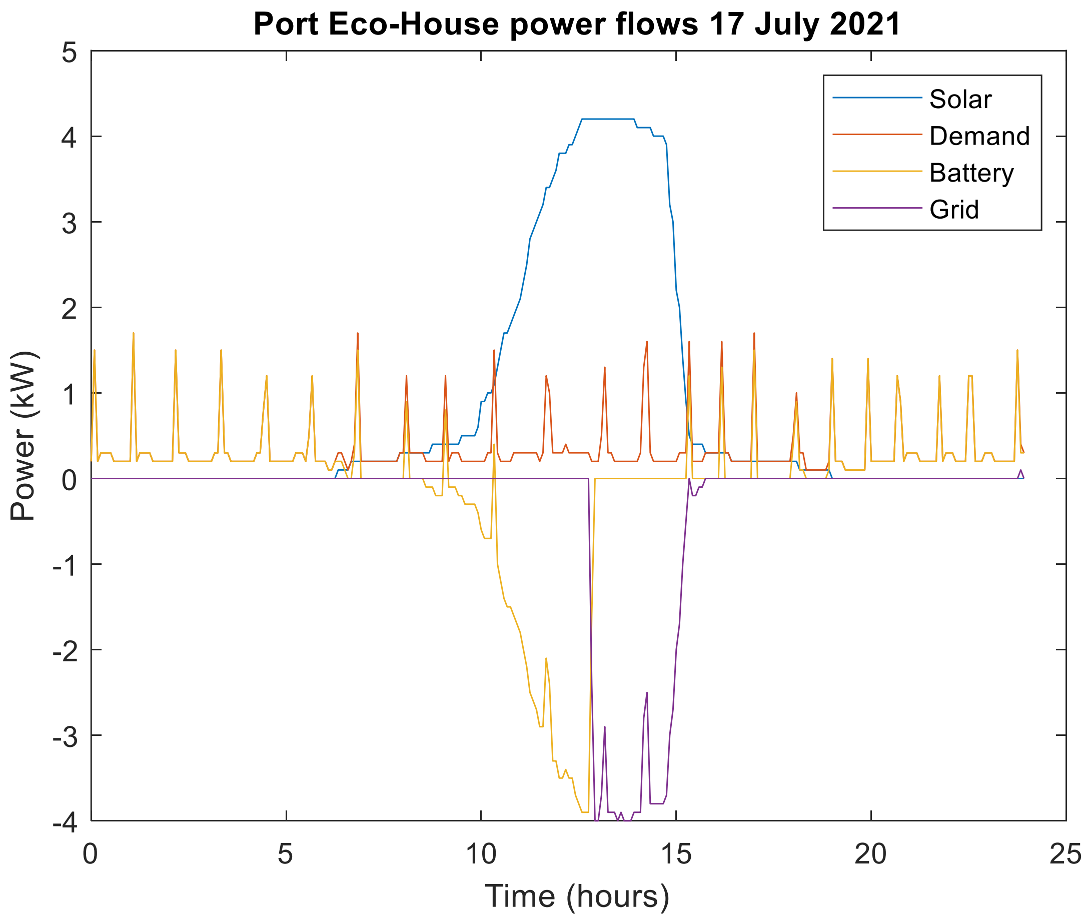
Monitoring data from Eco-House

- The bar chart shows the production of PV energy per month.
- The normal demand of the eco-house is around 300 kWh per month
- This demand is typical for a household of that size
- With the help of the Tesla battery, the eco-house is mostly self-sufficient for several months of the year



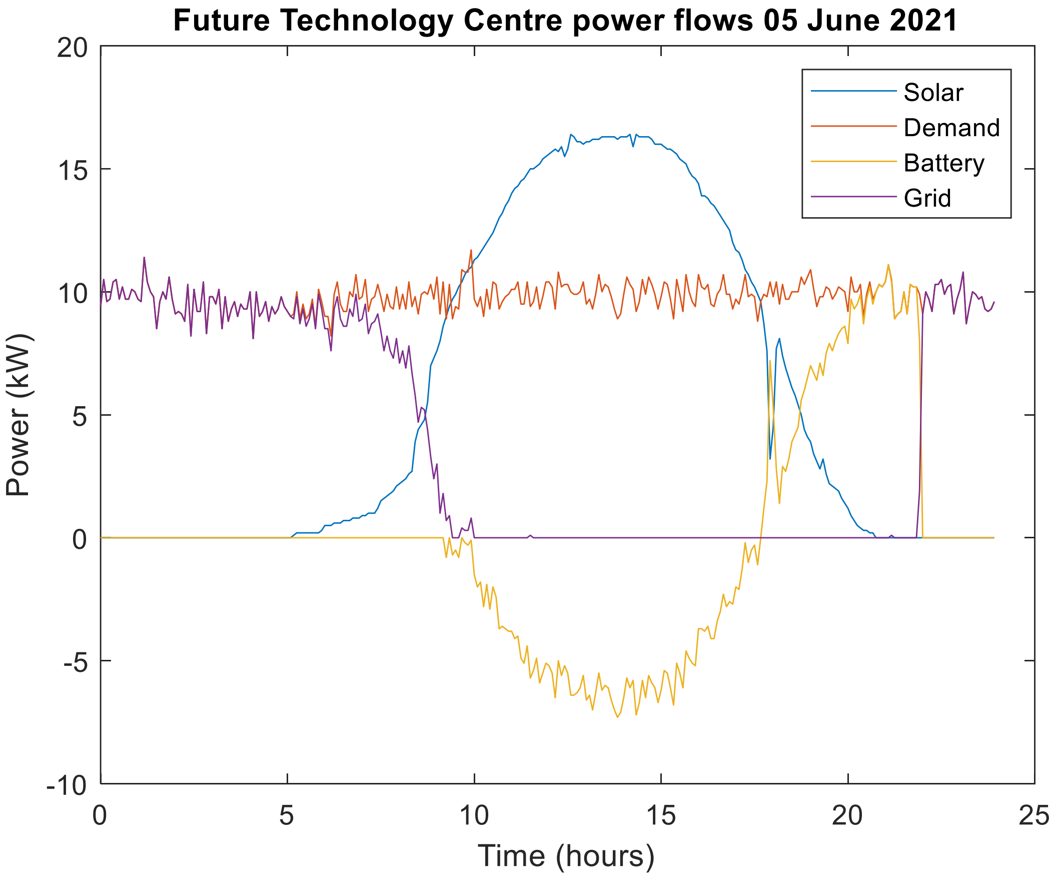
Monitoring data from Eco-House

- The figure shows the power flows at the Eco-House on 17 July 2021
- Notice how the excess solar power is stored in the battery between approximately 08:00 and 13:00.
- At around 13:00 the battery becomes fully charged and the excess solar power is exported into the local grid until about 15:20.
- Also notice that during this day the house was electrically self-sufficient, with no electrical energy being imported from the grid.



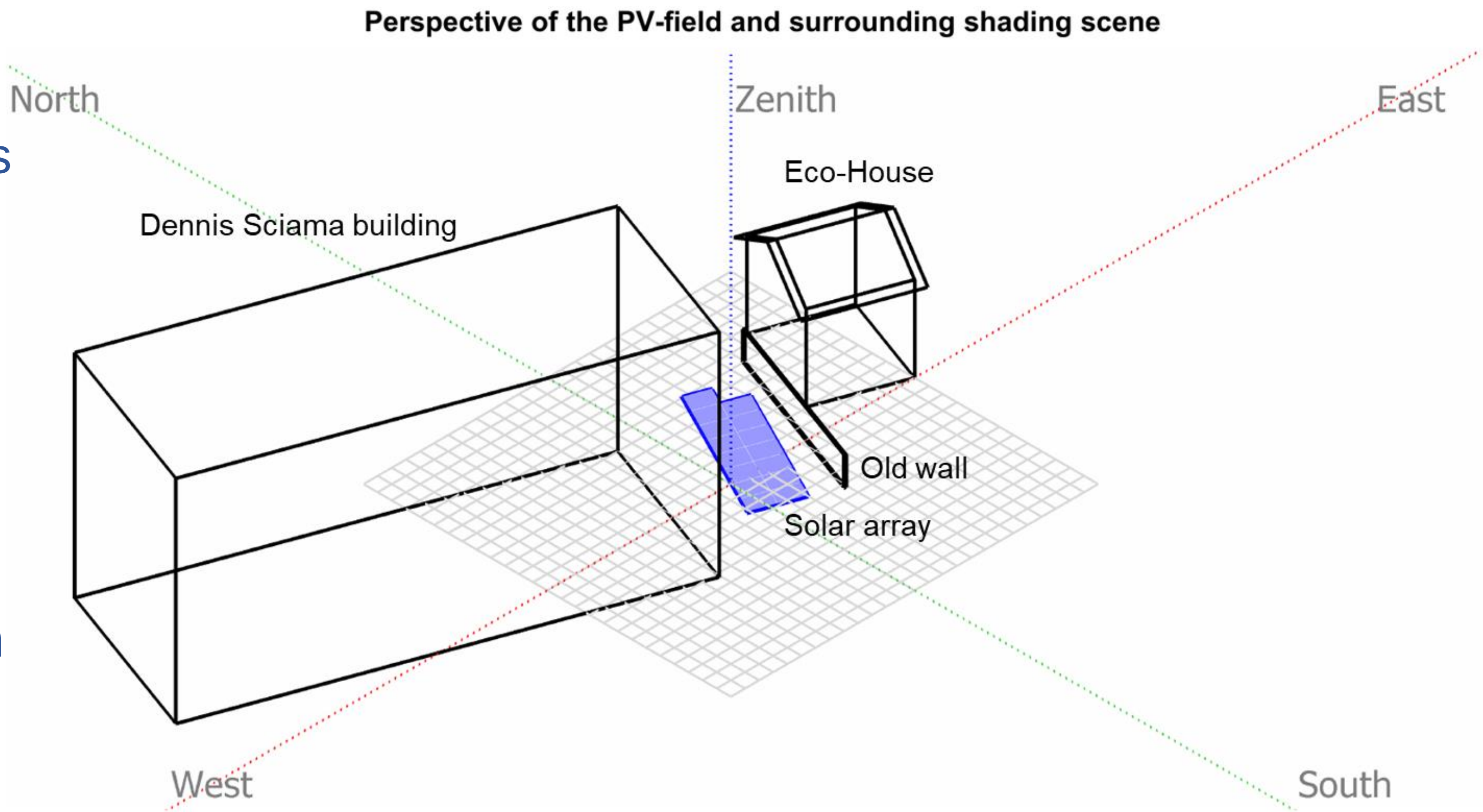
Monitoring data from the Future Technology Centre building

- The figure shows the power flows at the Future Technology Centre on 05 June 2021.
- Notice how the excess solar power is stored in the battery between approximately 10:00 and 17:20.
- At around 17:20, the battery bank reaches a maximum state of charge of 83% and it then starts to supply energy to the building until it fully discharges at about 22:00.
- Note that between about 10:00 and 22:00 the power import from the grid was nil
- Also note that between 20:50 and 22:00, the battery bank alone was supplying 100% of the power demand of the whole building.
- The data is a good illustration of how battery storage working in conjunction with solar photovoltaics can help maximise the self-consumption of renewable energy.

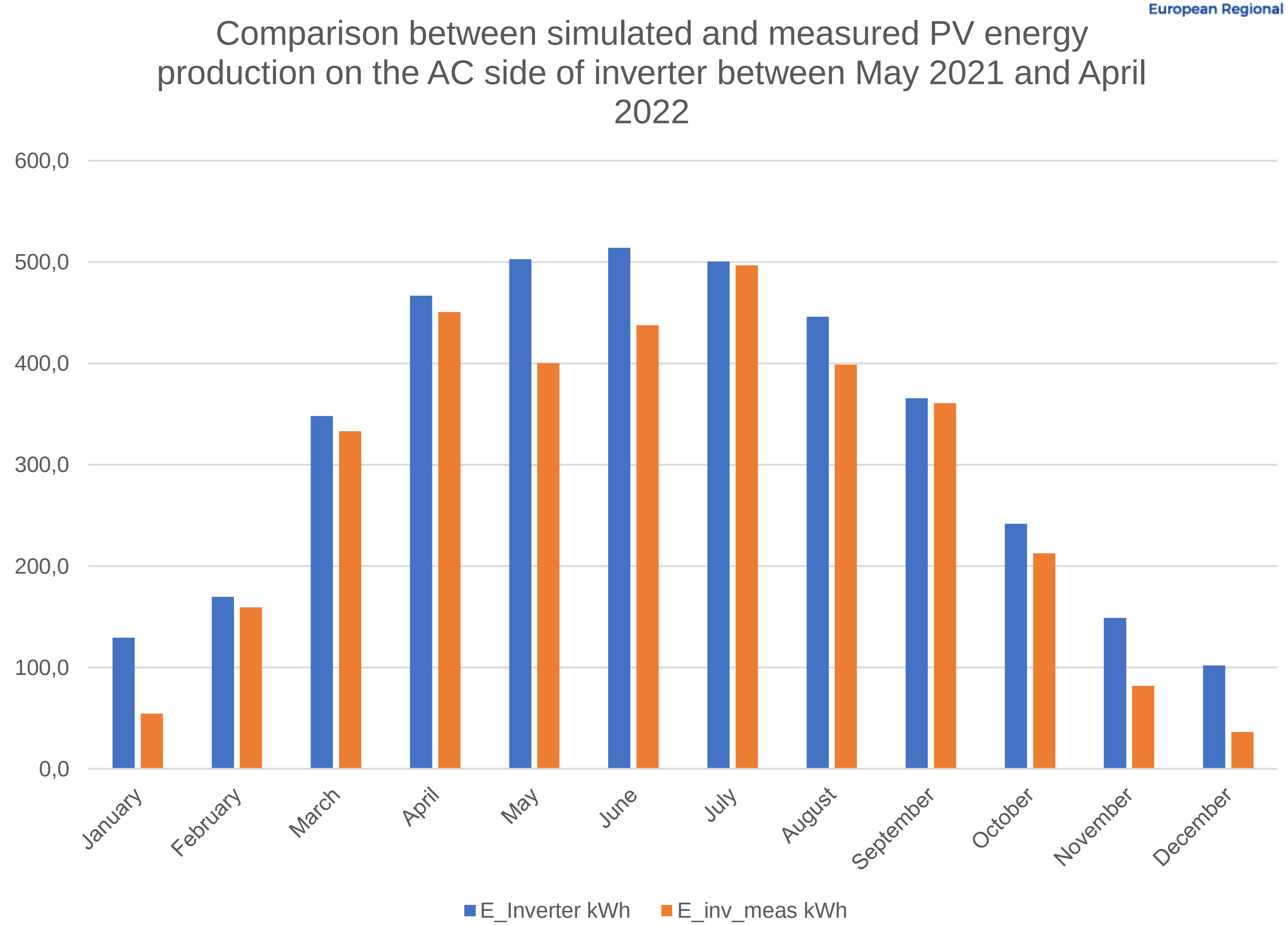


Modelling of the PV system

- A model has been created for the PV system
- The model includes all the relevant components, such as PV modules, power optimisers, inverter, battery and load.
- The model considers the shading effects of nearby structures
- It uses synthetic meteorological data based on actual local measurements to produce the simulations.



Modelling of the system



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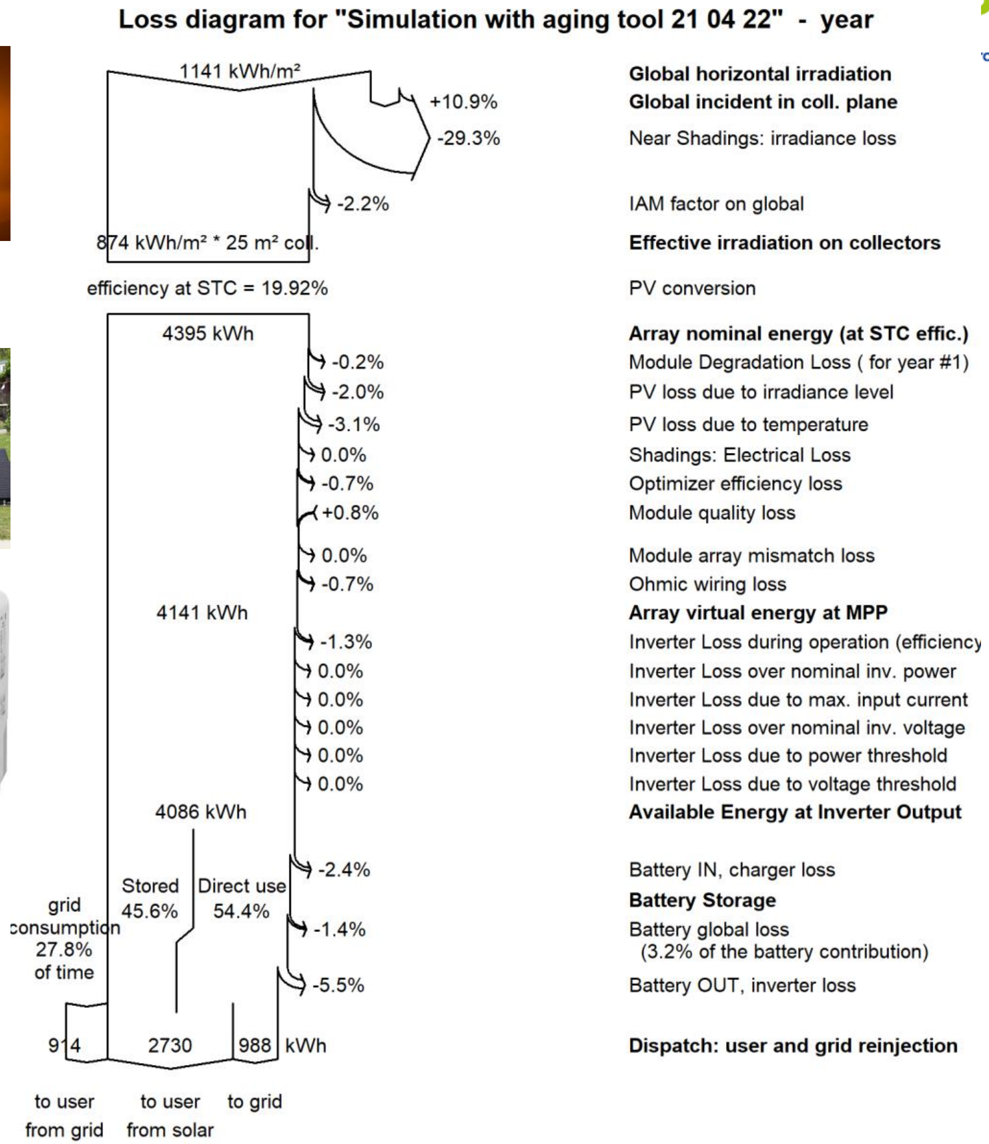
Modelling of the system

Loss diagram



Modelling of the system

CO_2 Emission Balance

Total: 26.3 tCO_2

Generated emissions

Total: 9.39 tCO_2

Source: Detailed calculation from table below:

Replaced Emissions

Total: 37.0 tCO_2

System production: 3938.46 kWh/yr

Grid Lifecycle Emissions: 470 gCO_2/kWh

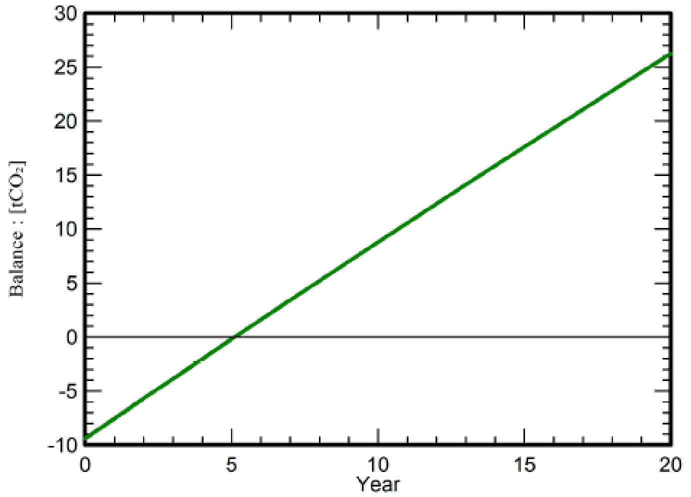
Source: IEA List

Country: United Kingdom

Lifetime: 20 years

Annual degradation: 0.4 %

Saved CO_2 Emission vs. Time



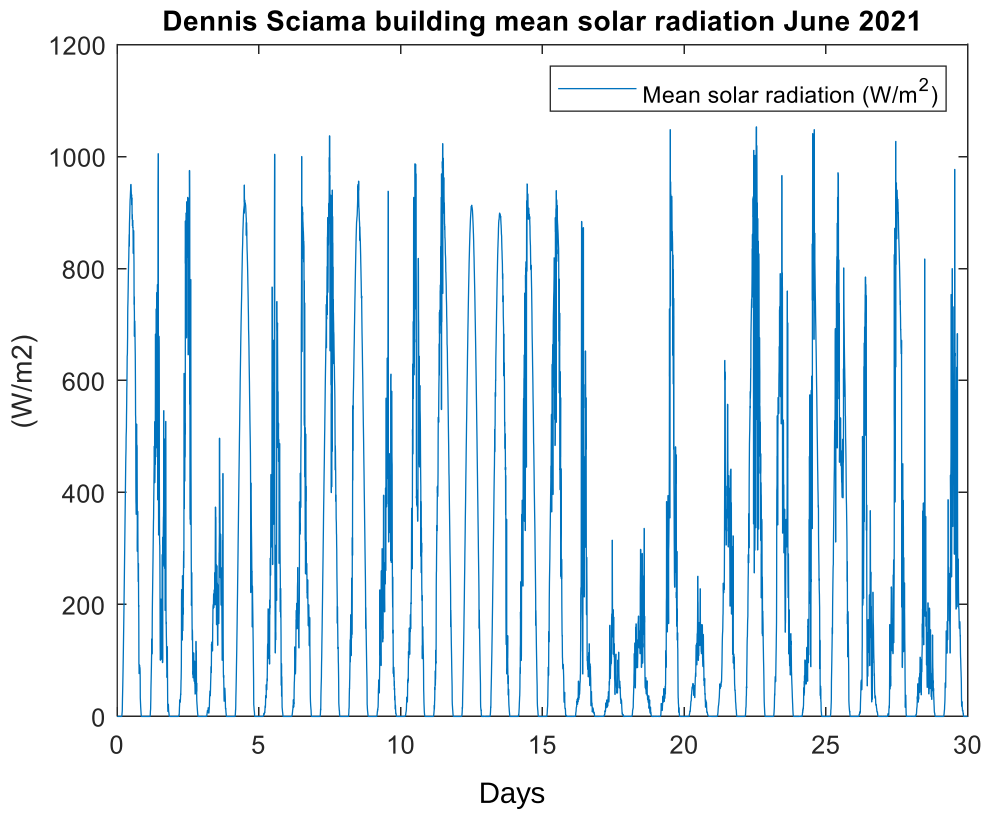
System Lifecycle Emissions Details

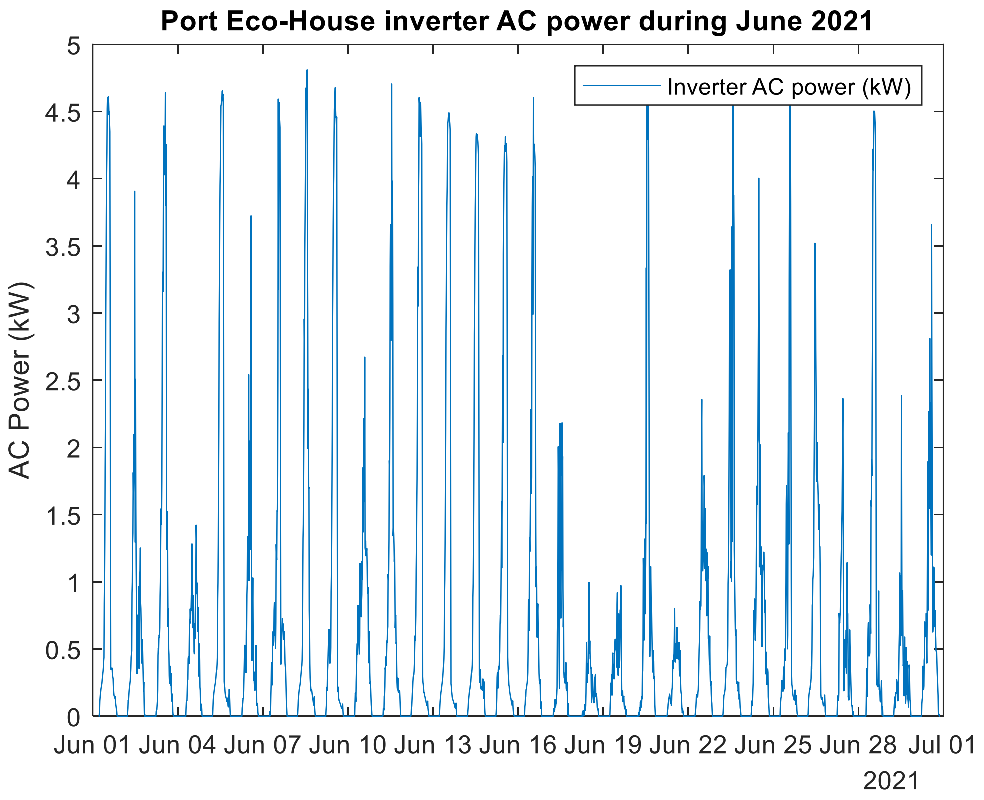
Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1713 kgCO2/kWp	5.03 kWp	8606
Supports	3.13 kgCO2/kg	150 kg	470
Inverters	311 kgCO2/units	1.00 units	311

Weather monitoring

- An existing weather station is available at the Dennis Sciama building, University of Portsmouth, which allows logging meteorological data that can support the research and training at the Solar Living Lab.
- Some of the measured meteorological variables can be very useful for modelling purposes and for correlating with various photovoltaic system variables.
- The weather station is located within 20m from the Port-Eco House and within 200m from the Future Technology Centre building.

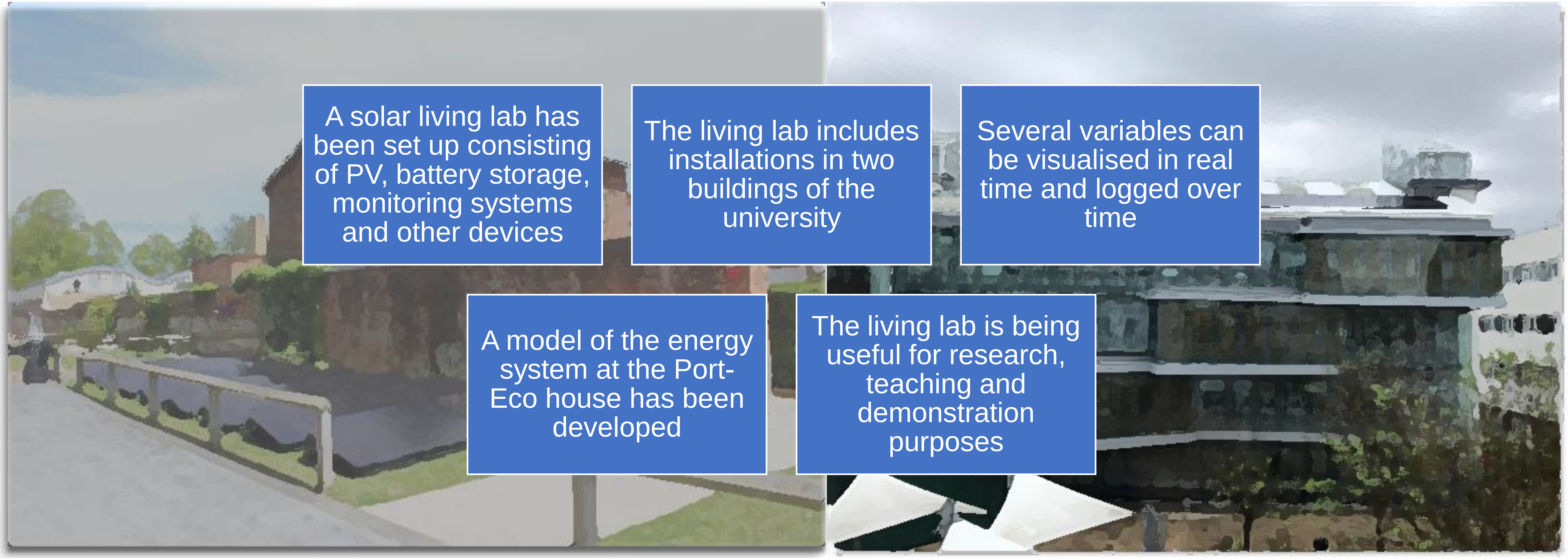
Example of weather monitoring





Short video

Concluding remarks



A solar living lab has been set up consisting of PV, battery storage, monitoring systems and other devices

The living lab includes installations in two buildings of the university

Several variables can be visualised in real time and logged over time

A model of the energy system at the Port-Eco house has been developed

The living lab is being useful for research, teaching and demonstration purposes

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Thank you