

D6.4: Monitoring systems set up in demonstration projects and running

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OUTPHIT – DEEP RETROFITS MADE FASTER, CHEAPER AND MORE RELIABLE

outPHit pairs such approaches with the rigour of Passive House principles to make deep retrofits cost-effective, faster and more reliable. On the basis of case studies across Europe and in collaboration with a wide variety of stakeholders, outPHit is addressing barriers to the uptake of high quality deep retrofits while facilitating the development of high performance renovation systems, tools for decision making and quality assurance safeguards. outphit.eu



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INTRODUCTION

The equipment used for monitoring energy consumption in existing buildings that have undergone energy upgrades is state-of-the-art and highly specialized. Specifically, the monitoring system is designed to measure every aspect of energy consumption and production in the case study buildings, as well as to monitor the indoor air quality of these projects. This involves tracking parameters such as temperature, relative humidity, and CO₂ concentration in multiple rooms within the pilot buildings.

The primary objective of this setup is to validate the expected energy demand calculated by the Passive House Planning Package (PHPP) following the EnerPHit renovations. Additionally, it helps in identifying any discrepancies between the projected energy usage and the actual consumption by the occupants.

The entire monitoring system was meticulously designed by Wolfgang Hasper at the Passive House Institute (PHI). It comprises a Data Acquisition Unit (DAU) and a variety of metering devices. The DAU is responsible for collecting all the signals from the metering devices and transmitting them directly to an online monitoring platform. This platform updates the data at least every ten minutes, providing real-time insights. The collected data is then thoroughly analyzed based on the specific requirements and usage patterns of the building occupants.

Overall, this comprehensive monitoring approach ensures that the energy performance of the upgraded buildings is accurately assessed, thereby facilitating continuous improvement and optimization of energy efficiency measures.

THE EQUIPEMENT

The data acquisition unit (DAU)

The data acquisition unit was built piece by piece. Each component had to be ordered individually and, in the end, all the parts were sent to PHI in order to be assembled from Wolfgang Hasper.

The DAU includes a variety of components with the main component being the concentrator of LoRa wan,

Incudes:

- Antenna: to receive signals from the metering devices
- Ethernet bridge: to connect the unit to the internet and upload all the monitoring data to the online platform
- Power supply



Figure 1 The DAU ©Hellenic Passive House Institute

The weather station



Figure 2 The weather station installed in case study 2 ©Hellenic Passive House Institute



Figure 3 The weather station during installation with spirit level ©Barani Design

The weather station is a self-powered device equipped with LoRa Wan communication protocol, capable of measuring the exterior temperature, relative humidity, CO₂ concentration and the radiation.

The weather station should be installed in a shaded free place and should be taken care periodically by cleaning the exterior PV panel to measure correctly the radiation and to be able to charge in order to function.

Finally, it is crucial to be installed completely straight in both directions, so a spirit level should be used.

The internal air quality (IAQ) sensor



Elsys.se *ERS CO₂ lite*

- Temperature ± 0.2 K
- Rel. Humidity ± 2 %
- CO₂ ± 70 ppm

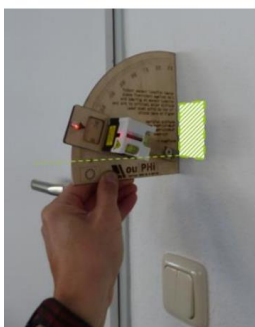


Figure 4 The IAQ sensors been placed on case studies ©Passive House Institute



Figure 5 The IAQ sensors been placed on case study 4 ©Hellenic Passive House Institute

The internal air quality sensors should be installed in interior walls only, should be in a height of more than 1,1m from the floor and away from direct solar radiation and internal heat sources.

They meter the temperature, relative humidity, CO₂ and they are supplied by batteries.

The energy meters



Figure 6 The netvox energy meter being tested in our office ©Hellenic Passive House Institute

They are installed within the utility meters to measure electricity consumption using magnetic cable sensors. Powered by batteries, they transmit the metering data via the LoRaWAN communication protocol.



Figure 7 The Fludia energy meter tested in our office ©Hellenic Passive House Institute

The Fludia metering devices measure energy consumption; however, unlike the Netvox devices, they are installed directly on the utility meter and capture either the meter's revolutions or LED pulses.



Figure 8 The Fludia energy meter being installed on case study 2 ©Hellenic Passive House Institute

The solar DHW production metering device



Figure 9 The Sharky 775 ultrasonic energy meter ©Hellenic Passive House Institute

The solar domestic hot water production will be measured by the Sharky devices, which are equipped with a thermocouple to measure water temperature and a magnetic flow meter. These devices are battery-powered and communicate via the LoRaWAN protocol. The ultrasonic compact energy meter can also be used to measure energy consumption in heating and cooling applications for billing purposes.

DATA FROM THE SENSORS FROM DIFFERENT CASE STUDIES

Greek case studies projects

Snapshots from the online platform for case study 2, located in Papagos, Athens, reveal that the project—a certified Passive House **EnerPHit**—demonstrates ideal indoor air quality and superior comfort, as confirmed by both the measurements and the tenants' feedback. Notably, the average indoor temperature during winter remains below the 20°C threshold considered in the Passive House standard for energy demand calculations, a choice entirely driven by the tenants, who feel comfortable even at 18°C. Additionally, the relative humidity and CO₂ concentration levels are consistently maintained within excellent ranges.

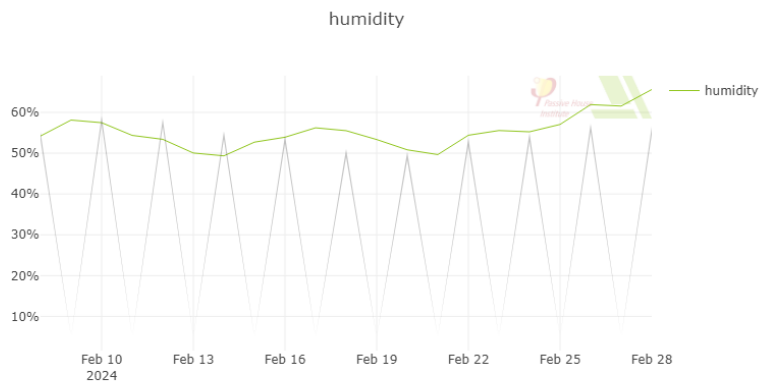


Figure 10 Indoor air humidity at case study 2 over a specific period © Hellenic Passive House Institute

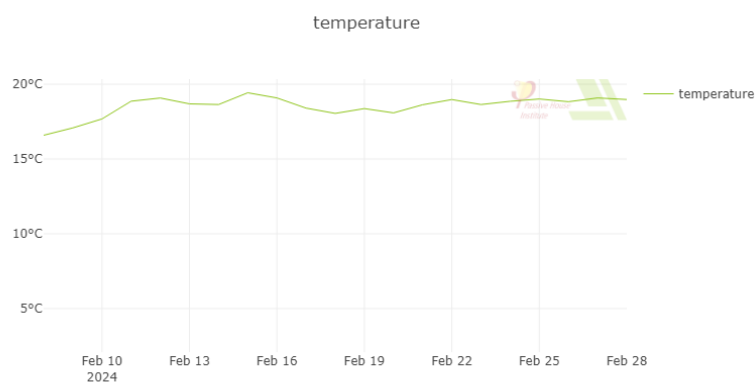


Figure 11 Indoor temperature at case study 2 over a specific period © Hellenic Passive House Institute

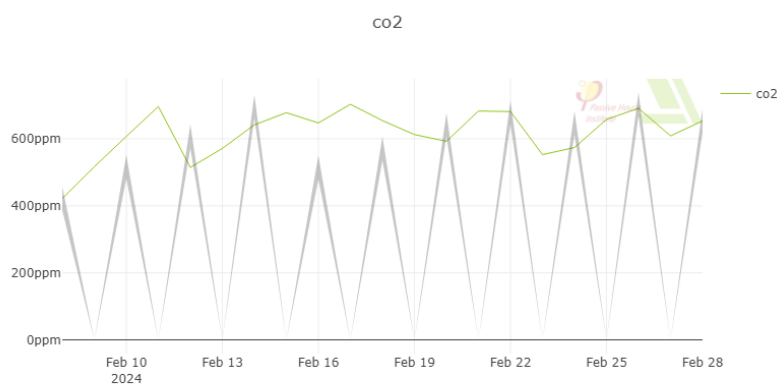


Figure 12 Indoor CO₂ concentration at case study 2 over a specific period © Hellenic Passive House Institute

Bulgarian case studies projects

Installation of the Netvox electricity meters at the OP32 Burgas Observer Project.



Figure 13 The Netvox energy meters installed at the OP32 Burgas Observer Project © EnEffect

Installation of the weather station at the OP32 Burgas Observer Project.



Figure 14 The Barani Design weather station installed at the OP32 Burgas Observer Project © EnEffect

Data is available for the 2023/2024 period. Outdoor temperatures were markedly milder than the climate data for the location suggest, the availability of solar radiation was slightly lower than average. Due to the coastal location relative humidity of outdoor air was high year-round.

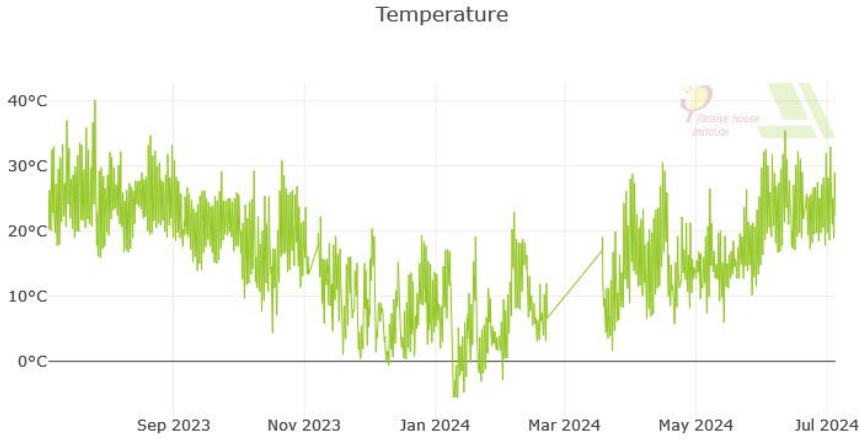
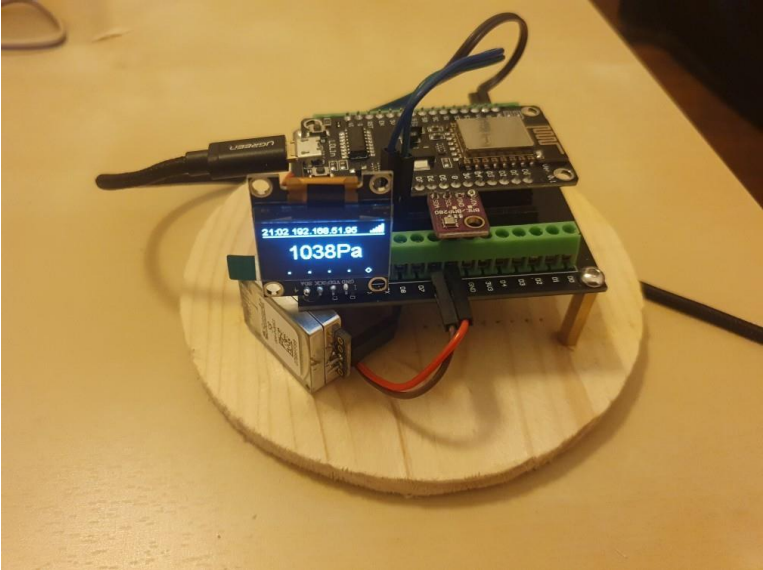


Figure 15 Outdoor air temperature in the period under consideration © EnEffect

French case studies projects

The French project CS09 is equipped with the following monitoring devices responsible for:

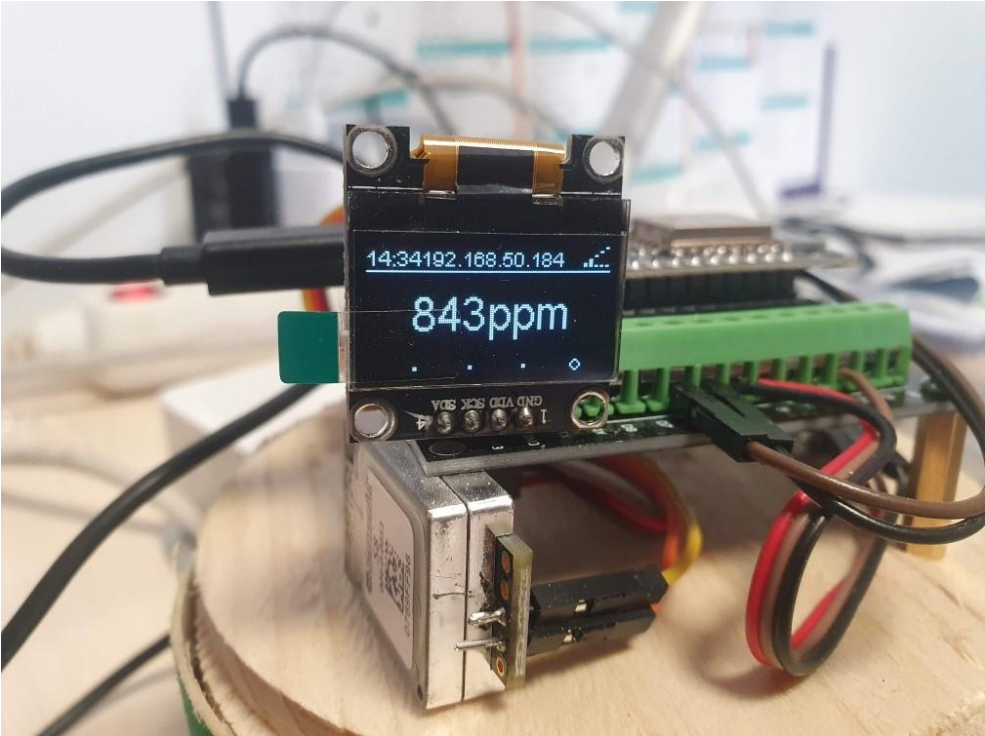
Atmospheric pressure measurement:



Relative humidity sensor:



And CO₂ concentration:



Spanish case studies projects

The Spanish project CS17 was well monitored for all the energy consumption and the IAQ as can be seen in the following pictures.

The DAU:



The electricity meters:



The IAQ sensors:



And the weather station:



SUMMARY OF CASE STUDY PROJECTS ANALYSES

The sensors were installed in most of the projects; however, the pandemic and the shortage of components during the design phase of the monitoring equipment made it challenging for partners to procure the necessary parts. Additionally, the ongoing pandemic, which persisted until late 2022, restricted access to the buildings, complicating the installation of sensors and other monitoring equipment. This limitation affected the amount of available data, but we were able to successfully install sensors and collect indoor air quality (IAQ) data in most cases. In some instances, a shortage of reliable technicians and their unavailability further hindered the installation of more technical sensors, such as heat meters and electricity meters.

Despite these challenges, the overall outcome of the project has been positive. All the case studies demonstrated significantly improved performance after renovation, and there was a notable reduction in energy costs.