Project Summary

The project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 773406

Version June 2021
A project about flexibility

Flexibility is understood as a power system's ability to cope with variability and uncertainty in demand, generation and grid, over different timescales.
The consortium

✓ H2020 EU funded
✓ 27M€ budget
✓ 33 partners
✓ Leaders: RTE, REE, TERNA, ELES, CEA, TUB
✓ Jan 2018 – Apr 2022
Objectives and WPs

Simulations of long-term scenarios
✓ Identify future needs and sources of flexibility
✓ Develop new tools and methods for flexibility assessment

WP1 Optimal mix of flexibilities
WP2 Market designs and regulations

4 Demonstrators
✓ Foster the participation of new flexibility providers
✓ Demonstrate new flexibility services and multi-services capabilities

WP3 Grid forming by multi-services hybrid storage
WP4 Multi-services by different storage and FACTS devices
WP5 Multi-services by coordinated grid devices, large demand-response and RES
WP6 Near real-time cross-border energy market
WP7 Scaling-up and replication
WP1: Optimal Mix of Flexibilities

Objectives:
- Quantify the needs of flexibility in different long-term scenarios
- Define the best sources of flexibility in the scenarios
- Create advanced tools and methodologies to analyze flexibility

Scenarios Definition:
- Neglected Climate Actions
- Current Goals Achieved
- Accelerated Transformation

Simulations:
- Multi-sectoral investment trajectories
  Tool: AnyMOD.jl
- Hourly dispatch of the electrical system
  Tool: Antares
- Local sizing and siting
  Tool: DESPLAN
- Reserves
  Tool: MORA
- Stability
  Tool: DlgSILENT
**SCENARIOS DEFINITION**

- Neglected climate actions
- Current Goals Achieved
- Accelerated Transformation

**SIMULATIONS**

- Multi-sectoral investment trajectories
  Tool: anyMod- Genesys
- Hourly dispatch of the electrical system
  Tool: Antares
- Local sizing and sitting
  Tool: DESPLAN
- Reserves
  Tool: MORA
- Stability
  Tool: DgSILENT

**Presentation of OSMOSE project**

**WP1: Status**

- ✓ 3 Scenarios developed (see Deliverable 1.1)
- ✓ Methodologies for time series generation
- ✓ AnyMOD.jl tool available open-source to better take into account sector coupling

- ✓ Methodology for flexibility assessment
  ✓ All scenarios simulated

- ✓ Large perturbation angle and frequency stability, Small perturbation angle stability and voltage stability assessed for critical cases for the Sicilian system in 2030 and 2050 scenarios
  ✓ Flexibility options available proved to be effective

- ✓ Impact of short-term RES uncertainty on cross-border provision reserves assessed for the scenarios “Current Goals Achieved” 2030 and 2050, and respective flexibility needs calculated
WP2: market designs & regulations

**OBJECTIVES**

- Explore and propose some market-based solutions for the development of an optimal mix of flexibility sources in Europe.
- Create advanced tools and methodologies for market design analysis.

**SIMULATIONS**

- Nodal market in UDE’s model with DA and RT uncertainties
- Zonal market in UDE’s model with DA and RT uncertainties
- Zonal market in RTE’s model with DA and RT uncertainties
- Nodal RTE with DA, ID and RT uncertainties
- With co-optimization
- With different product granularity
- With extension of flow-based
- With extension of flow-based

*RT : Real Time ; DA : Day Ahead; ID : Intra Day
orange is for CEGrid-JMM model from UDE, and blue is for the PROMETHEUS-ATLAS model from RTE

Presentation of OSMOSE project
**WP2: status**

- **Simulations**
  - Nodal market in UDE’s model with DA and RT uncertainties
  - Zonal market in UDE’s model with DA and RT uncertainties
  - Zonal market in RTE’s model with DA and RT uncertainties
  - Nodal RTE with DA, ID and RT uncertainties
  - Zonal market in RTE’s model with DA, ID and RT uncertainties

*RT : Real Time ; DA : Day Ahead; ID : Intra Day

- Orange is for CEGrid-JMM model from UDE, and blue is for the PROMETHEUS-ATLAS model from RTE

- **✓** Methodology for error forecast
- **✓** Methodology to model the interface between TSOs and DSOs.
- **✓** Analysis of KPIs for possible electricity markets targeting optimized flexibilities

- **✓** First zonal market simulations produced, providing spot market prices.
- **✓** First analysis allowing to quantify difference in forecast errors at zonal and nodal scale.
- **✓** Webinar on the first findings from WP2 market simulations.
Overview of demonstrations

**WP3 DEMO:** Grid forming for the synchronisation of large power systems by multi-service hybrid storage
- Supercapacitors 1MW-10s
- 0.5MVA-60min Li-ion battery
- RTE substation
- 720 kVA/560 kWh LTO battery
- 25 kWh LOT battery
- EPFL campus

**WP4 DEMO:** Multiple services provided by the coordinated control of different storage and FACTS devices
- STATCOM 4 MVar
- Supercapacitors 0.8MW
- 1500 V Li-ion batteries (2MW/0.5MWh)
- CENER 20 kV grid-connected facilities
- Microgrid in CENER
- Different batteries

**WP5 DEMO:** Multiple services provided by grid devices, large demand-response and RES generation coordinated in a smart management system
- 7 industrial consumers ~120 MW of flexibility
- 2 wind farms - 53 MW +1 battery (2 MW - 2 MWh)
- ENEL, E2I
- 7x150kV lines Dynamic Thermal Ratings TERNA

**WP6 DEMO:** Near real-time cross-border energy market
- Soverzene plant 20MW ENEL
- Santa Massenza plant 70MW HDE
- DEM, TES and SENG plants 135MW HSE
- High voltage grid TERNA & ELES
WP3 Demo:
Grid forming by multi-service hybrid storage

### OBJECTIVES

- Test the robustness and effectiveness of grid forming control in two real environments
- Assess multi-services compatibility
- Define DC power and energy management strategies
- Test the portability of the control strategies over different hardware platforms

### SERVICES

- Grid forming
- Fast frequency control, FCR, aFRR
- Congestion management*

### DEVICES

- Supercapacitors 1MW-10s 0.5MVA-60min Li-ion battery
- RTE substation
- 720 kVA/560 kWh LOT battery
- 25 kWh LOT battery
- EPFL Campus
- 0.5MVA-60min Li-ion battery

*These services are not at the core of the demo, only their compatibility with grid forming will be assessed
WP3 Demo: Status

- KPI defined to assess grid forming
- Demonstration and simulations validating the KPI of grid-forming control compared to grid following
- Successful implementation of grid forming in two « off the shelf » storage devices
- Multi-services algorithm developed, now to be tested in the EPFL demo

- Devices
  
  **Grid forming**
  
  720 kVA/560 kWh LOT battery
  
  25 kWh LOT battery
  
  EPFL Campus

**Services**

- Fast frequency control, FCR, aFRR
- Congestion management*

*These services are not at the core of the demo, only their compatibility with grid forming will be assessed

---

**Multi-service control algorithm for converters**

**Overall Specifications of the Demonstrations**

- Deliverable number: D3.1
- Published

---

**OSMOSE WP3: Factory Acceptance Test of the grid forming demonstrator**

- Camille Camacho, Gauthier Denis, Thibault Provost
- RTE R&D, Le Béhuard, France
- Email: camille.camacho@alte.as-france.com

- Michael Zavala, Alex Sanchez-Ruiz, Juan Jose Valdes
- ENEL, Spain
- Email: michael.zavala@enel.es

- Yannick Verney, RTE CNR
- Lyon, France
- Email: yannick.verney@rte-cnr.fr

Real-time Control of Battery Energy Storage Systems to Provide Ancillary Services Considering Voltage-Dependent Capability of DC-AC Converters

- Zhih Yan, Maurice, IEEE, Antonio Zurcher, IEEE, Franco Hacham, IEEE, RETA, Senior Member, IEEE, Nancy, France
- Email: zhih.yan@telecom-nancy.fr

Performance Assessment of Grid-forming vs Grid-following Converter-interfaced BESS on Frequency Regulation in Low-inertia Power Grids

- Yana Zarei, Zhih Yan, Fallahinejad, Antonio Zurcher, Rachel Christ of, Munich
- Email: yana.zarei@telecom-nancy.fr
**WP4 Demo: Multiple services provided by coordinated control of storage and FACTS**

**OBJECTIVES**

- Define a Master Control to coordinate different flexibility solutions
- Design a new hybrid and modular storage solution offering multi-services
- Develop a lithium-ion battery connected at high voltage in DC (≥ 1 kV)

**SERVICES**

- Emulation of inertia, Fast Fault Current Injection, Power oscillation Damping
- Frequency regulation
- Setpoint tracking, Management of renewable energy variability, program management
- Congestion Management, Voltage Control

**DEVICES**

- Master control
- STATCOM (12 Mvar)
- Ultracapacitors (0.8MW)
- Li-Ion batteries (2MW/0.5MWh)
- CENER 20 kV grid-connected facilities
- Different batteries
  - PV and wind turbine
  - Controllable load
  - Micro grid in CENER lab
- Ultracapacitors (0.8MW)
- Li-Ion batteries (2MW/0.5MWh)
- CENER 20 kV grid-connected facilities
WP4 Demo: Status

- SAFT battery ready to be integrated in the Hybrid Flexible Device.
- Containerization and wiring of all power module components in the container close to completion (July 2021)
- On field installation works are planned for August-September 2021.

CENER facilities (Sangüesa - Navarra)

STATCOM (12 Mvar)
Ultracapacitors (0.8MW)
Li-Ion batteries (2MW/0.5MWh)
CENER 20 kV grid-connected facilities

Different batteries
PV and wind turbine
Controllable load
Micro grid in CENER lab

Emulation of inertia, Fast Fault Current Injection, Power oscillation Damping
Frequency regulation
Setpoint tracking, Management of renewable energy variability, program management
Congestion Management, Voltage Control

Master control

SERVICES

DEVICES

CENER facilities

Different batteries
PV and wind turbine
Controllable load
Micro grid in CENER lab
WP5 Demo: Multiple services provided by grid devices, large DR and RES coordinated in a smart management system

**Devices**

- 9 industrial consumers
  - ~120 MW of flexibility
- 2 wind farms - 33 MW
  - +1 battery (2 MW - 2 MWh)
- 7x150kV lines
  - Dynamic Thermal Ratings
  - Terna

**Services**

- Frequency Restoration Reserve and Automatic Voltage Control
- Automatic Voltage Control and Synthetic Inertia
- Congestion management with an Energy Management System

**Objectives**

- Demonstrate the provision of FRR and AVC by single or aggregated industrial loads
- Demonstrate the provision of Synthetic Inertia and AVC by wind farms
- Test innovative DTR
- Develop an Energy Management system to coordinate congestion management by DTR, RES and industrial loads
WP5 Demo: status

- **Devices**
  - 9 industrial consumers (~120 MW of flexibility)
  - 2 wind farms - 33 MW +1 battery (2 MW - 2 MWh)
  - 7x150kV lines
  - Dynamic Thermal Ratings
  - TERNA

- **Services**
  - Frequency Restoration Reserve and Automatic Voltage Control
  - Automatic Voltage Control and Synthetic Inertia
  - Congestion management with an Energy Management System

- ✓ 5 Industrial load sites have been upgraded successfully: 88MW for congestion management, 5.5MVar for voltage control and 0.4MW for aFRR will be available for the demo.
- ✓ First local tests on Automatic Voltage Control on the two wind power plants were successfully conducted.
- ✓ A Synthetic Inertia control device has been developed by Enel Green Power and installed on its Pietragalla plant premise.
- ✓ D5.4 released. It explains all relevant activities and technical information related to the development and implementation of the software solutions needed to carry out the first use case of WP5 demonstrator.
WP6 Demo:
Near real-time cross-border energy market

**OBJECTIVES**

- Design a market which takes advantage of the flexibility near real-time
- Develop the software and platforms for bids creation, selection and activation
- Demonstrate the effectiveness and security of this market

**SERVICES**

Near real-time energy cross border market taking into account grid constraints

**DEVICES**

- Soverzene plant 20MW participating ENEL
- Santa Massenza plant 70MW participating HDE
- DEM, TES and SENG plants 135MW participating HSE
- High voltage grid Terna & Eles
WP6 Demo: Status

Lake Santa Massenza (Santa Massenza plant)

 ✓ Video on WP6 demonstrator concepts!
 ✓ EN4M software, FEB creation and OPT tools have been installed and tested individually on ELES business environment.
 ✓ Conclusive tests of the bidding generators were run from the flexibility provider’s side.

Near real-time energy cross border market taking into account grid constraints
WP7: Scaling up and replication

**INTEROPERABILITY**

Objectives:
- Refine IEC61850 interoperability framework
- Demonstrate the engineering process of IEC61850 ENTSOE profile with different specifications tools
- Demonstrate IEC61850 interoperability framework with products from different manufacturers

**TSO-DSO FLEXIBILITIES COORDINATION**

Objectives:
- Provide an optimization framework taking into account different time scales for voltage control on the DSO grid in coordination with the TSO
- Demonstrate the tool and its benefits in a demo in real-time simulation

**BATTERY ENERGY STORAGE SYSTEM: DESIGN & CONTROL AND SHARED DATABASE**

Objectives:
- Develop methods and tools for BESS design & control for a decrease of Levelised Cost
- Creation of a shared database with advanced data analytics for Energy Storage Systems in operation
**WP7: Scaling up and replication**

**INTEROPERABILITY**

- Objectives:
  - ✓ Refine IEC61850 interoperability framework
  - ✓ Demonstrate the engineering process of IEC61850 ENTSOE profile with different specifications tools
  - ✓ Demonstrate IEC61850 interoperability framework with products from different manufacturers

**TSO-DSO FLEXIBILITIES COORDINATION**

- Objectives:
  - ✓ Provide an optimization framework taking into account different time scales for voltage control on the DSO grid in coordination with the TSO
  - ✓ Demonstrate the tool and its benefits in a demo in real-time simulation

**BATTERY ENERGY STORAGE SYSTEM: DESIGN & CONTROL AND SHARED DATABASE**

- Objectives:
  - ✓ Develop methods and tools for BESS design & control for a decrease of Levelised Cost
  - ✓ Creation of a shared database with advanced data analytics for Energy Storage Systems in operation

- Deliverables:
  - **D7.1**
    - First tests done
  - **D7.5**
    - Webinar
    - First tests of Flexibility Scheduler software ongoing
    - Optimal sizing method: D7.5

- Other:
  - ✓ Database developed & tested
  - ✓ Integration of on-field BESS data from WP3-WP4 demo
Thank you!

https://www.osmose-h2020.eu/

@Osmose_H2020

osmose-h2020