INTERREG IMPROVEMENT AWARENESS RAISING EVENT IN PORTUGAL

Integration of renewable energies in public buildings towards the nZEB - Lisbon, 26 October 2022

Lisbon Pilot Plant strategies towards nZEB goal

David Loureiro – LNEG

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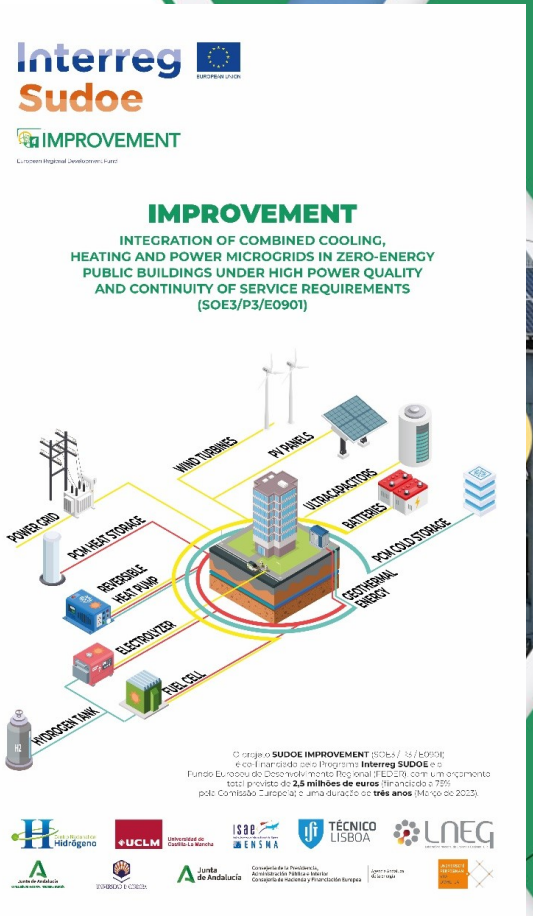
Summary

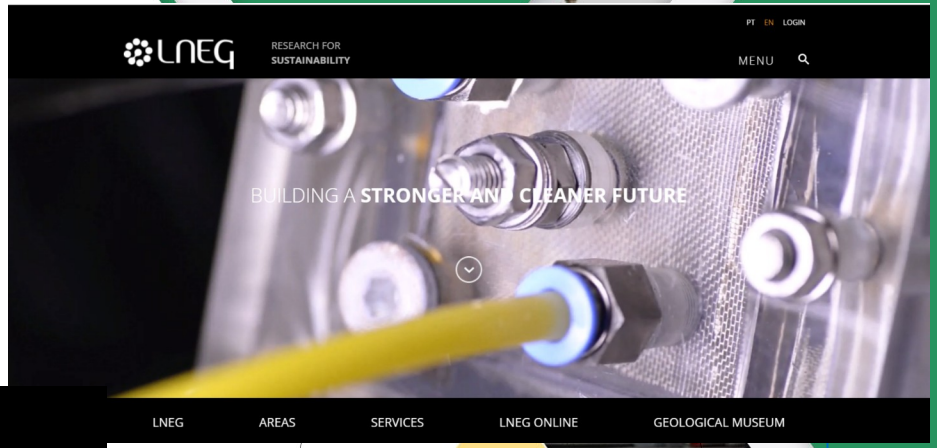
- LNEG's Mission and Research resources
- Framework and main objectives
- Portuguese Pilot Plant
- Passive Building Renovation
- Integration of endogenous renewable generation
- Pilot Plant Test Plan
- Thermal Efficiency Performance Indicators
- Conclusions

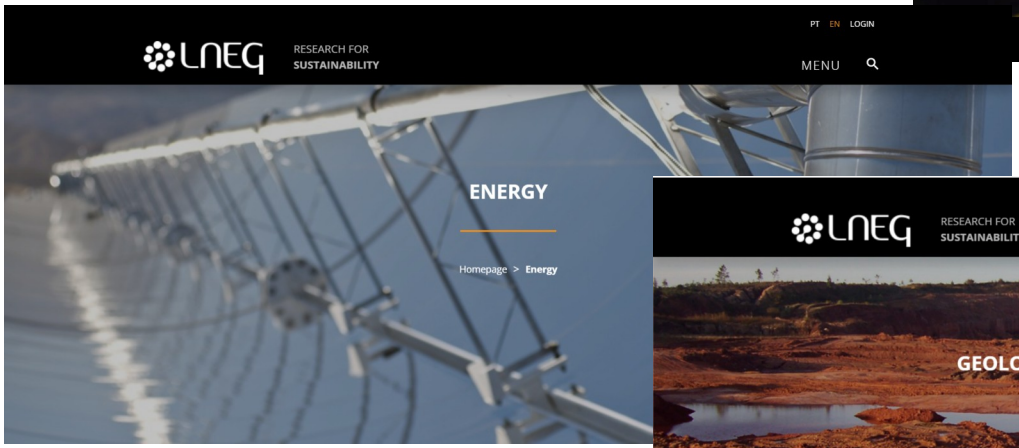


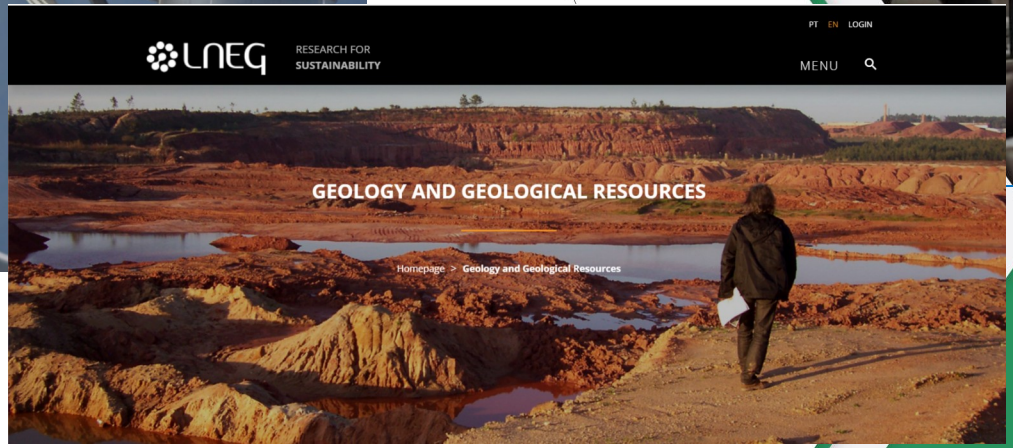
LNEG´s mission and research resources

MISSION

LNEG mission under the motto “Building a cleaner and better future” is to contribute independently to the development economy and improving the quality of life, placing knowledge in Energy and Geology at the service of society.







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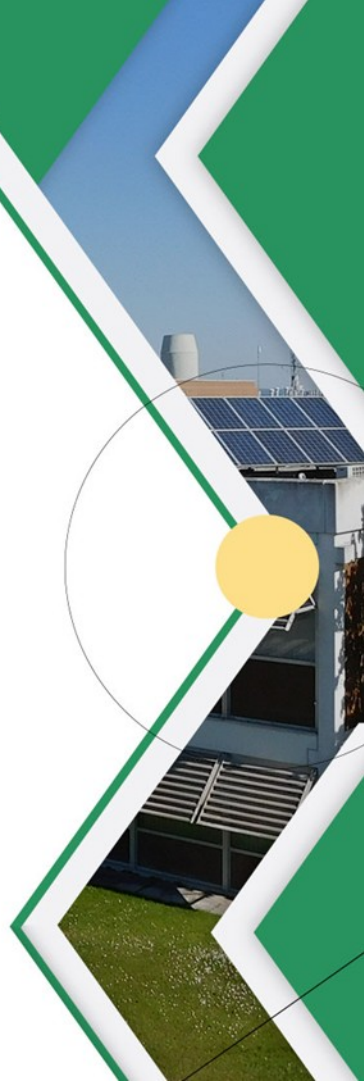
FRAMEWORK

The European Energy and Climate Plans are underway in the European Union, which include the measures of each Member State - in Portugal, through the PNEC 2030 - specifically aimed at urban rehabilitation, the promotion of energy efficiency in buildings and the integration of renewable energies as a strategy to reduce dependence on fossil fuels the alignment of the national economy with a trajectory of carbon neutrality.

The IMProvement project will develop, validate and demonstrate a system for the renovation of existing public buildings converting them into Zero Energy Balance-nZEB buildings by integrating micro-grids for combined heat, cold and electricity generation in a system designed for typical weather conditions of the SUDOE regions.



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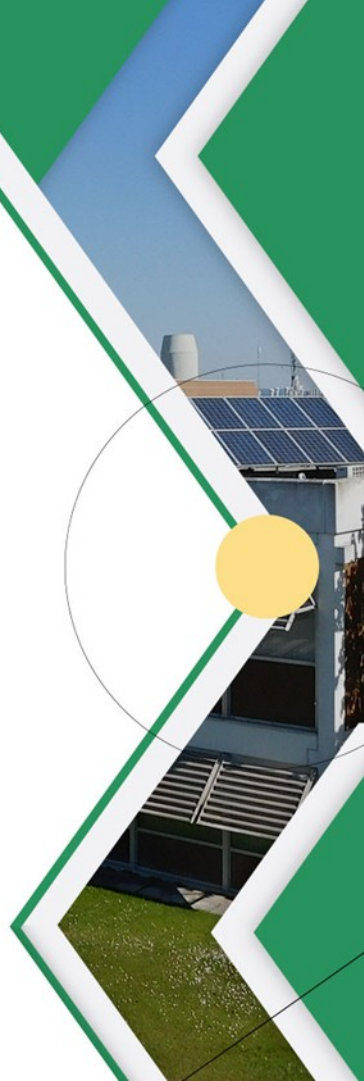
MAIN OBJECTIVES

Integrate active and passive technical strategies and solutions suitable for public buildings with a view to converting them into buildings with almost zero energy requirements (towards nZEB).

Increase energy efficiency in public buildings, through a renewable-based microgeneration system combined with heating, cooling, electricity and energy storage systems.

Develop a fault-resistant power control system for microgrids according to high quality design criteria.

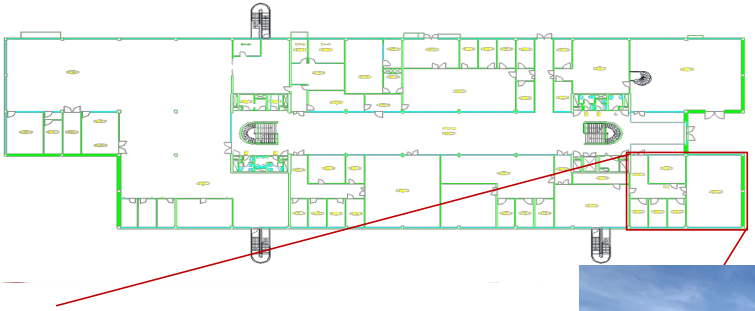
Design an energy management system for micro-grids with a combined energy storage system according to criteria of minimum degradation, maximum efficiency and priority in the use of renewable energies.



Portuguese Pilot Plant

Portuguese (Lisbon) Pilot Plant

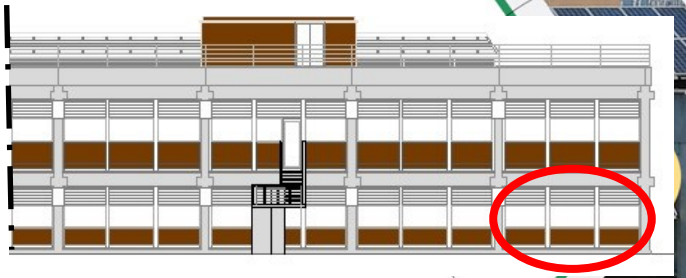
Selected public building built in the 1980s (INETI) on Campus do Lumiar (Lisbon) and internally identified as LNEG - Building C.



Área Piloto (Planta)

Área Piloto - Vista Exterior (Sul/Poente)

Área Piloto (Poente)



Área Piloto (Sul)

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IMPROVEMENT

European Regional Development Fund

Portuguese Pilot area (operated by LNEG & IST) (Laboratory for Integration of Renewable Energy) at LNEG/Lisbon

Portuguese (Lisbon) Pilot Plant

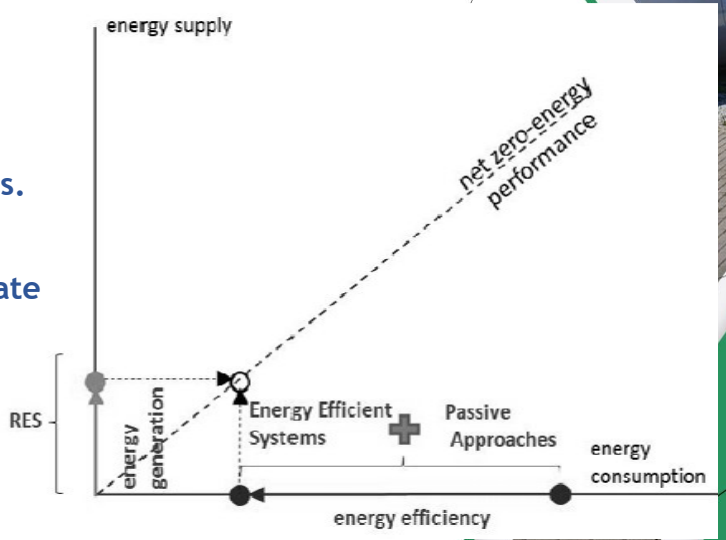
Evaluation of passive and active, technical and economic solutions, which will be adopted and evaluated experimentally.

PROBLEMS:

- ❑ **Inadequate comfort conditions in pilot area rooms - thermal requirements, ventilation, lighting and nZEB energy efficiency.**

SOLUTIONS:

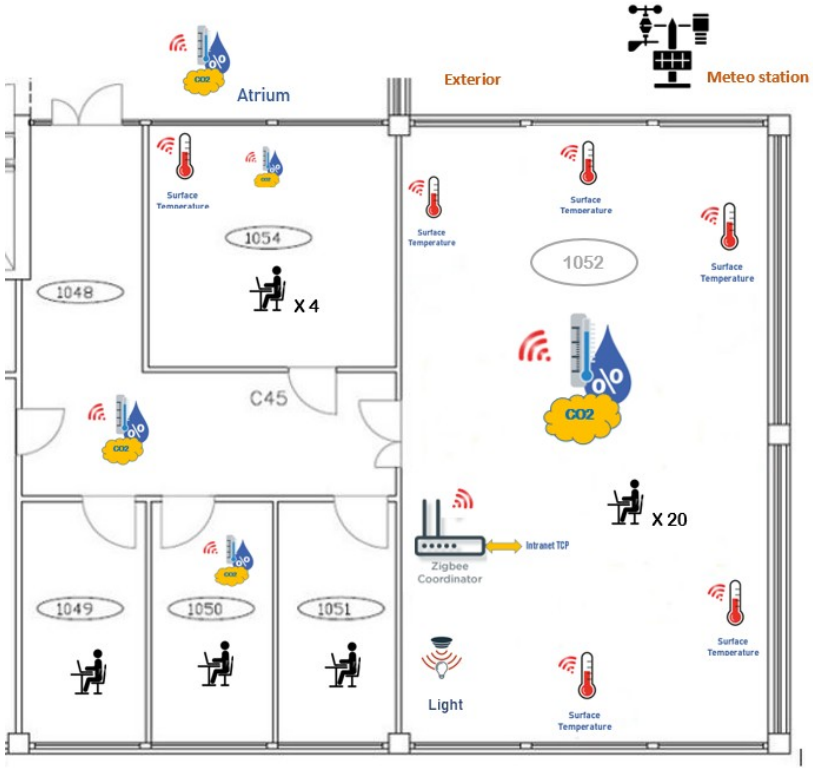
- ❑ **renovation of existing mechanical ventilation and HVAC systems.**
- ❑ **Replacement of internal (fluorescent) lighting with energy-efficient LEDs.**
- ❑ **Installation of high efficiency heat pump assisted solar thermal system with sensible heat thermal energy storage tank for HVAC cold/heat climate (SHW).**
- ❑ **Autonomous solar thermal installation for domestic hot water (DHW).**
- ❑ **Renewable electrical production by micro wind turbine and solar photovoltaic systems with battery storage and intelligent microgrid control system.**

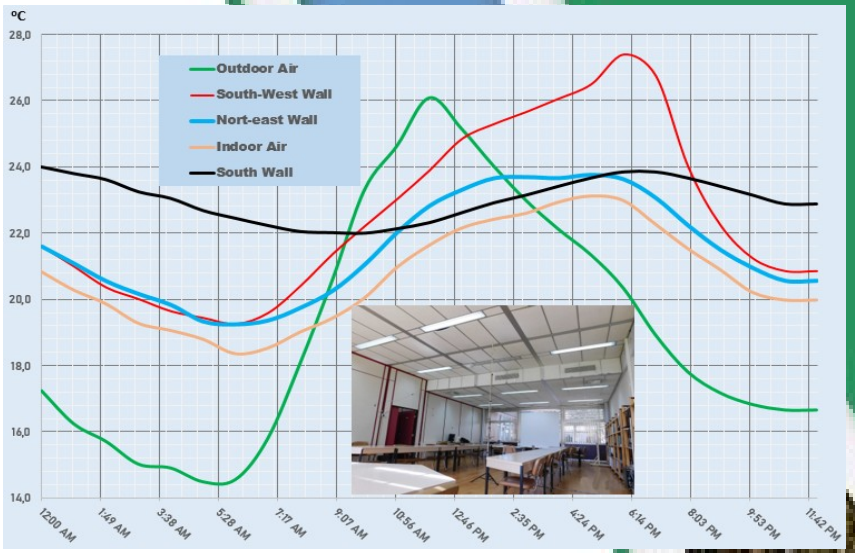


Passive building renovation

Building envelop renovation

Thermal comfort monitoring

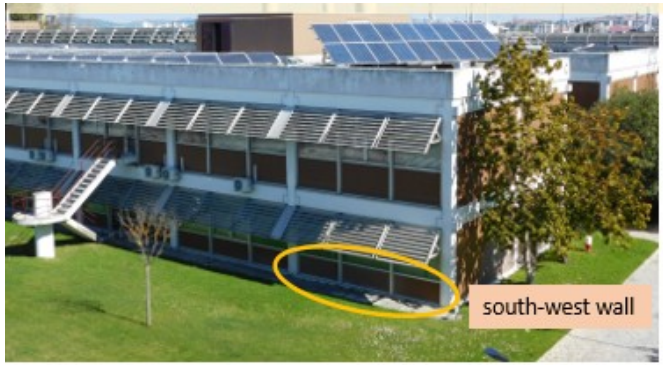


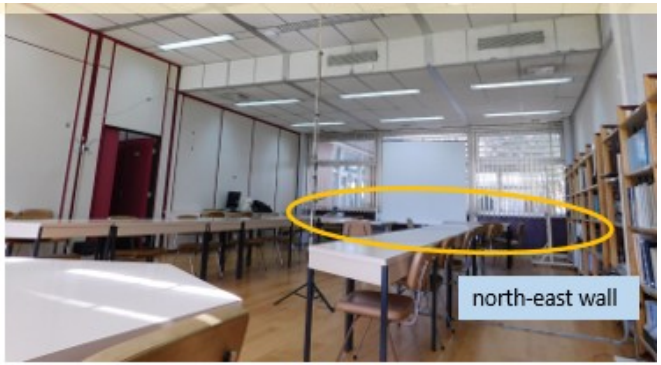


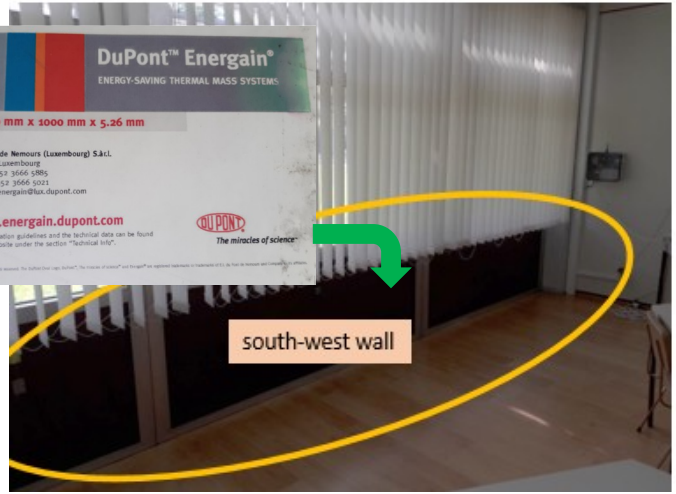
CONFORT SENSORS

Model	Function	Range	Precision	Transmission	Output
Schneider SED-CO2-G-5045	Room Temp	0-50 °C	+- 0,3 °C	Wireless	ZigBee Pro
	Room RH	0-100 %	+ - 3%		ZigBee Pro
	Room CO2	0-5000 ppm	+ - 60 ppm		ZigBee Pro
Schneider SLR 320	Room Light	0-20 klux	+- 5%	2 Wire	4-20mA
Schneider ZBRPT1	Room Surface Temp	-40 +70 °C		Wireless	ZigBee Pro

Renovation Pilot Area to nZEB Solutions
South-West & North-East PCM walls





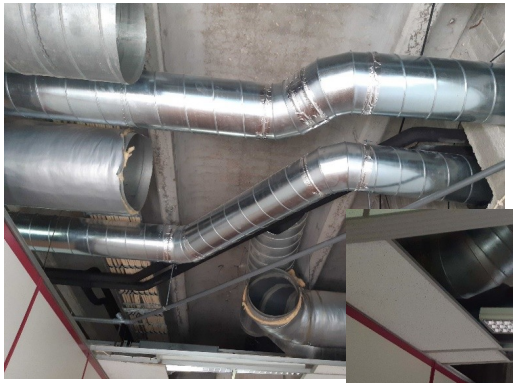


Renovation Pilot Area to nZEB Solutions

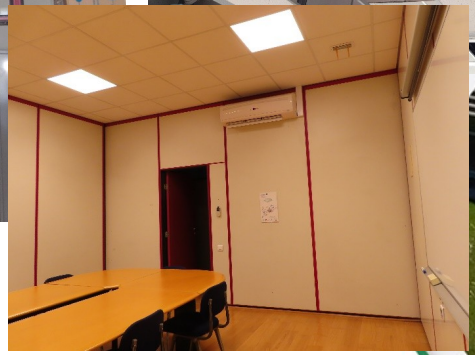
#1. Adaptation of air conditioning and ventilation systems with fan coil units

According to the work plan, specialized enterprises were consulted and subsequently hired to carry out the requalification work in LNEG pilot area in accordance with national public procurement.

Before



After



Renovation Pilot Area to nZEB Solutions

#2. Adaptation of the heat pump and heat exchanger to high energy efficient air conditioning system

Acquisition of equipment to replace the inoperative/obsolete heat pump and heat recovery ventilation unit

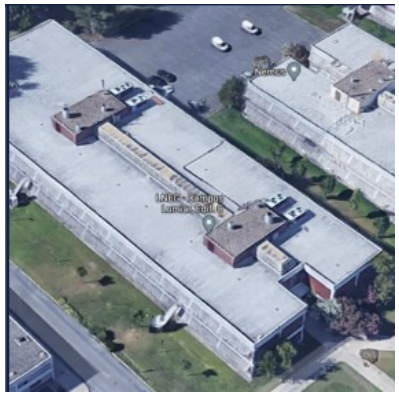
Before

After

Renovation Pilot Area to nZEB Solutions

#3. Reinstallation of solar thermal collectors with storage tank

Specialized enterprises were consulted and subsequently hired to carry out the requalification work in LNEG pilot area in accordance with national public procurement.



Before

After

Renovation Pilot Area to nZEB Solutions

#4. Renovation building to nZEB with insulation, lighting and passive systems

Installation of thermal insulation, replacement of the fluorescent lighting system by LED, replacement of the suspended ceiling and replacement of shades, blinds and screens

Before

After

Renovation Pilot Area to nZEB Solutions

#5 Thermal insulation South-West façade with PCM pannels

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Laboratório Nacional de Energia e Geologia, I. P.

Integration of endogenous renewable generation in a nZEB building

Centro Nacional del Hidrógeno
UCLM Universidad de Castilla-La Mancha
ISAE ENSMA
IJF TÉCNICO LISBOA
LNEG Laboratório Nacional de Energia e Geologia, I. P.
Junta de Andalucía
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Junta de Andalucía
Consejería de la Presidencia, Administración Pública e Interior
Consejería de Hacienda y Financiación Europea
Agencia Andaluza de la Energía
UNIVERSITÉ PERPIGNAN VIA DOMITIA

RES in nZEB buildings

Pilot Plant Test Plan

Pilot Plant Test Plan

Data available for the pilot area for the Thermal Test Plan (>2021)

- Occupation time schedule of room 1050, room 1052 and room 1054;
- Air temperature and relative humidity comfort, C02 air quality, natural and artificial lightning and internal enveloping surface temperature (Rooms: 1050,1052 and 1054);
- Fan Coils time schedule and power consumption;

Data available for the technical area for the Thermal Test Plan (>2022)

- Air-to-water inverter Heat Pump operation parameters;
- Air-to-water heat exchanger operation parameters;
- Energy Enthalpy Meters operation parameters;
- Water pumps (hot/cold) operation parameters (time schedule, temperatures, flow);
- Thermal water storage tanks temperatures: solar 300L and Inertial 1000L.

Data available from Environment Weather Station (>2019)

- Solar irradiation;
- Air temperature and Relative Humidity;
- Wind velocity and direction

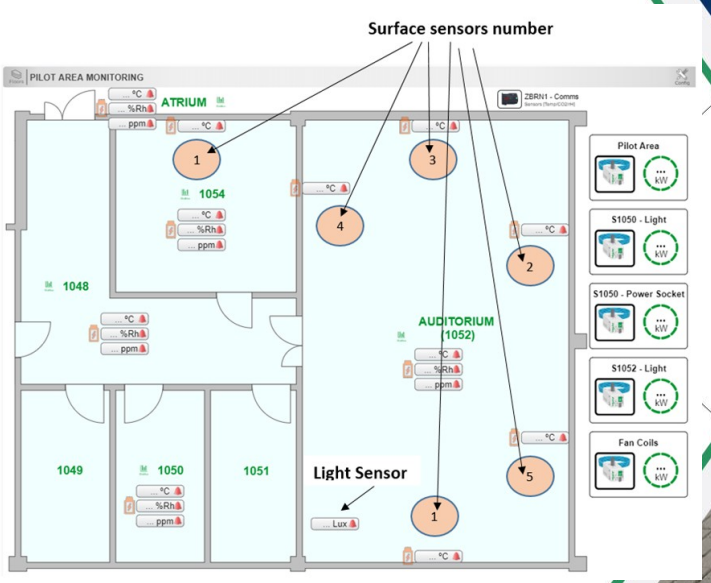
Comfort characterization

Passive solutions

- natural lighting
- efficient incorporation of artificial lighting
- phase change materials to regulate thermal comfort (1052)
- replacement of the false ceiling by panels of high thermal and acoustic insulation efficiency).

Monitoring the comfort levels and air quality

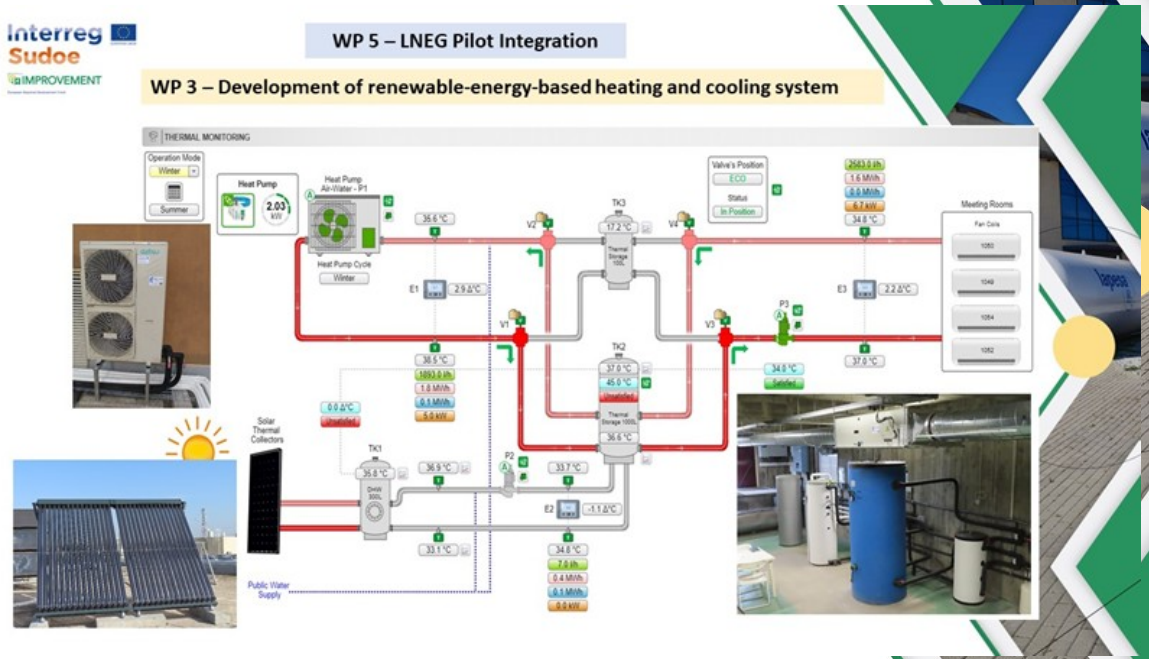
- set of wireless sensor
    a. air temperature,
    b. relative humidity and
    c. CO2 concentration levels.



Characterization of the thermal power system (heating/cooling) of the Portuguese Pilot Plant

HVAC Equipment

- Air/water Heat Pump DAITSU CRAD2 60T 14.5kW;
- Solar Water Heating (SHW) set of solar evacuated collectors with heat pipes BAXI AR30 4.8m2 with accumulation water tank BAXI FST 300L;
- Inertial water tank LAPESA G1000 IS_02, 1000L to delivery hot/cold water to the fan-coils hydraulic circuit;



Thermal Efficiency Performance Indicators

Thermal Efficiency Performance Indicators (*PIs*): PT project

- **Solar Fraction** is the energy supplied by the solar part of a system divided by the total system load.

- **Fractional Energy Savings** is the reduction of purchased energy achieved by the use of a solar heating system, calculated as 1 - [(auxiliary energy used by solar heating system)/(energy used by conventional heating system)].

- **Thermal Performance** is defined as a set of performance indicators. The heat delivered by the solar heating system, QL; the solar fraction, fsol; the parasitic energy, Qpar; the net auxiliary energy demand, Qaux, net energy savings, fsav.

- **Seasonal Performance Factor** is the ratio of the useful energy of the heat pump heat released in the course of one year over the electrical energy used to drive the compressor and the auxiliary drives.

Thermal Efficiency Performance Indicators (*PIs*): PT project

- **Efficiency** is the ratio between the useful energy output from the system (heating or cooling) to the energy input to the system.
- **Primary energy ratio of non-renewable energy sources** is the ratio of the useful energy output of the renewable system to the primary energy input.
- **Thermal energy savings in summer** is the is the thermal energy consumed during the summer period with the IMPROVEMENT EMS implemented in the building.
- **Thermal energy savings in winter** is the is the thermal energy consumed during the winter period with the IMPROVEMENT EMS implemented in the building.

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THANK YOU!

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