Interreg Sudoe
IMPROVEMENT

INTEGRATION OF COMBINED COOLING, HEATING AND POWER MICROGRIDS IN ZERO-ENERGY PUBLIC BUILDINGS UNDER HIGH POWER QUALITY AND CONTINUITY REQUIREMENTS

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- Introduction
- Objectives
- Microgrid as solution
- Power Management System
- Thermal Management System
- Microgrid Energy Management System
- Pilot Plants

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Introduction

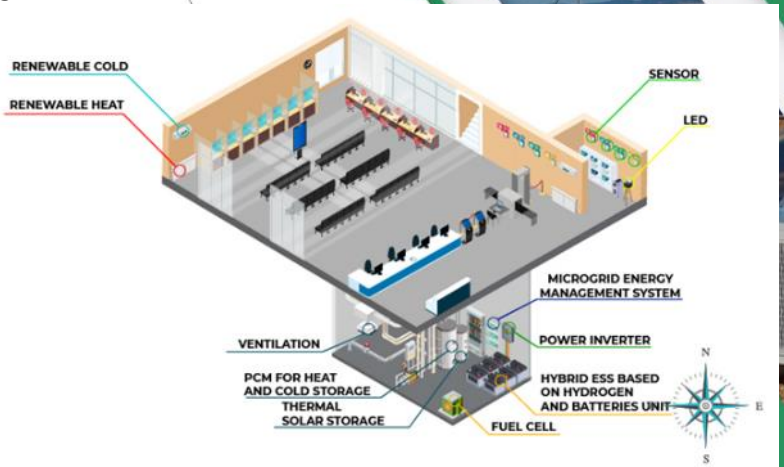
In recent years, numerous projects have been developed to reduce energy consumption in buildings, both from the point of view of energy efficiency and integration with renewable energies.

However, the specific problem of integrating this type of energy systems in facilities, is that the reliability of the electricity supply has to be considered as a fundamental aspect.

Introduction

There are some places where power outages can mean more than economic losses:

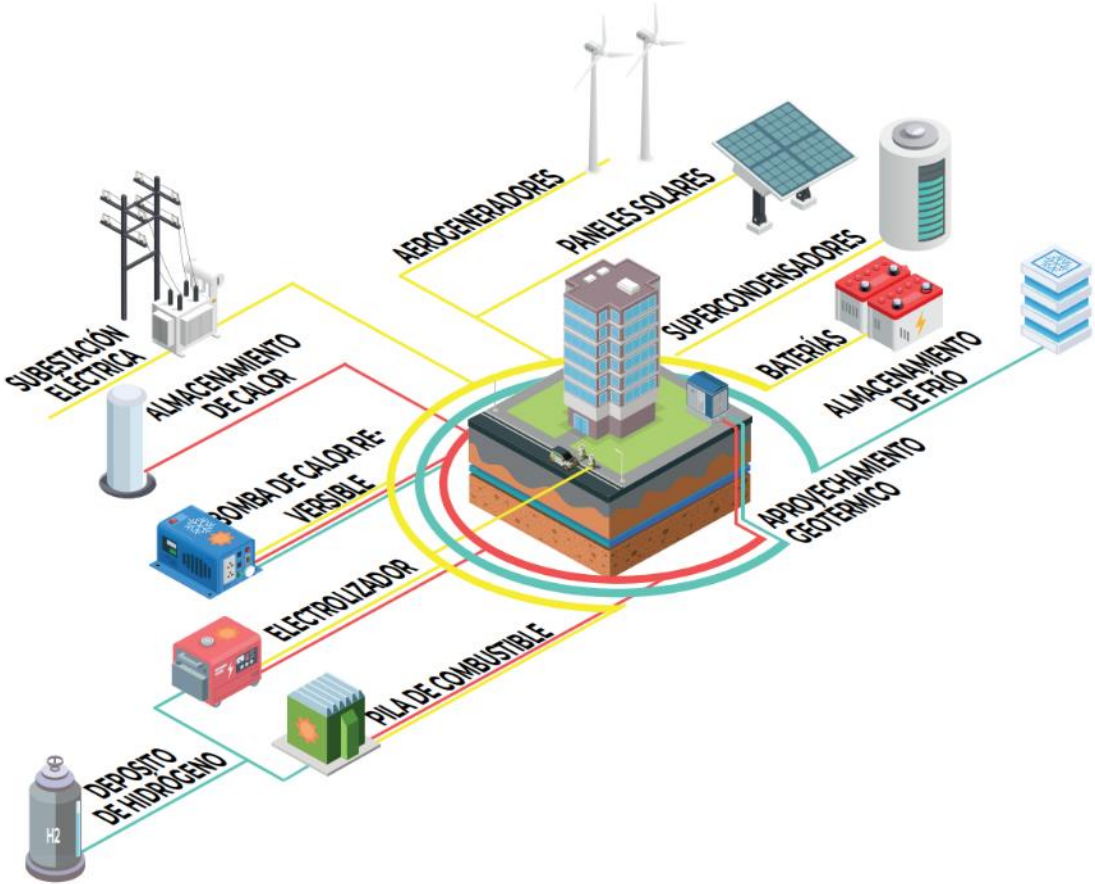
- For health reasons in hospitals
- Scientific considerations in technology centers and universities
- Defense conditions either in military installations
- Security and surveillance in transport stations and airports



Objectives

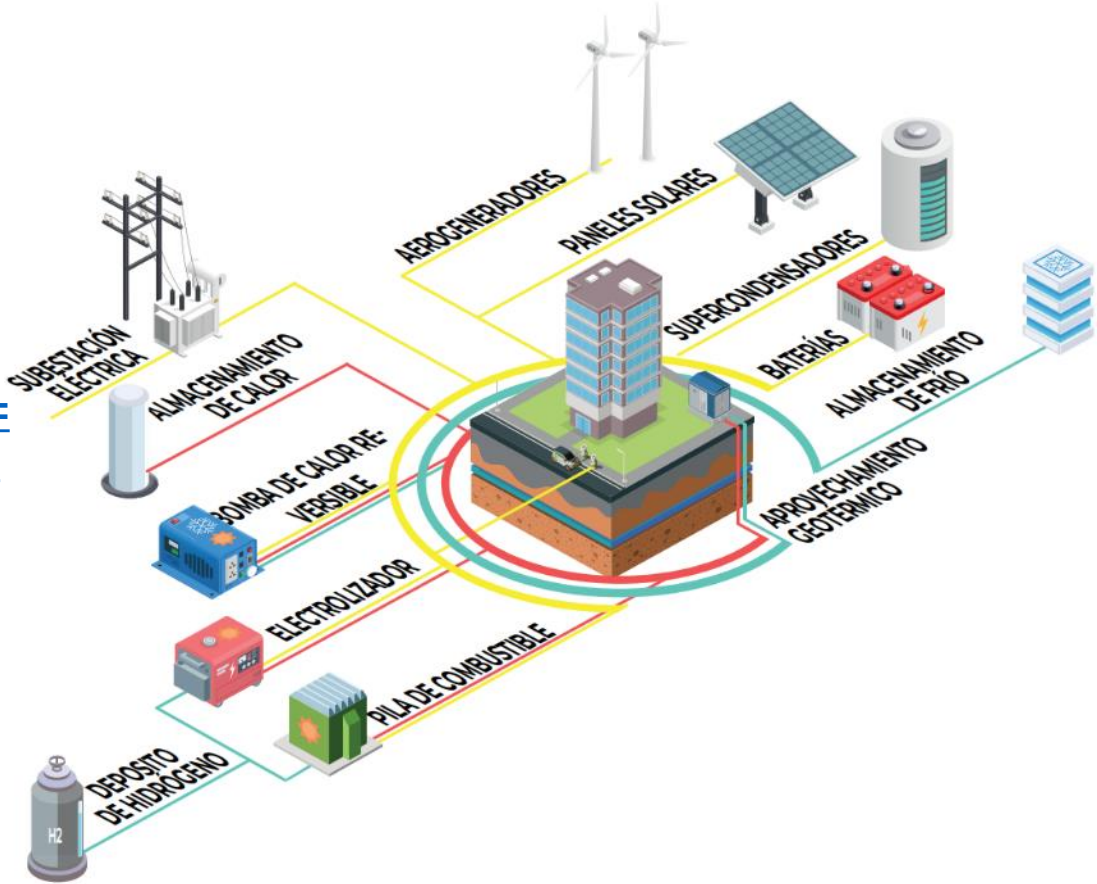
The main objective of the IMRPOVEMENT project

To convert **public buildings** into **zero energy buildings** by integrating renewable **energy microgrids with combined heat, cooling and power generation** with inverters with active neutral control using **hybrid energy storage systems (Hydrogen, batteries, ultracapacitor)** that will ensure power quality and continuity of service to equipment sensitive to power quality disturbances (high-tech equipment) while increasing energy efficiency in this type of buildings.



Video promotional

https://eu.yourcircuit.com/guest?token=08e6b87e-f3a7-483c-afe1-e2d4b1d044a0



Objectives

Specific Objectives

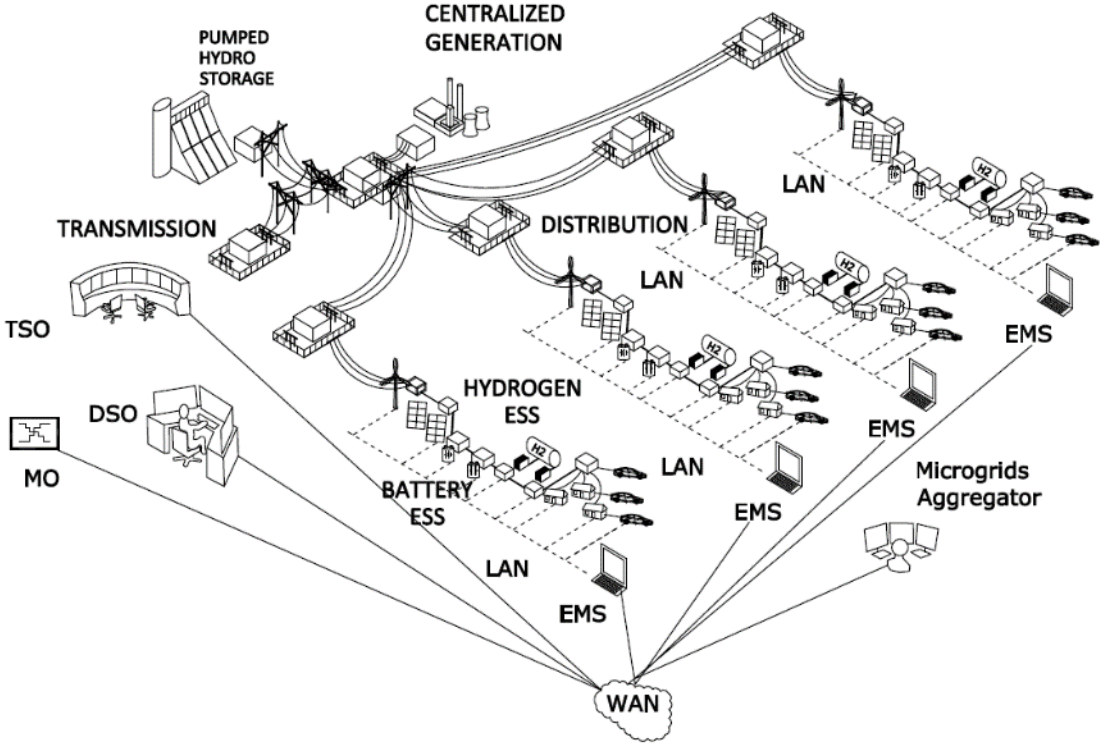
- Development of a system to improve energy efficiency in public buildings through a solar heating and cooling generation system and the incorporation of active/passive techniques for buildings with zero energy consumption.

- Development of a fault resistant power control system for microgrids under high quality design criteria and continuity of supply.

- Development of an energy management system for renewable generation microgrids with a hybrid energy storage system under criteria of minimum degradation, maximum efficiency and priority in the use of renewable energies

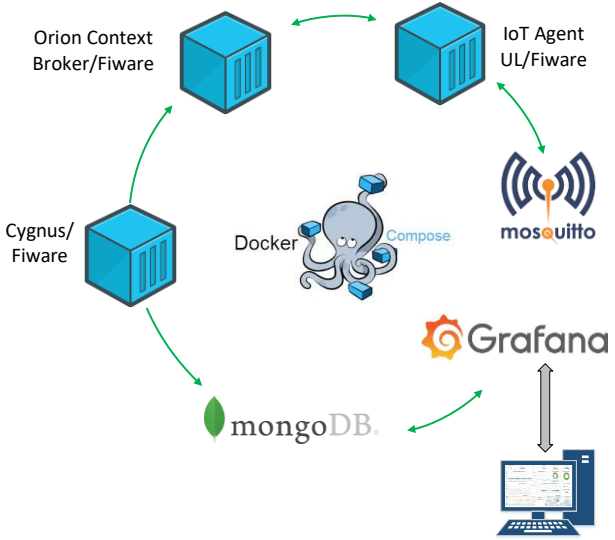
Microgrid as solution

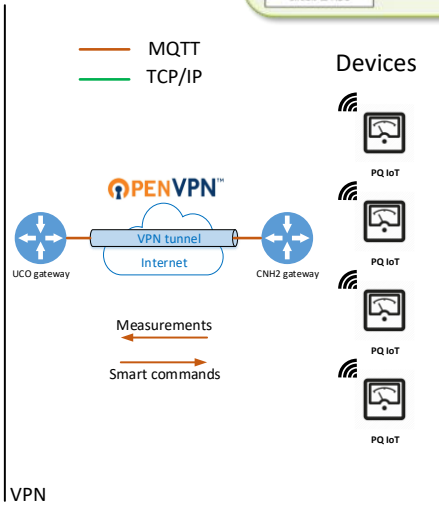
- Resilience to grid failures
- Flexibility
- Economic optimization of energy prices
- Solve grid congestion problems
- Quality of supply

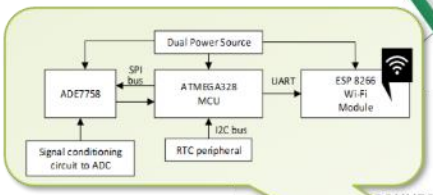


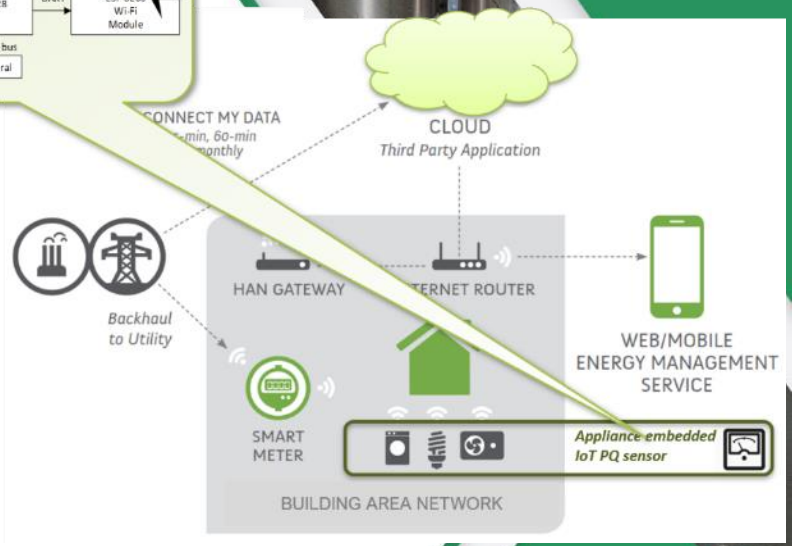
Power Management System

The inclusion of IoT sensors in Power Quality Advanced Metering Infrastructure



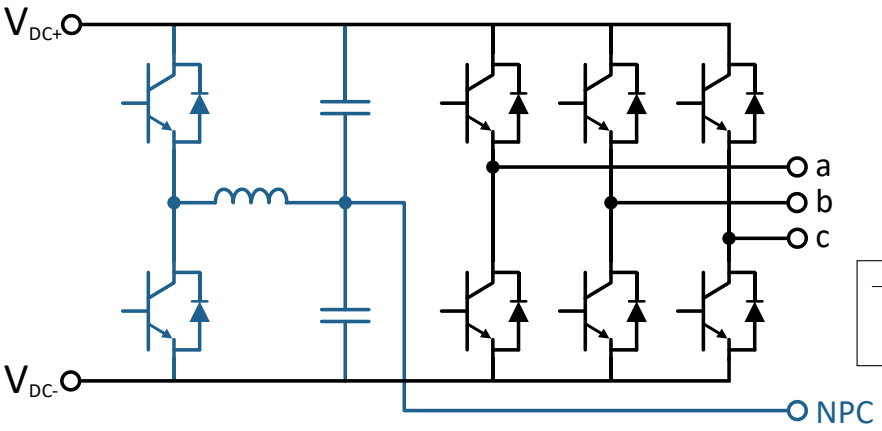


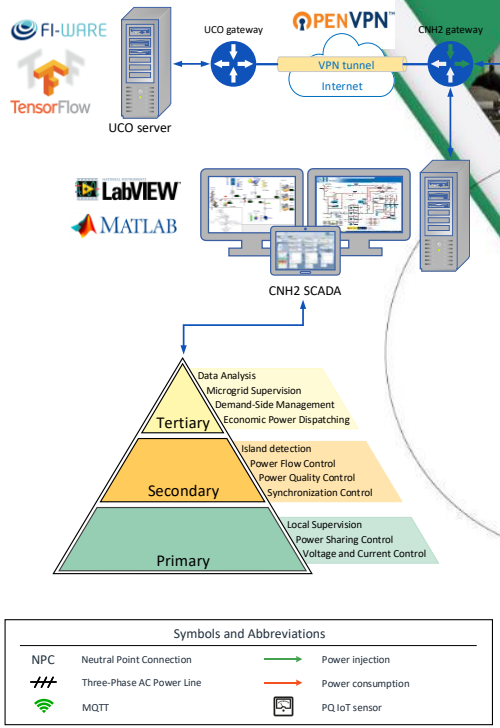


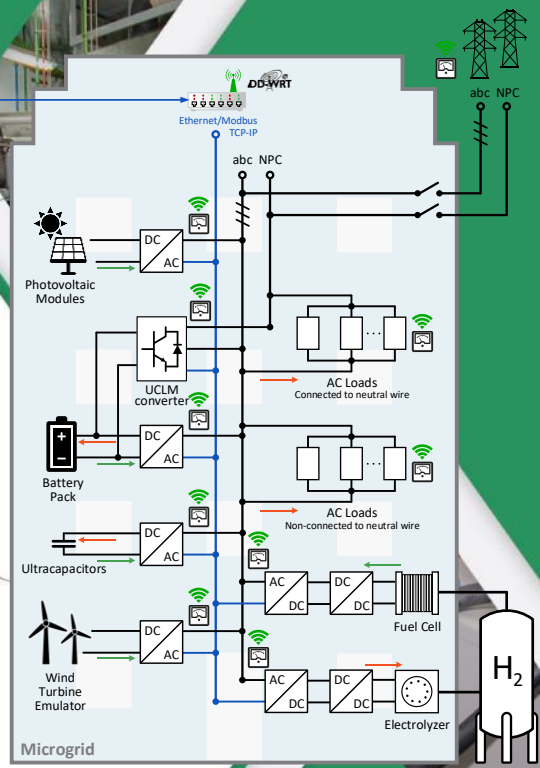


Power Management System

The development of a three-phase four-leg inverter to improve the power quality of the complete system





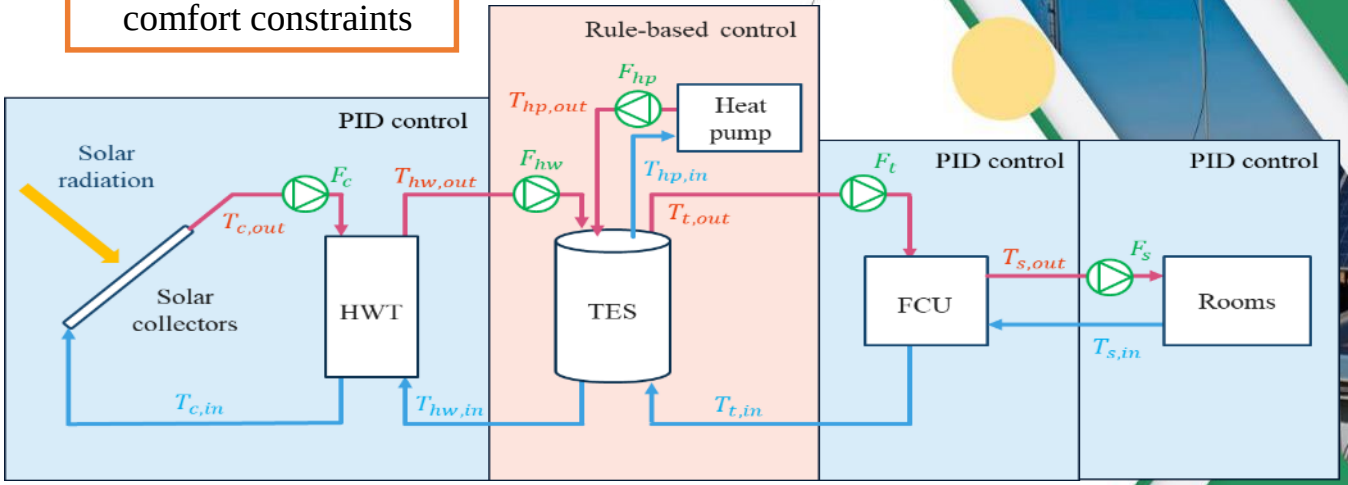


Energy Management System

Objectives
- manage thermal energy
- satisfy thermal comfort constraints

Control strategies
- reference strategy: PID+rule-based control
- advanced strategy: model predictive control (MPC)+PID

Portuguese pilot
- solar collectors
- hot water tank (HWT)
- thermal energy storage (TES)
- heat pump
- fan coil units (FCU)
- 4 rooms

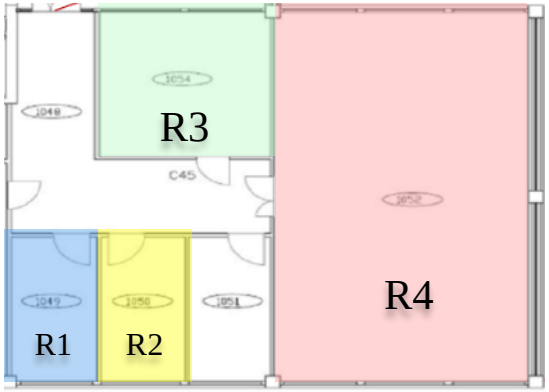


Reference strategy: PID+rule-based control

Energy Management System

FCU control: PID → MPC+PID

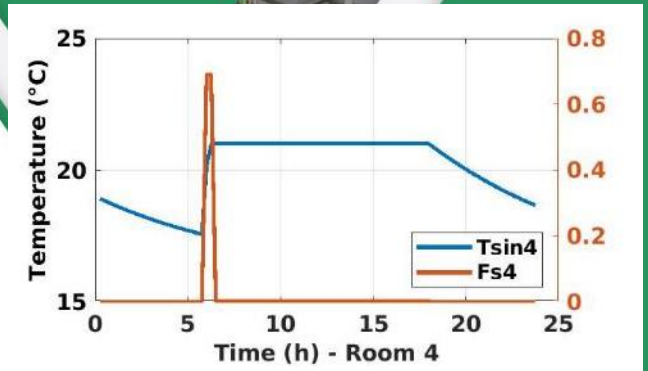
- PID: turns on the FCU from 6AM to 6PM (all rooms)
- MPC: turns on the FCU from 7:30AM to 2PM (room 4)
- FCU is less used and energy consumption is reduced with MPC+PID (all rooms)
- Comfort constraints are satisfied with both control methods



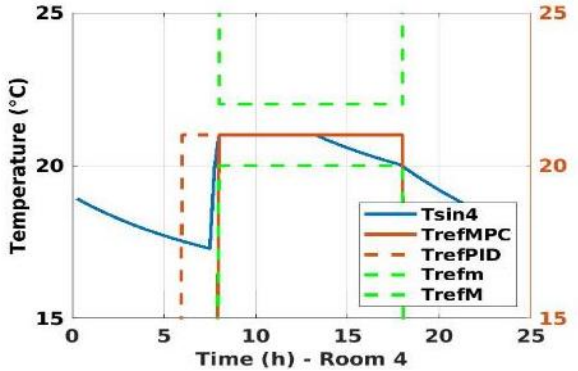
Rooms in the building

T_{sin4}: temperature of the room 4 (°C)

F_{s4}: volumetric flowrate of the air leaving the FCU (m^3/s)



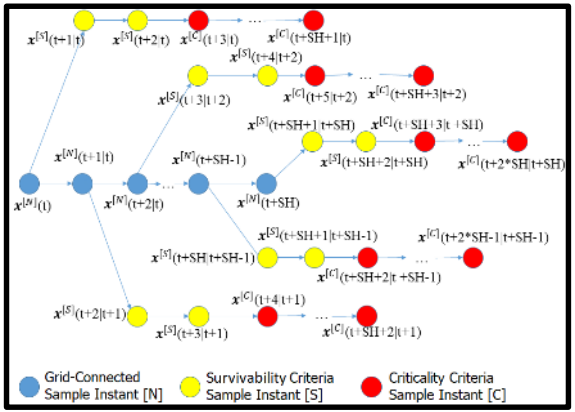
Air temperature regulation in room 4 (PID)

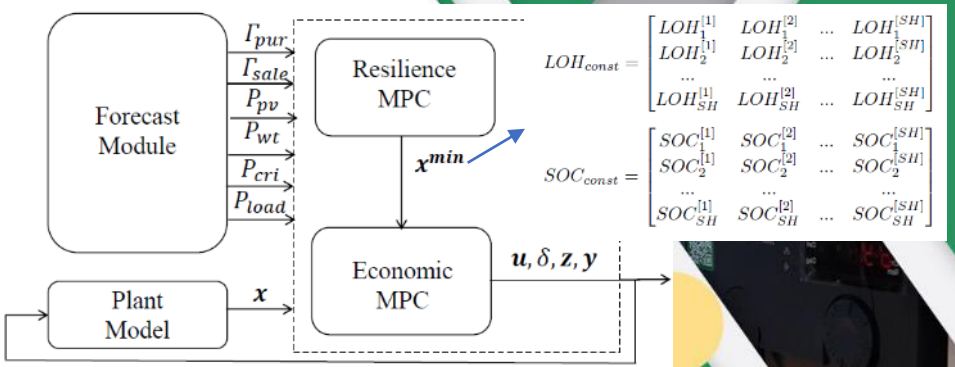


Air temperature regulation in room 4 (MPC+PID)

Energy Management System

One of the techniques used in the second algorithm developed is Resilience-Oriented Schedule of Microgrids

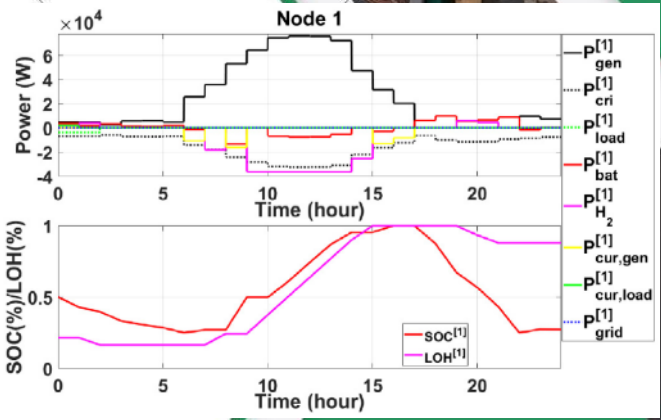




Two levels of resilience are established:

1) **Survivability:** Supply of the greatest number of loads during a certain time 2 hours from the event of loss of the main grid.

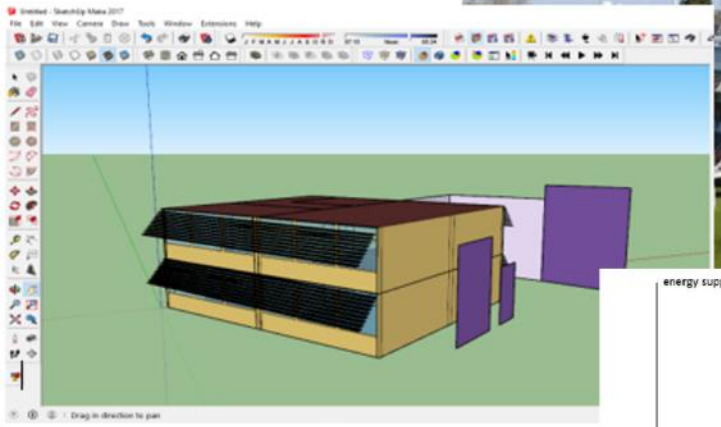
2) **Criticality:** Supply of critical loads during a horizon of 24 hours from the event loss of main network. This is done considering the loss of the main network at each optimization instant.

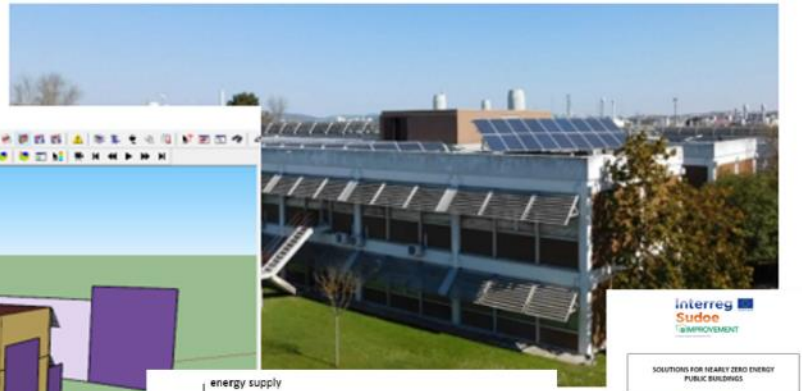


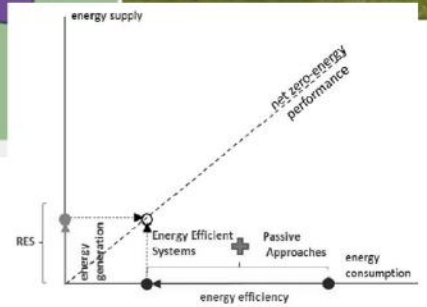
LNEG Pilot Plant

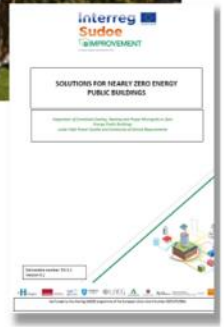
The main objective is to achieve and offer a thermal comfort situation in the facilities.

Numerical Study



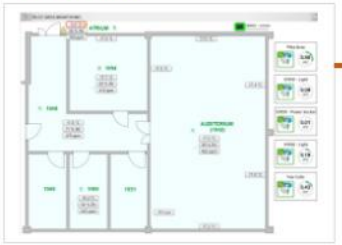




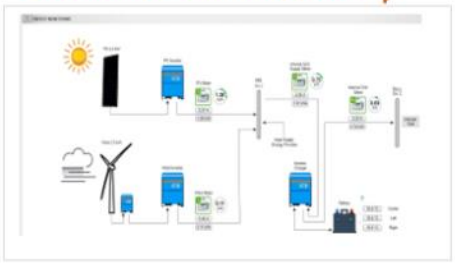


LNEG – Thermal EMS Pilot Plant

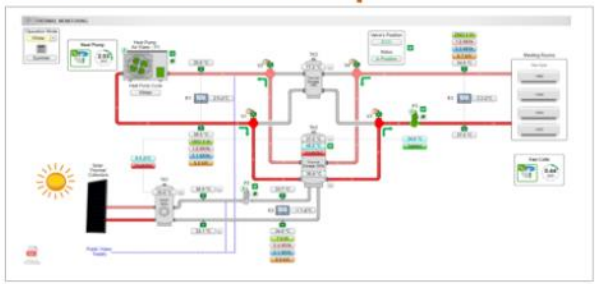
Pilot Plant



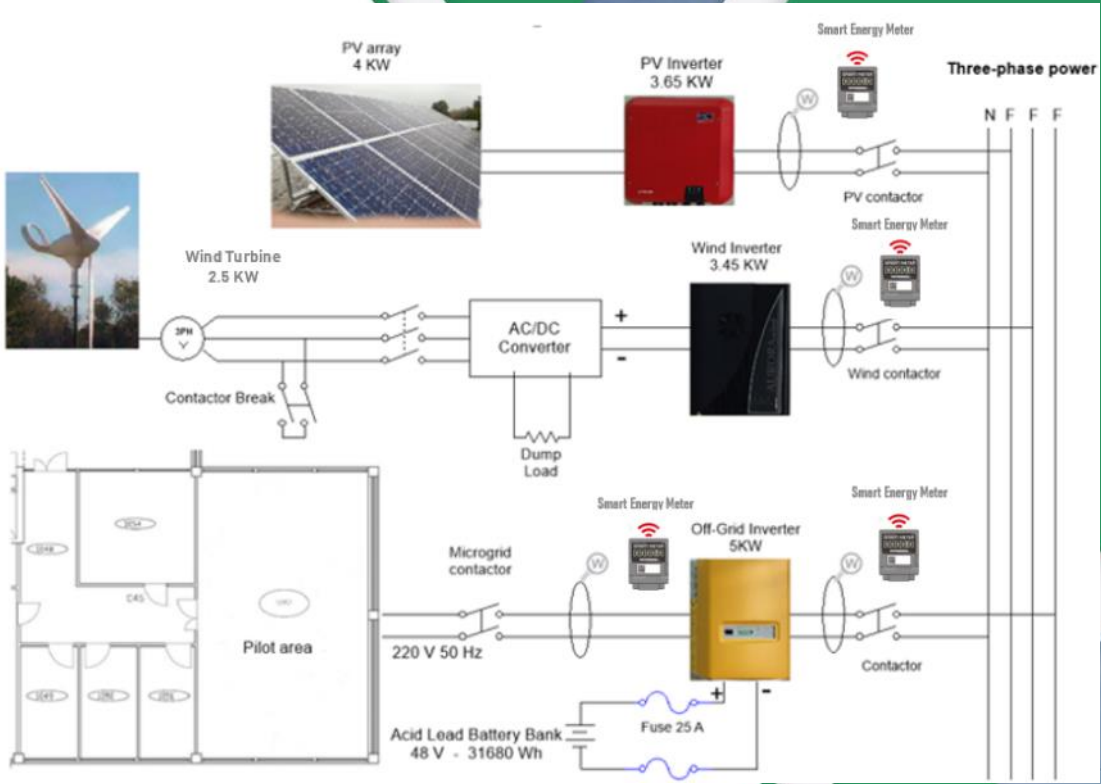
Electrical Production System



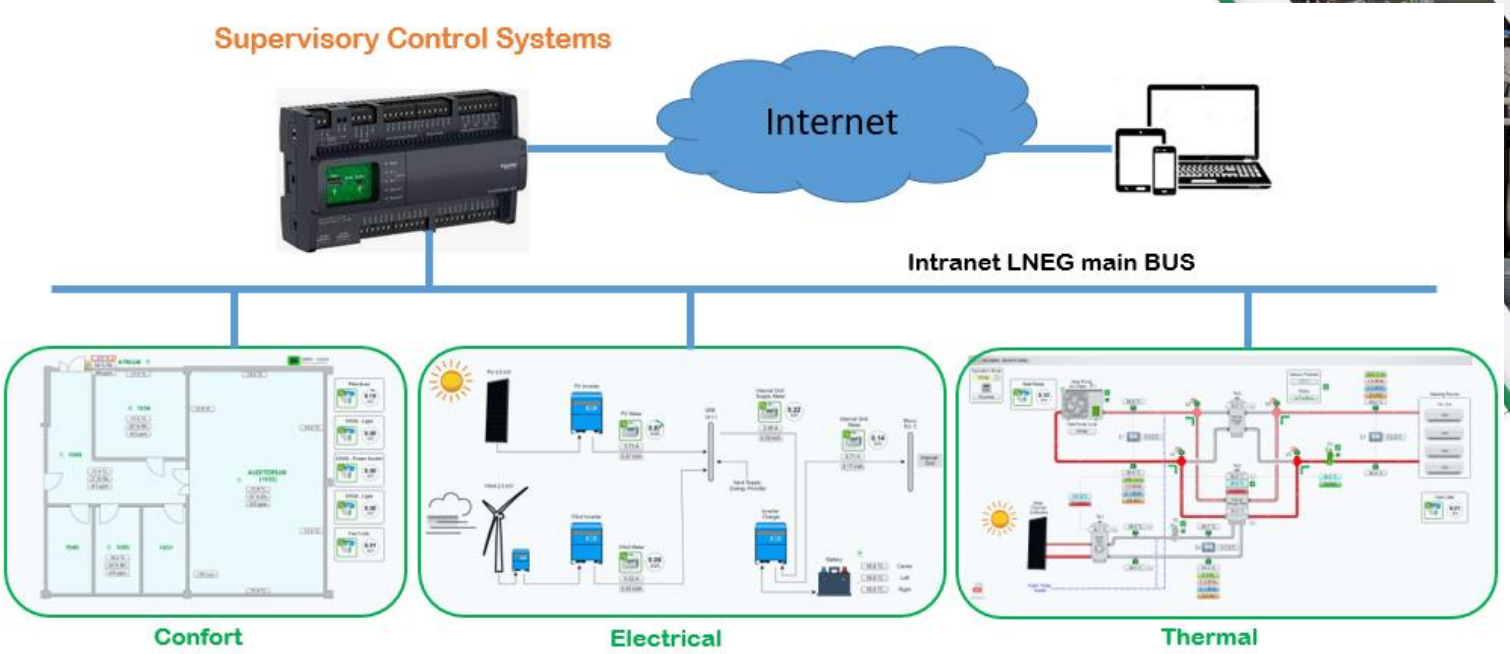
Thermal EMS System plant



LNEG - Electrical Pilot Plant

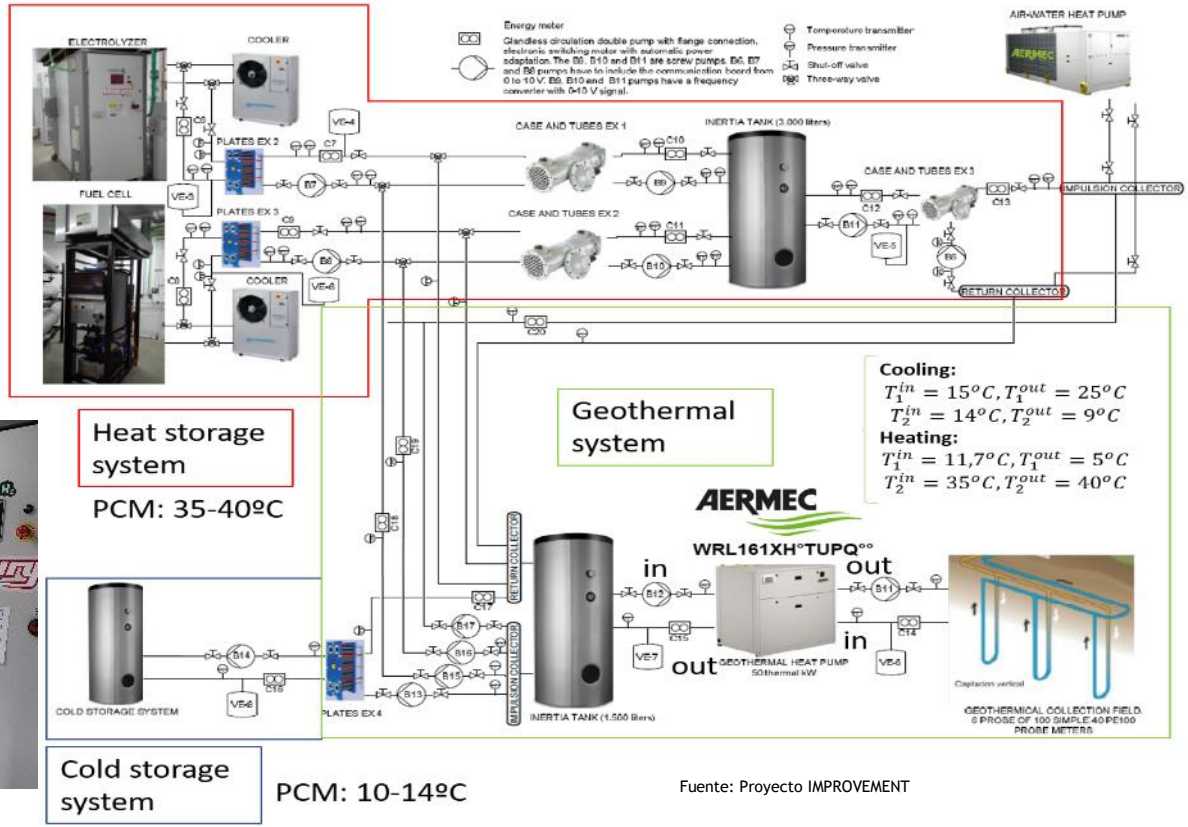


LNEG – Pilot: Control System



CNH2 Pilot Plant

CNH2 – Thermal EMS Pilot Plant



Fuente: Proyecto IMPROVEMENT

CNH2 – Thermal EMS Pilot Plant

Geothermal installation exterior part

CNH2 – Thermal EMS Pilot Plant

Geothermal installation internal part

CNH2 – Thermal EMS Pilot Plant

Cold Energy Storage System

CNH2 – Thermal EMS Pilot Plant

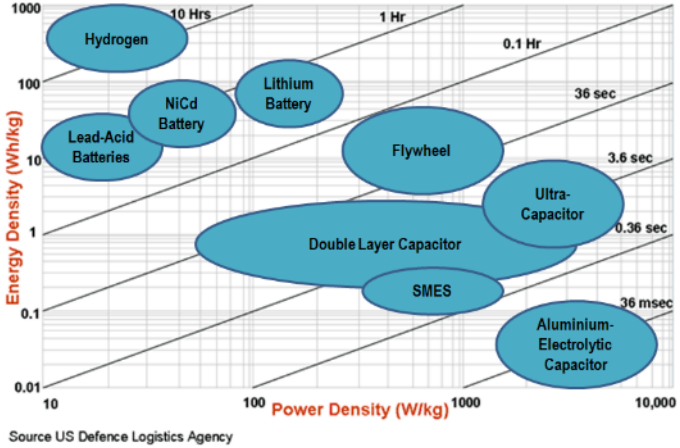
Heat Energy Storage System

Where we have a circuit of water to recover the heat from the Fuel Cell and the Electrolizer and use it to store heat to reduce the power consumption of the building

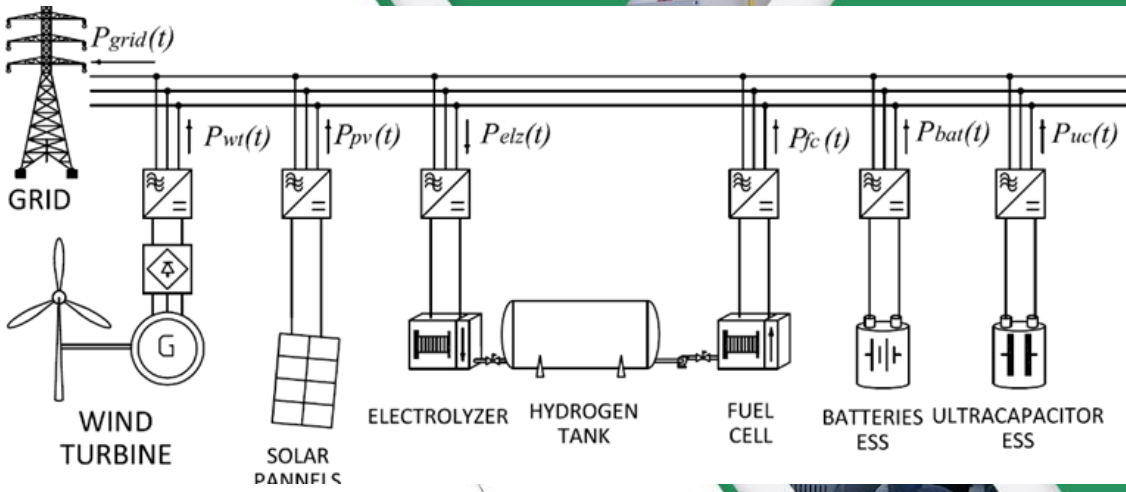
CNH2 - Electrical Pilot Plant

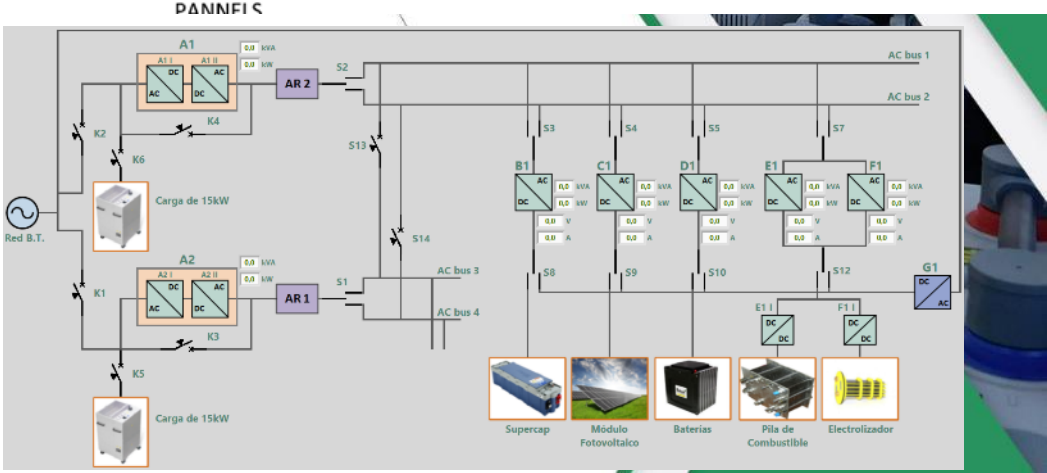
Storage System composed by:

- Batteries
- Ultracapacitors
- Hydrogen Storage



Source US Defence Logistics Agency





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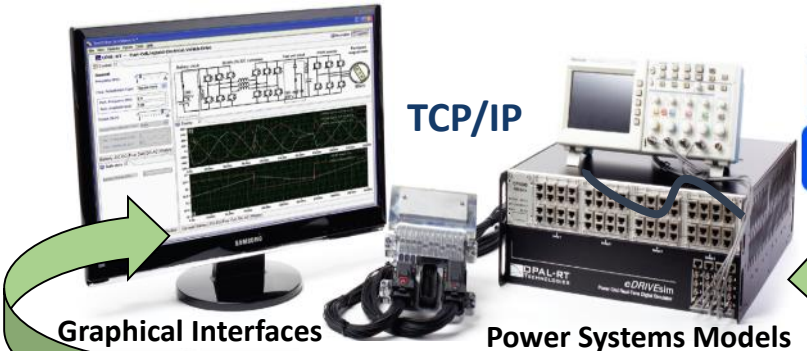
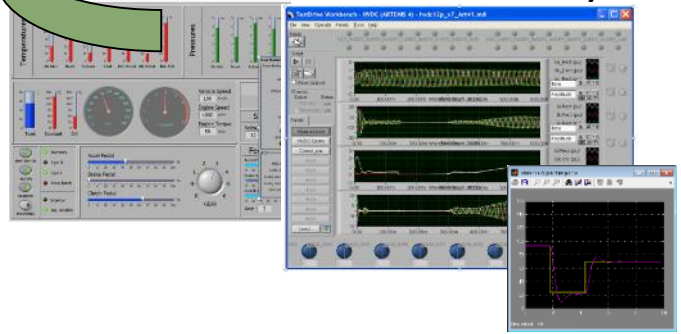
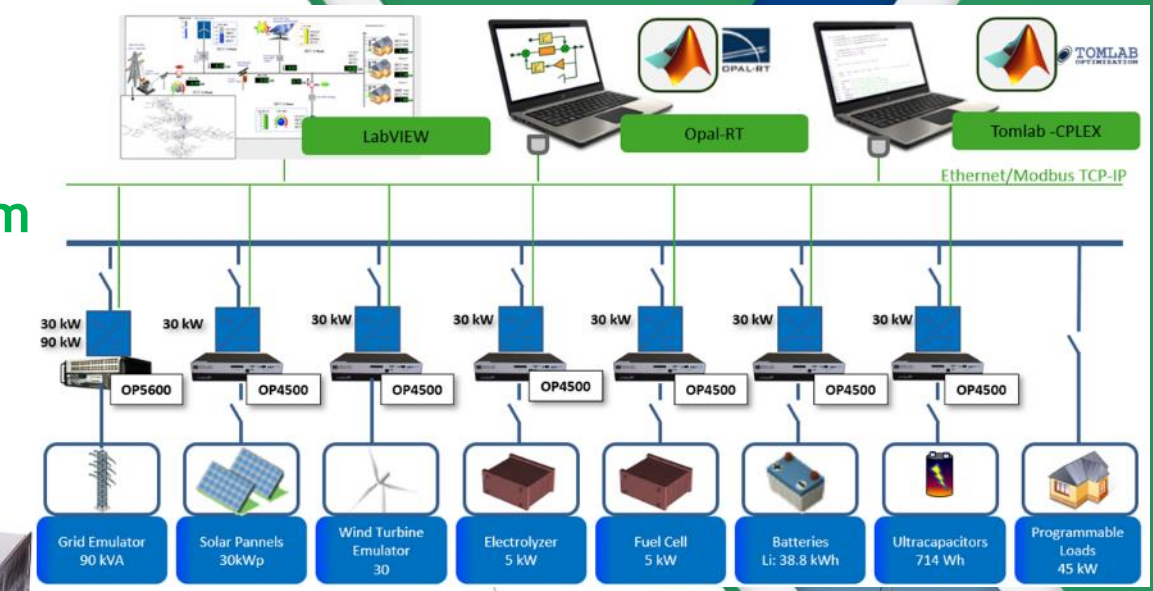
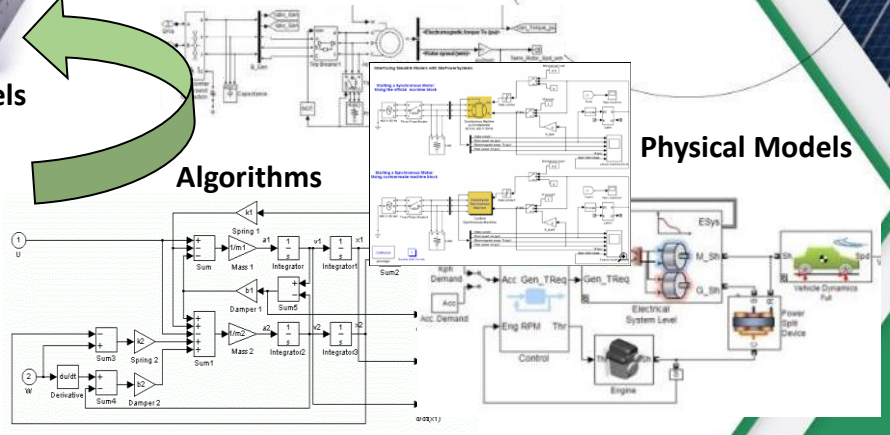
CNH2 - Pilot: Control System

The control system is carried out by means of a SCADA supervisory system developed in Labview.









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Thanks you very much!

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CNH2

Puertollano, 28 November 2023

Centro Nacional del Hidrógeno