Interreg Sudoe
IMPROVEMENT
European Regional Development Fund

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Integration of CCHP Microgrids in NZEB with Critical Loads under high PQR Requirements, a Position Paper

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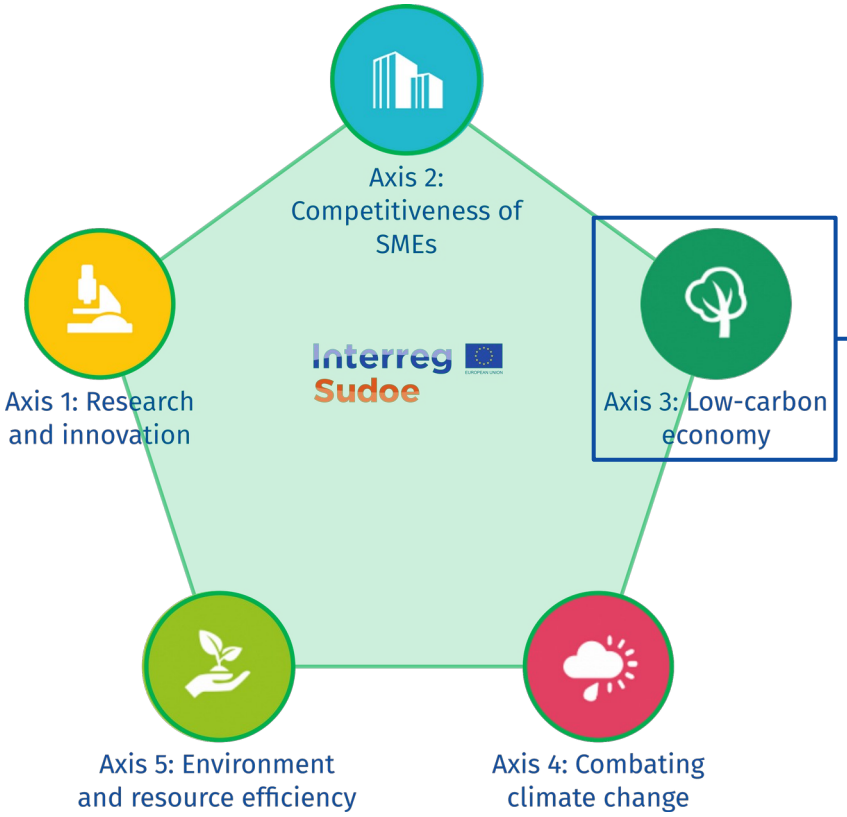
Centro Nacional del Hidrógeno · UCLM Universidad de Castilla-La Mancha · isae ENSMA · IST TÉCNICO LISBOA · LNEG · Junta de Andalucía · Universidad de Córdoba · Junta de Andalucía Consejería de la Presidencia, Administración Pública e Interior Consejería de Hacienda y Financiación Europea · Agencia Andaluza de la Energía · Université Perpignan Via Domitia

1. Introduction & objectives

Interreg SUDOE



The Interreg SUDOE programme promotes transnational cooperation to solve common problems in Southwestern Europe territory:

- low investment in research and development
- weak competitiveness of the small and medium-sized enterprises
- exposure to climate change and environmental risks

IMPROVEMENT has a budget of 2.5 million €

75 % Interreg SUDOE + ERDF

25% Self-financing

ERDF: European Regional Development Fund

IMPROVEMENT projects: Objectives

Turn existing public buildings into NZEB

- Improve thermal efficiency
  - Solar heating
  - Cooling production
  - Active & passive techniques for NZEB
- Improve Power Quality & Reliability
  - Developing a fault resilient control system
  - Active neutral point control
  - IoT Supervisory system
- Integrate advanced microgrid EMS
  - Hybrid storage system
  - Minimum degradation
  - Minimum cost of use
  - Maximization of renewable energy consumption

- Existing public buildings
- Predominance of critical loads

→ Data centers, railroad stations, airports & hospitals

IMPROVEMENT Project: Partners

UPVD - Université Perpignan Via Domitia
ISAE - Institut Supérieur de l'Aéronautique et de l'Espace

France

LNEG - Laboratório Nacional de Energía e Geologia
IST - Instituto Superior Técnico (IST) of Lisboa

Portugal

CNH2 - Centro Nacional del Hidrógeno 2 (CNH2)
JA - Junta de Andalucía
UCO - Universidad de Córdoba
AAE - Agencia Andaluza de la Energía
UCLM - Universidad de Castilla-La Mancha

Spain

IMPROVEMENT project: Pilot plants

Portuguese pilot plant

Campus do Lumiar - Build C
(Lisbon, PT)

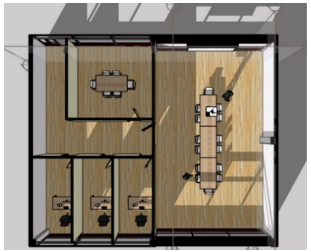
Spanish pilot plant

Centro Nacional del Hidrógeno 2
(Puertollano, Ciudad Real, SP)

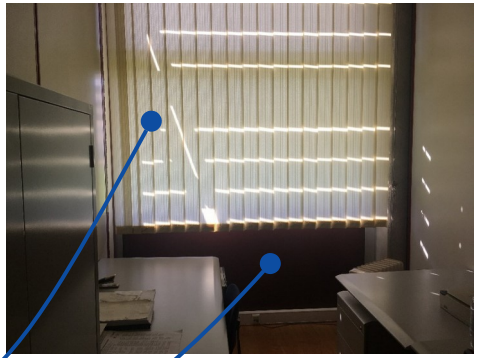
2. Position and work in progress

Portuguese pilot plant (I): Pilot Area

170 m²



- 3 x offices
- meeting room
- auditorium



Energy passive measures

- Natural ilumination
- PCM materials
- Shading devices
- Efficient lighting
- Thermal isulation

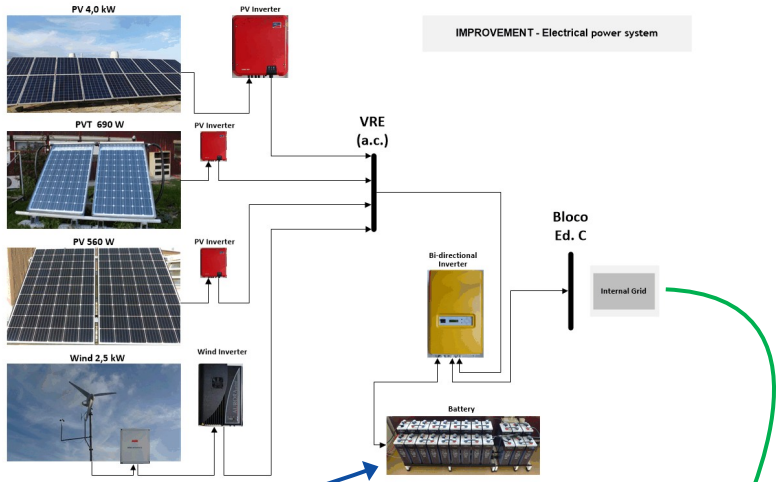
Portuguese pilot plant (II): Electrical System

Renewable electricity resources

- 4 kWp PV panels
- 2.5 kW wind turbine

Energy storage system

- 24 lead-acid batteries (48 V @ 660 Ah)



When MG is in isolated mode, hierarchy of load is defined:

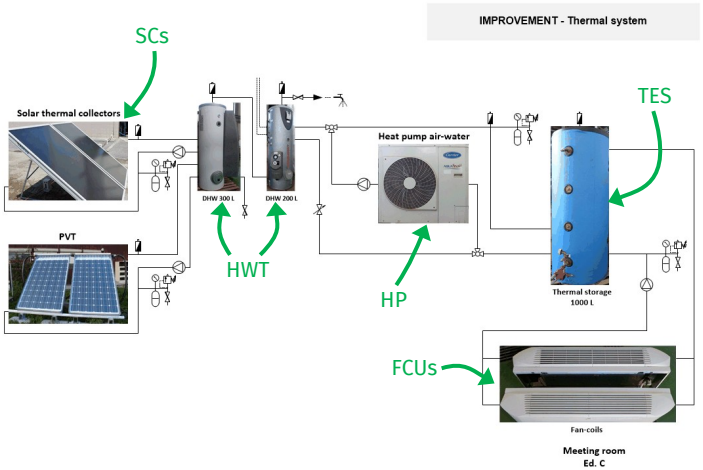
Priority loads

- Dimmable LED
- Charging Schuko plugs

Non-Priority loads

- Fan-coils
- Schuko plugs

Portuguese pilot plant (III): Thermal System



- Fan-coils
- High efficiency HP (14.5 kW)
- Solar Vacuum Collectors (4.8 m²)
- 300 l thermal storage
- 1000 l water tank
- 200 l DHW
- Hybrid PV-T SCs

Pilot Area heating & cooling

FCU: Fan Coil Unit HP: Heat Pump HVAC: Heating, Ventilation and Air Conditioning HWT: Hot Water Tank

MPC: Model-based Predictive Controller SC: Solar Collector TES: Thermal Energy Storage

Portuguese pilot plant (IV): Energy Management System

- Strategy 1: PID + rule-based controllers

PID Controllers
- SCs
- FCUs
- Temperature

+

Rule-based Controller
- TES system

Targets:
- User thermal comfort (6 a.m – 6 p.m)

- Strategy 2: MPC + MPC + PID controller

MPC 2
- TES system

PID Controller
- SCs
- FCUs

+

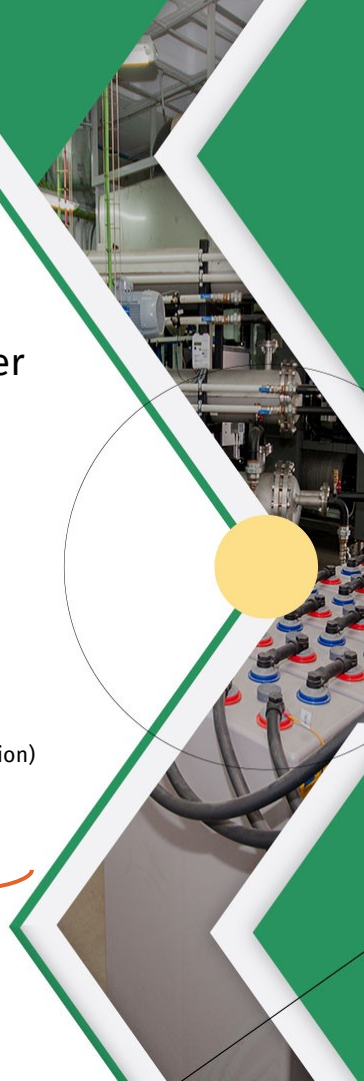
MPC 1
- Turn ON-OFF HVAC

Targets:
- User's thermal comfort
- min(electricity consumption)
- max(heat production)
- min(heat pump use)

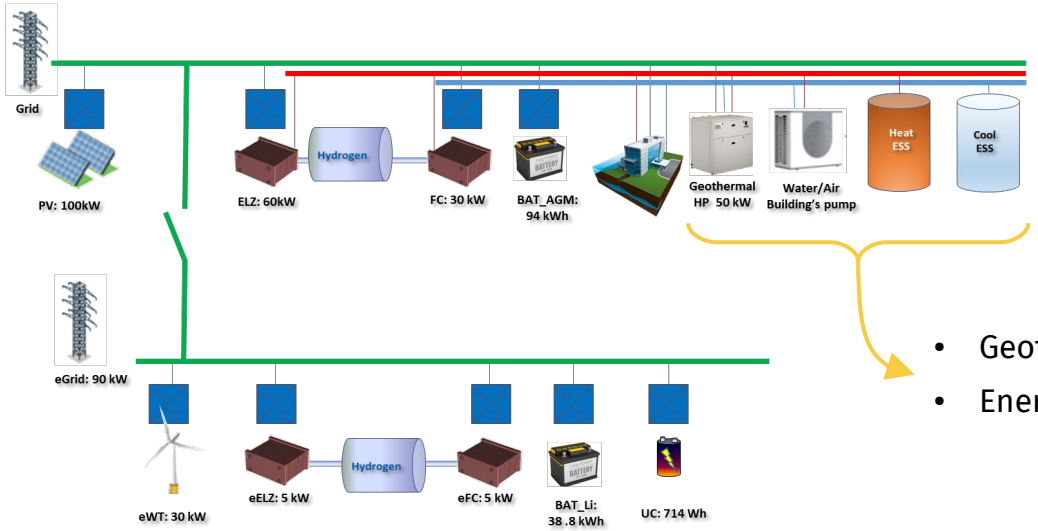
Tested

Under development

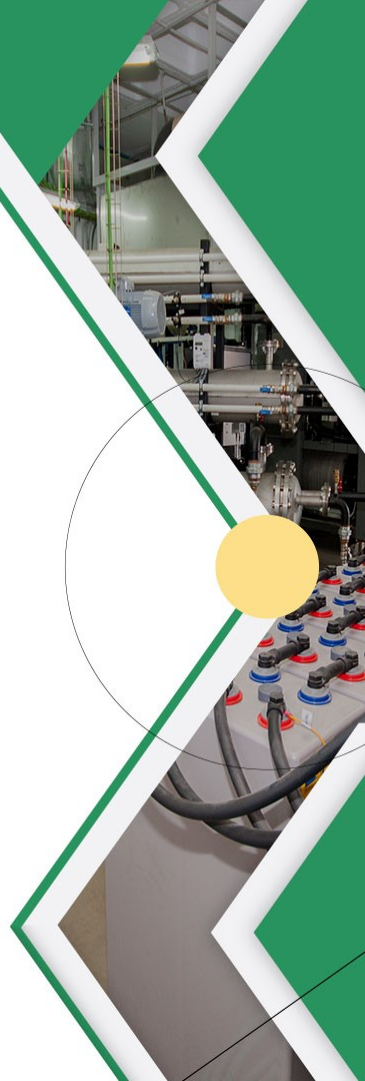
FCU: Fan Coil Unit
HP: Heat Pump
HVAC: Heating, Ventilation and Air Conditioning
HWT: Hot Water Tank
MPC: Model-based Predictive Controller
SC: Solar Collector
PID: Proportional-Integral-Derivative
TES: Thermal Energy Storage



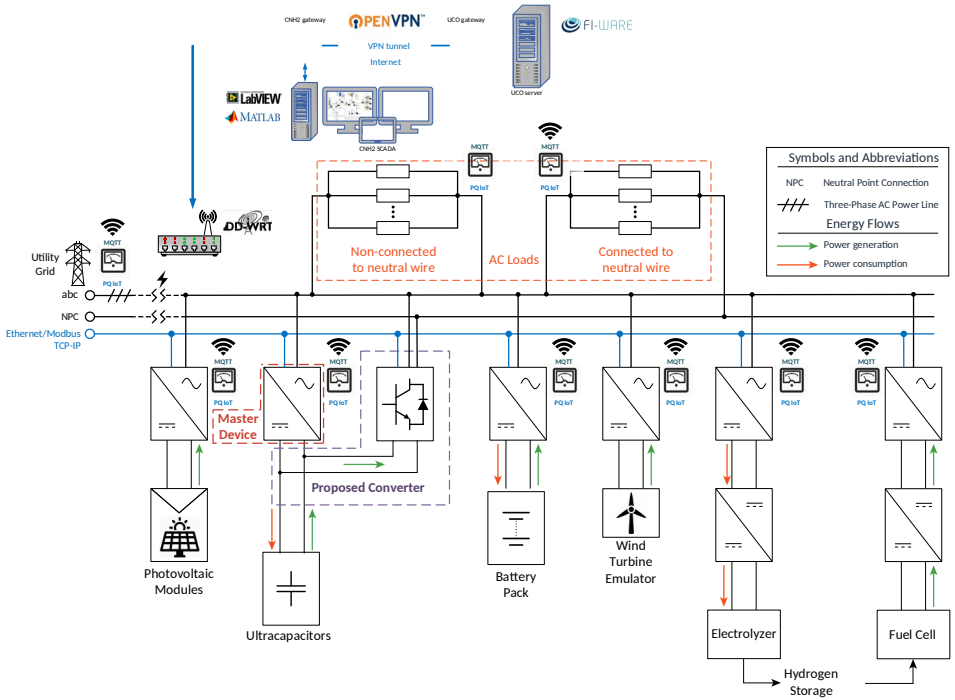
Spanish Pilot Plant (I): General scheme & thermal system



- Geothermal heat recovery system
- Energy Storage System (heat & cold)



Spanish Pilot Plant (II): Electrical system



Energy Management System

- Optimize costs of energy
- Reduce the degradation of the equipment

CONTROL

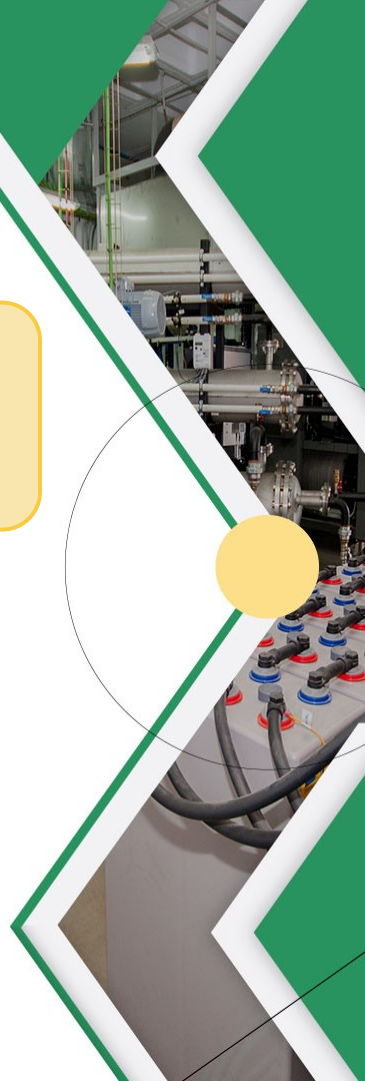
Hybrid Energy Storage System (ESS):

- Batteries
- Supercapacitors
- Hydrogen

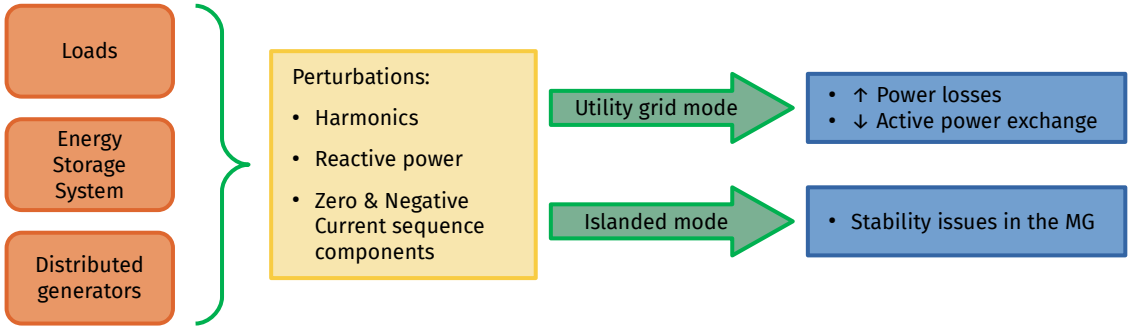
CONTROL

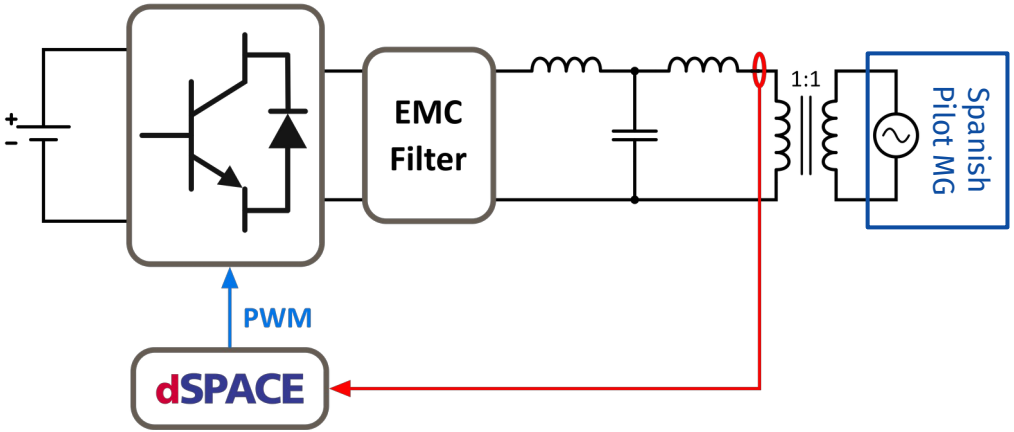
Renewable electricity sources:

- Solar panels
- Wind turbines

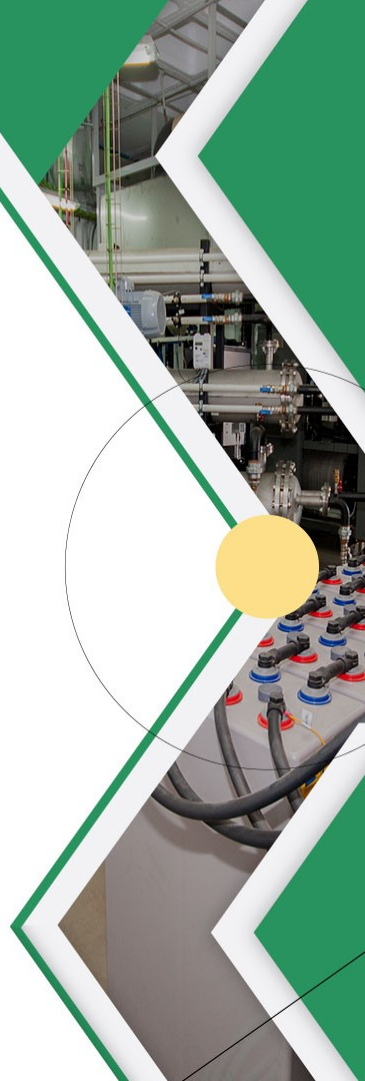


Spanish Pilot Plant (III): Active Power Filter





APF:
- Mitigate perturbations
- ↓ Reactive power
- ↑ Reliability of the MG
- ↑ Robustness of the islanded mode



Spanish Pilot Plant (IV): IoT Power Quality Sensors

DERs & Loads

PQ problems

Submetering

v2.x.x

- Main keys:
  - Calculations and data aggregation according to IEC 61000-4-30 standard
  - Current sensing: using a current probe with proportional current output
- Purpose:
  - Send PQ data to FIWARE platform (or others)
- Status: Tested

vS1.x.x

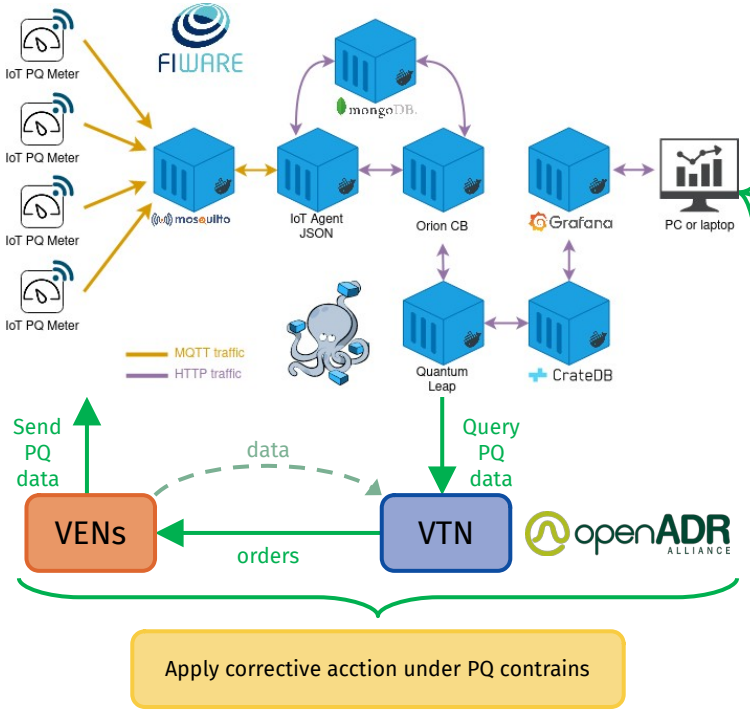
- Main keys:
  - Current sensing: using a current probe with proportional current output
  - EIA-485 communication
  - Battery Holder
  - UEXT connector (SPI, UART, I2C, etc.)
- Purpose:
  - Direct communication with uLabBox (via EIA-485)
- Status: Testing hardware & firmware

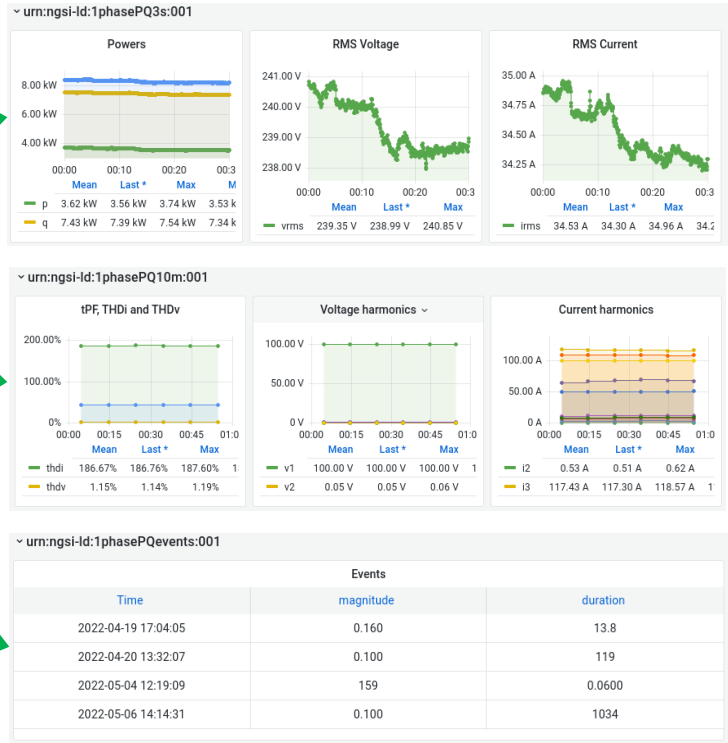
IoT PQ Meters

Sending

Energy consumption & PQ indicators

Spanish Pilot Plant (V): IoT Power Quality Infrastructure





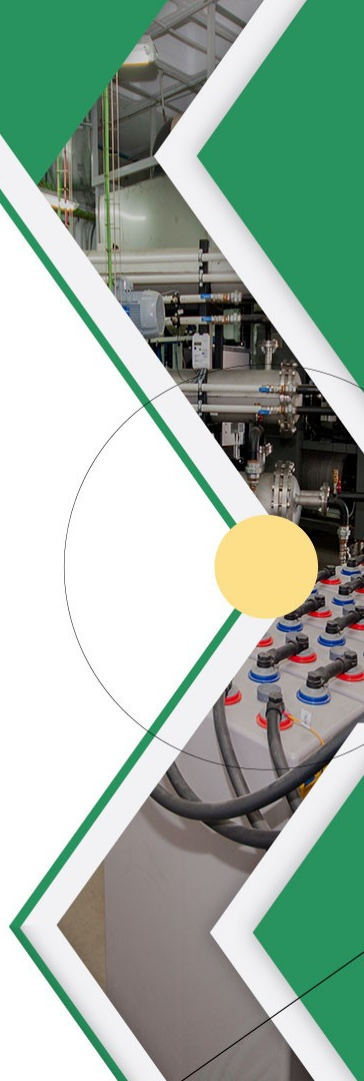
Exploitation, transfer of results and design of the regulatory actions

Objectives

1) Analyze legislation and associated administrative procedures
2) Review barriers to full deployment of the technology
3) Elaborate recommendations to facilitate the expansion of the technology

Documents

1) Review and a proposal of the regulatory framework
2) Review study of the technical codes and national markets (within and outside the SUDOE area)



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THANK YOU VERY MUCH!

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