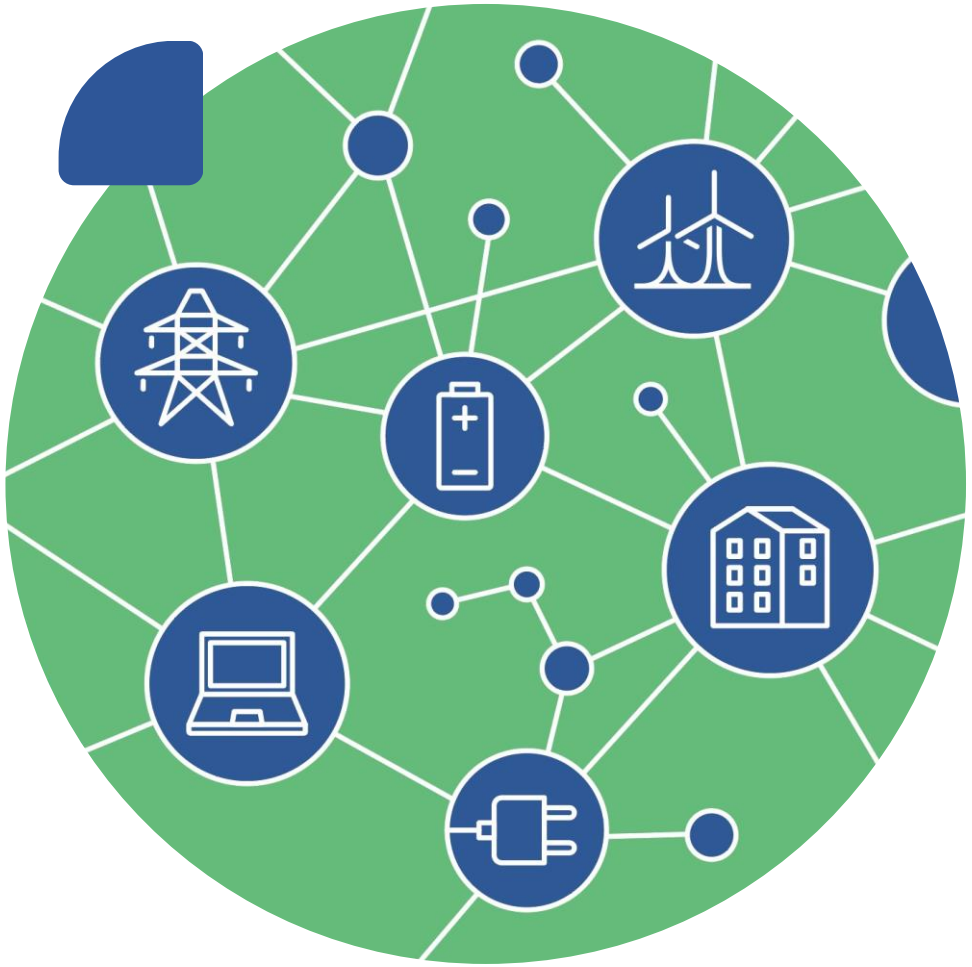


OSMOSE

OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

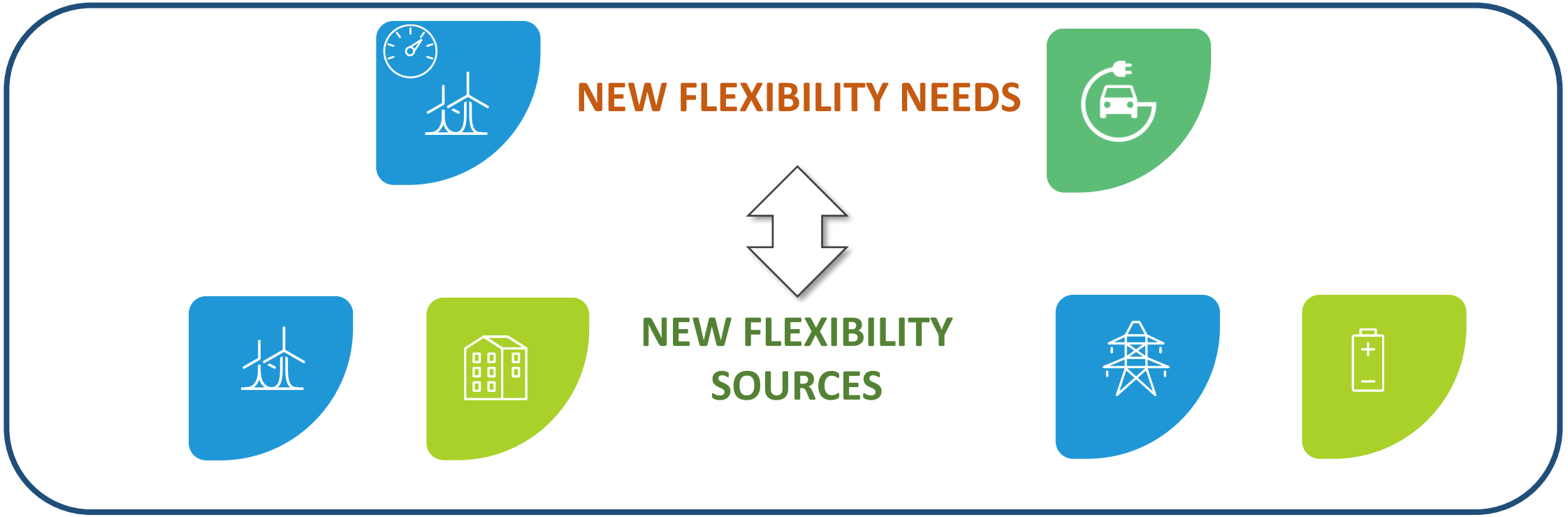
Project Summary

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

Version June 2021

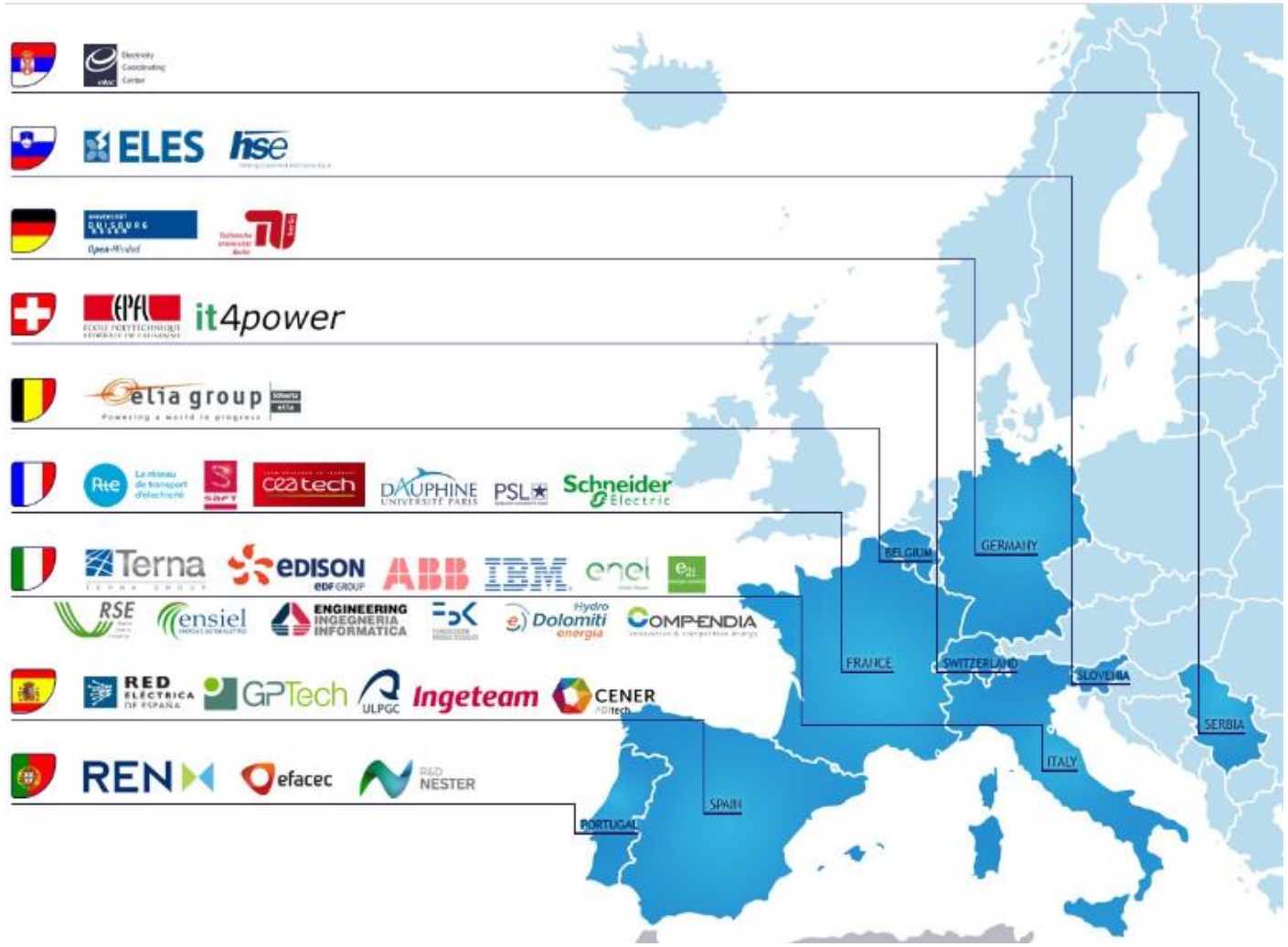
A project about flexibility

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

WP7 Scaling-up and replication

4 Demonstrators

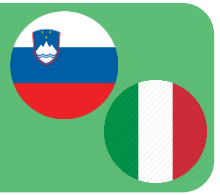
- ✓Foster the participation of new flexibility providers
- ✓Demonstrate new flexibility services and multi-services capabilities

WP3 Grid forming by multi-services hybrid storage

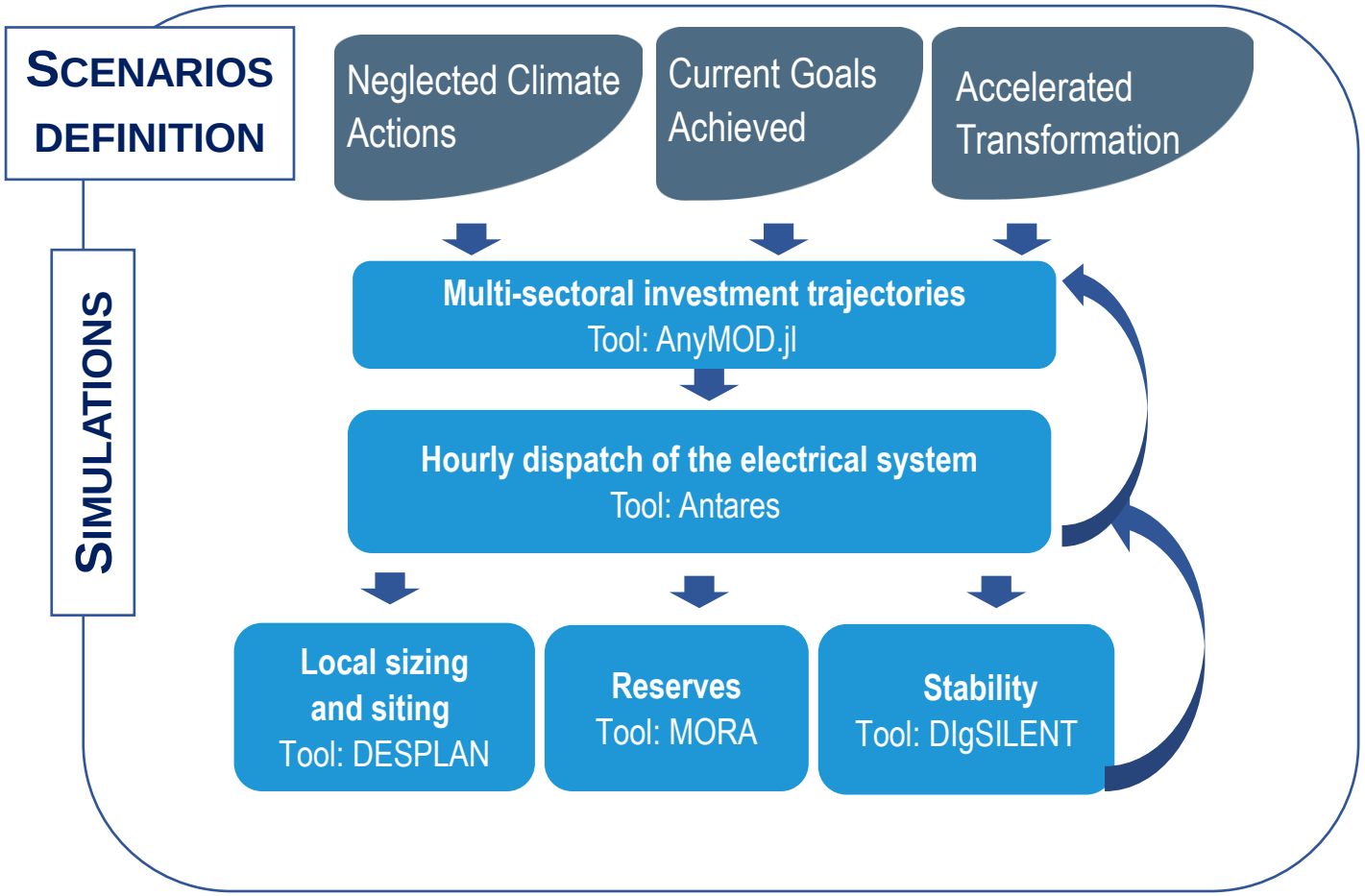
WP4 Multi-services by different storage and FACTS devices

WP5 Multi-services by coordinated grid devices, large demand-response and RES

WP6 Near real-time cross-border energy market



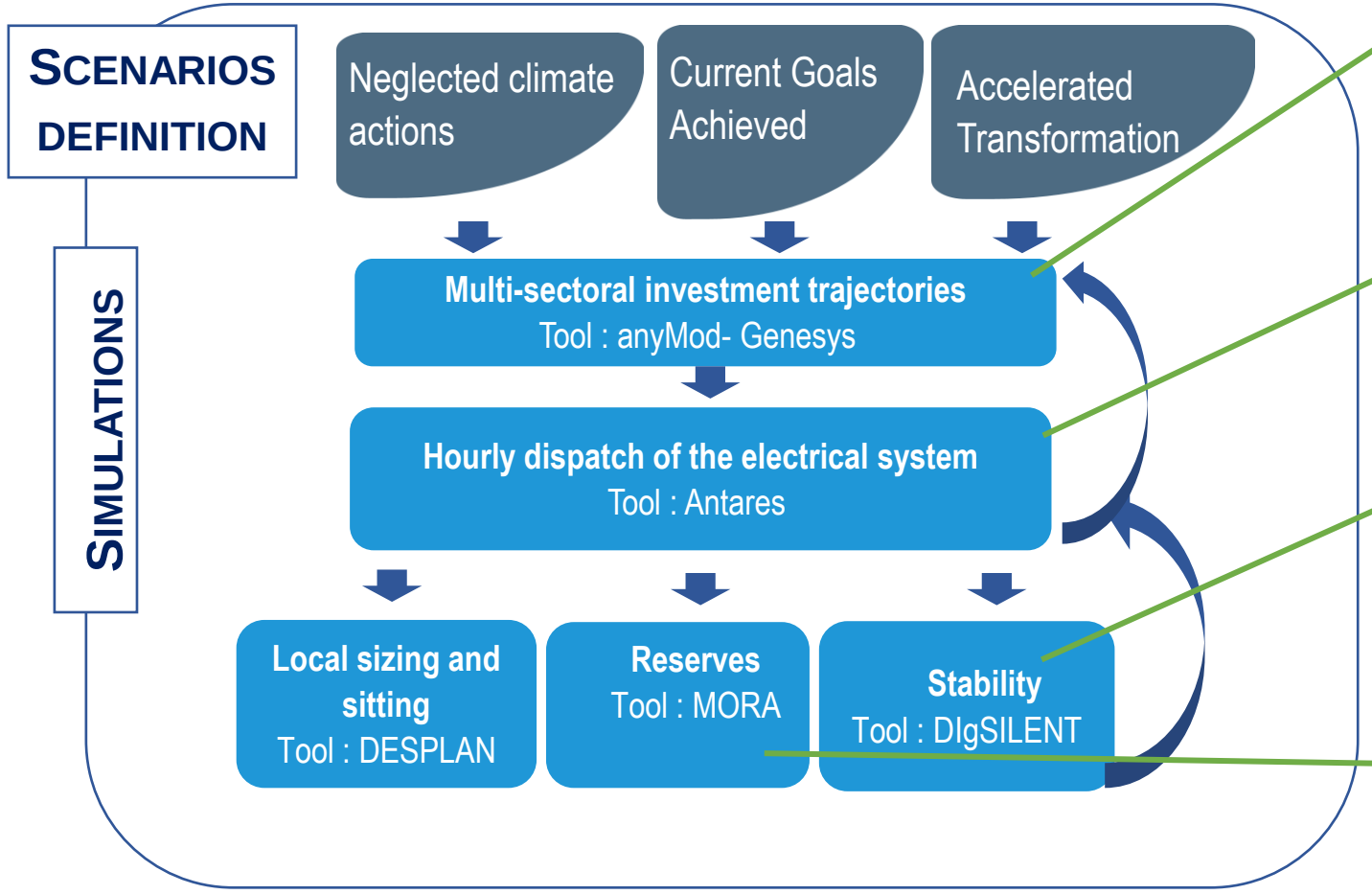
WP1: Optimal Mix of Flexibilities



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

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

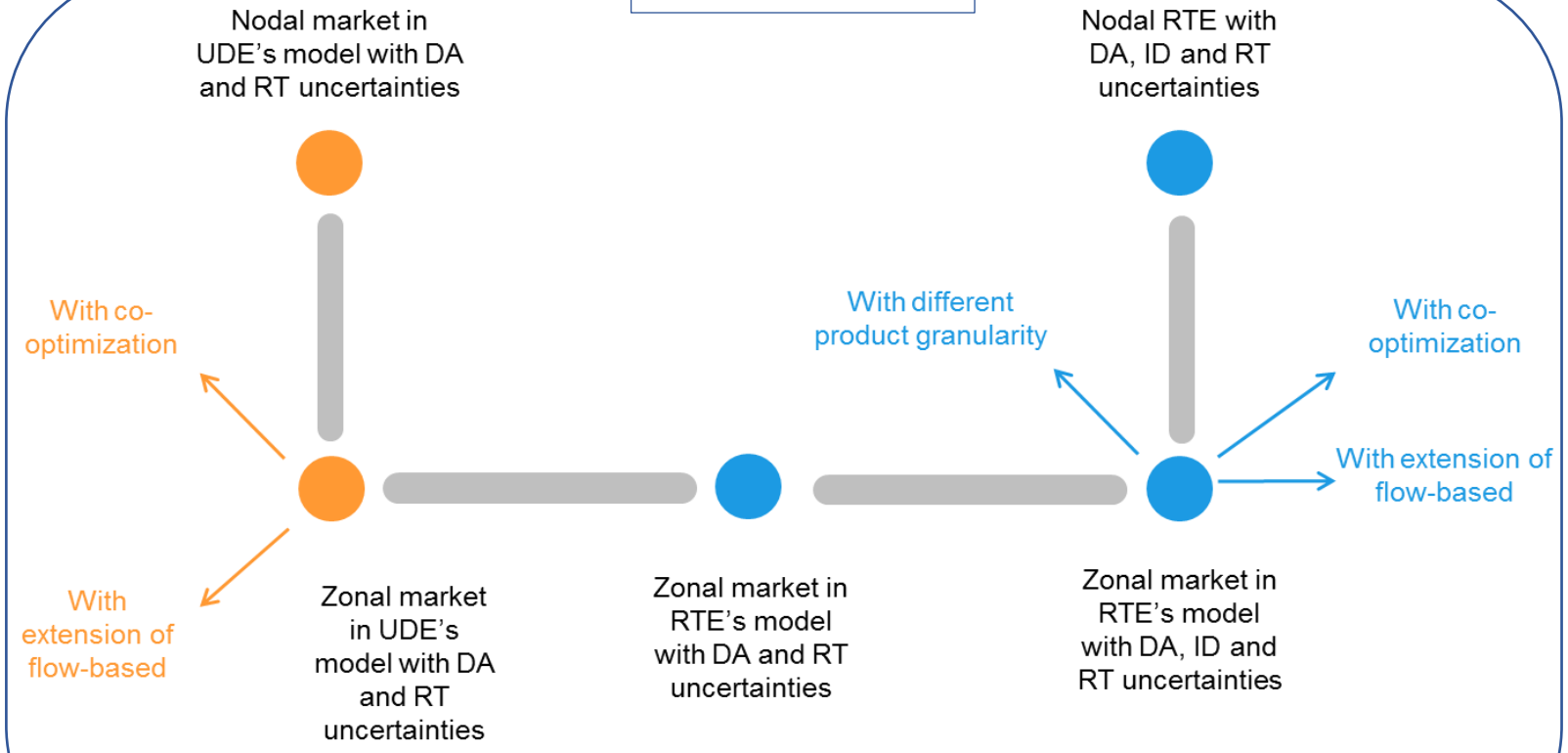
✓Methodology for flexibility assessment
✓All scenarios simulated

✓ 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

SIMULATIONS

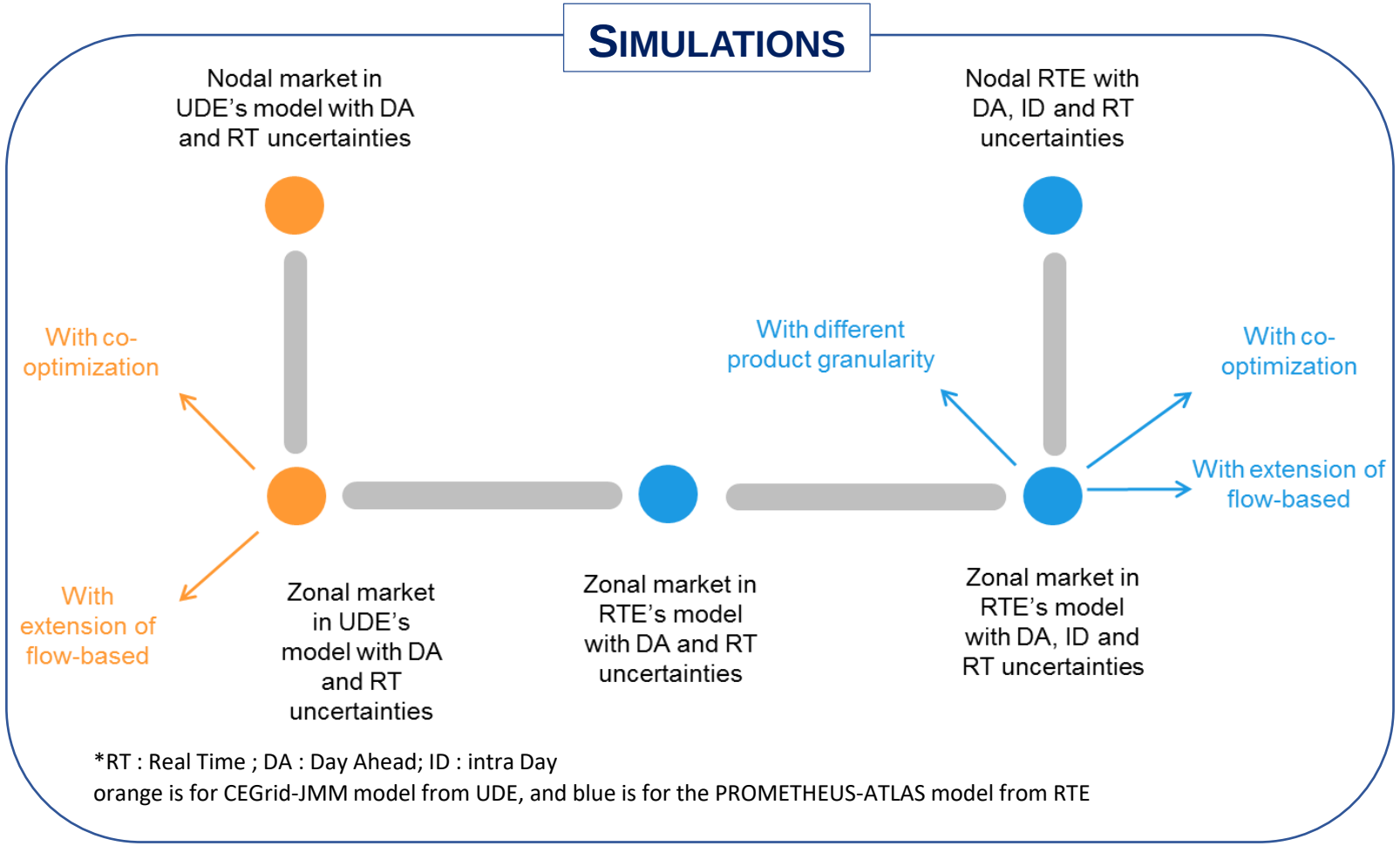


*RT : Real Time ; DA : Day Ahead; ID : intra Day
orange is for CEGrid-JMM model from UDE, and blue is for the PROMETHEUS-ATLAS model from RTE

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

WP2: status



- ✓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.

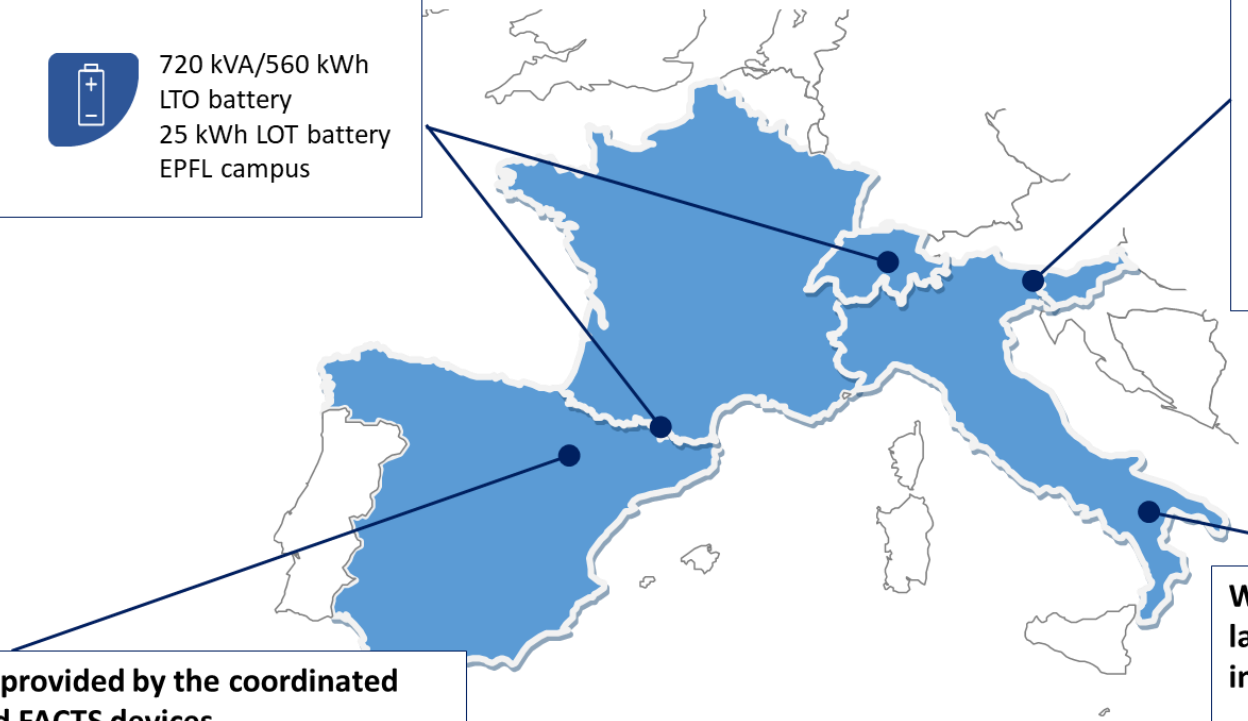
OSMOSE PROJECT

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



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

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

WP3 Demo:
Grid forming by multi-service hybrid storage

DEVICES

Supercapacitors 1MW-10s
0.5MVA-60min Li-ion battery
RTE substation

720 kVA/560 kWh LOT battery
25 kWh LOT battery
EPFL Campus

SERVICES

Grid forming

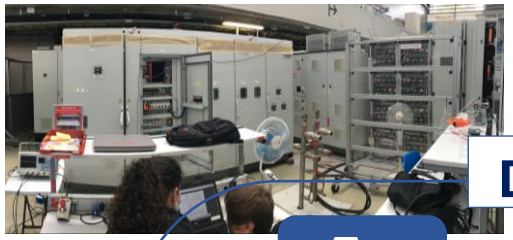
Fast frequency control, FCR, aFRR
*Congestion management**

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

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

WP3 Demo: Status



DEVICES

Supercapacitors 1MW-10s
0.5MVA-60min Li-ion battery
RTE substation

720 kVA/560 kWh LOT battery
25 kWh LOT battery
EPFL Campus

SERVICES

Grid forming

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*

- ✓ 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 developped, now to be tested in the EPFL demo

Multi-service control algorithm for converters

Deliverable number: D3.1

Published

Overall Specifications of the Demonstrations

D3.2

OSMOSE WP3: Factory Acceptance Test of the grid forming demonstrator

Carmen Cardozo, Guillaume Denis and Thibault Prevost, RTE R&D, La Defense, France
Markel Zubiaga, Alain Sanchez-Ruiz and Juan Jose Valera, Ingeteam, Bilbao, Spain
Yannick Vernay, RTE CNER, Lyon, France, Email: yannick.vernay@rte-france.com

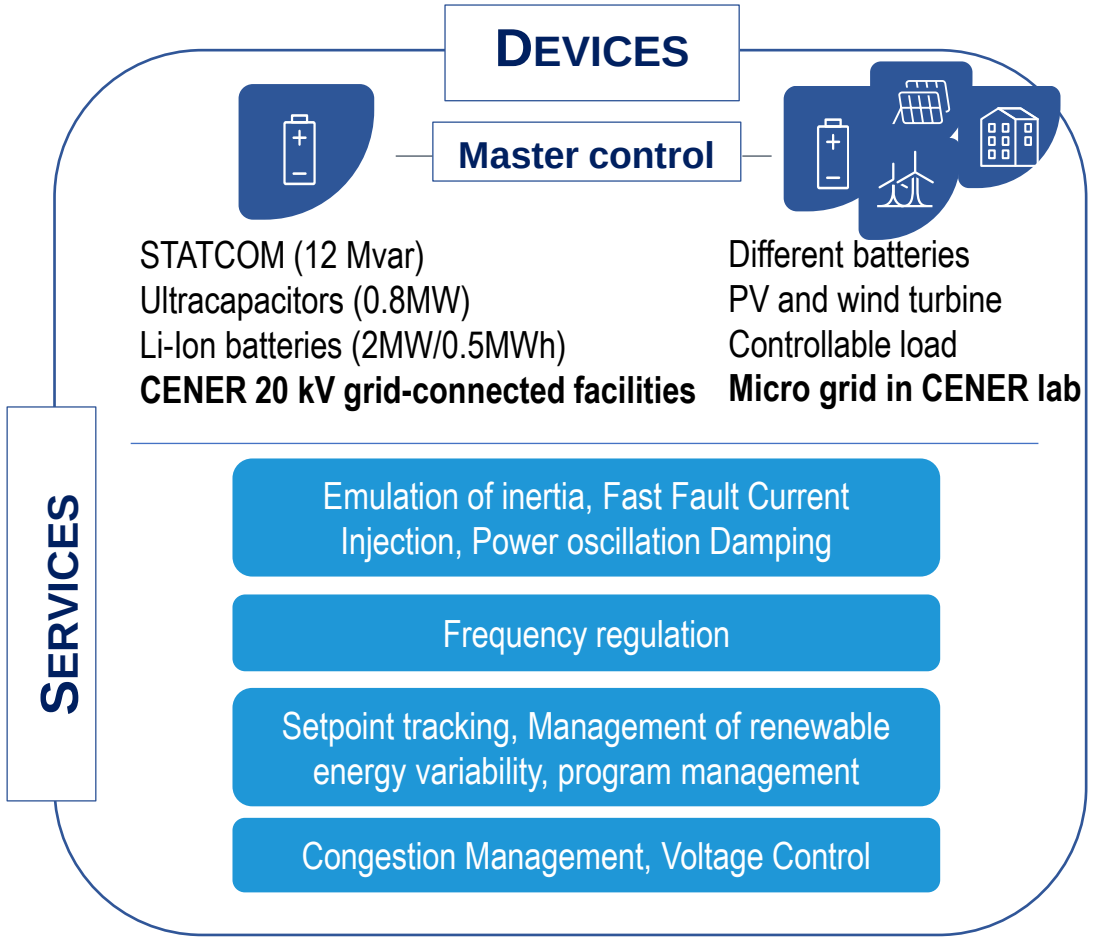
Real-time Control of Battery Energy Storage Systems to Provide Ancillary Services Considering Voltage-Dependent Capability of DC-AC Converters

Zhao Yuan, *Member, IEEE*, Antonio Zecchino, *Member, IEEE*, Rachid Cherkaoui, *Senior Member, IEEE*, Mario Paolone *Senior Member, IEEE*

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

Yihui Zuo, Zhao Yuan, Fabrizio Sossan, Antonio Zecchino, Rachid Cherkaoui, Mario Paolone

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)

WP4 Demo: Status

CENER facilities
(Sangüesa - Navarra)

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

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

- ✓ 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.

WP5 Demo: Multiple services provided by grid devices, large DR and RES coordinated in a smart management system

DEVICES

9 industrial consummers
~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

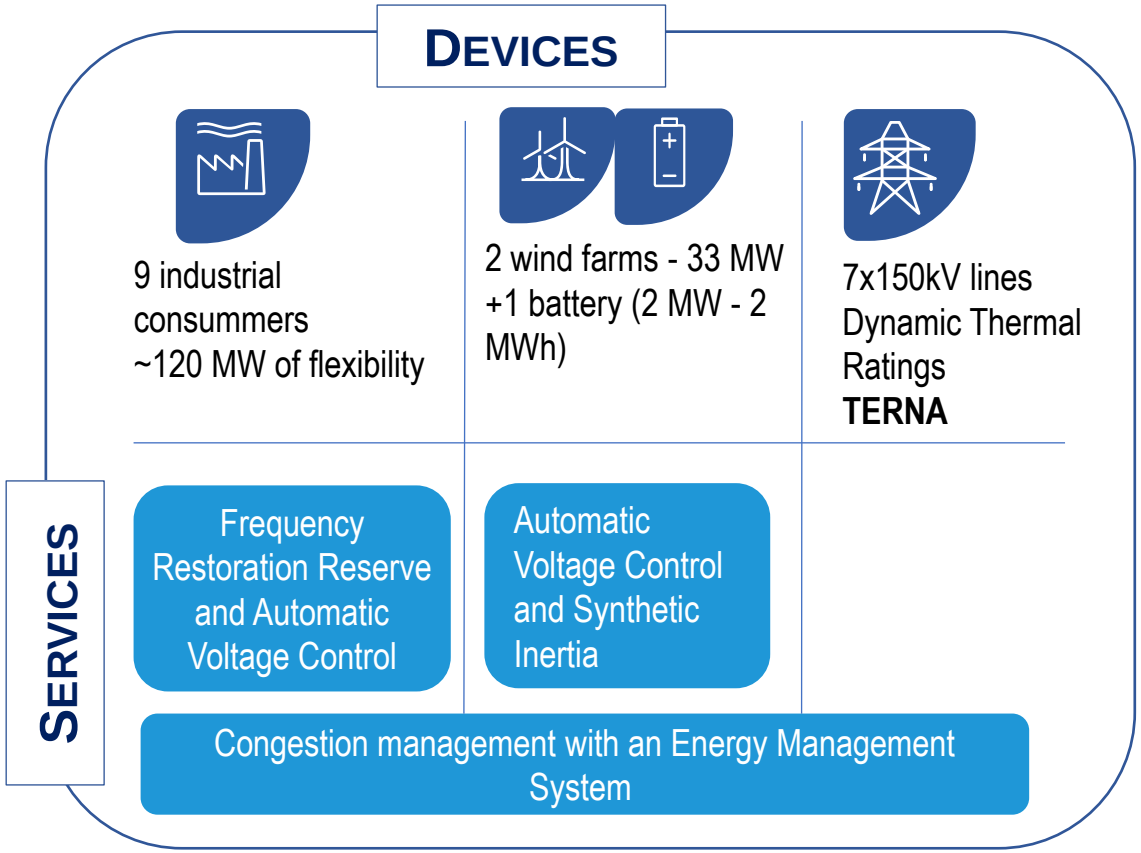
Automatic Voltage Control and Synthetic Inertia

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



- ✓ 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.


Pietragalla site with BESS & wind turbines


Installation of Dynamic Thermal Rating

WP6 Demo:
Near real-time cross-border energy market

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**

SERVICES

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

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

WP6 Demo: Status

Lake Santa Massenza (Santa Massenza plant)

DEVICES

Soverzene plant 20MW participating **ENEL**

Santa Massenza plant 70MW participating **HDE**

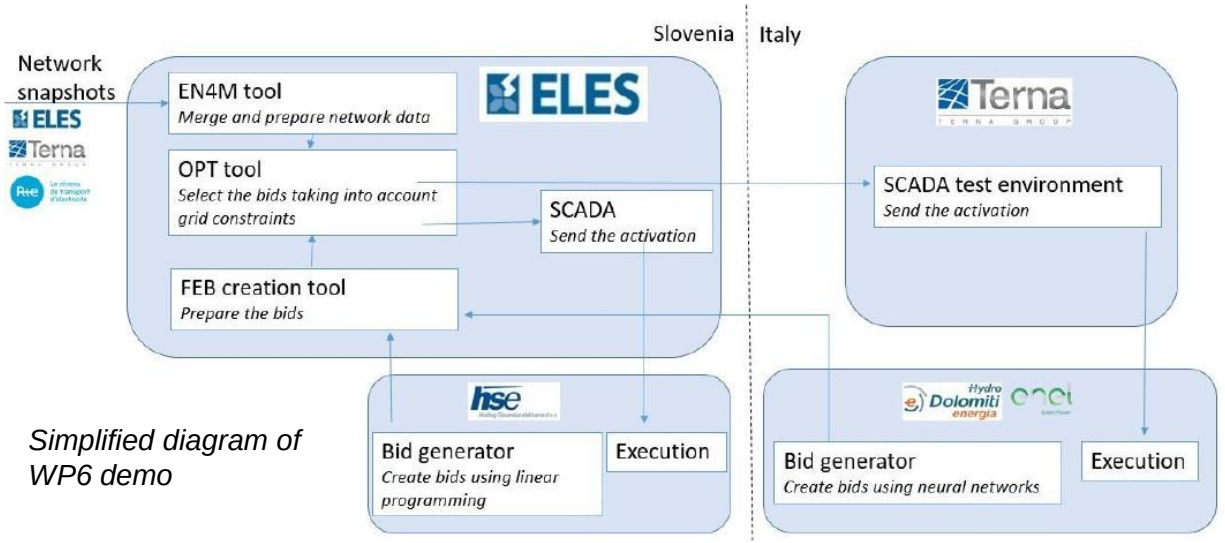
DEM, TES and SENG plants 135MW participating **HSE**

High voltage grid **TERNA & ELES**

SERVICES

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

- ✓ 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.



Simplified diagram of WP6 demo

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

Deliverable D7.1

First tests done

Webinar

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

First tests of Flexibility Scheduler software ongoing

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

Optimal sizing method: D7.5

- ✓ **Database developed & tested**
- ✓ **Integration of on-fields BESS data from WP3-WP4 demo**

Thank you!

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