OSMOSE INSIGHTS

Project newsletter #6

MAY 2021

OSMOSE

OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

Edito

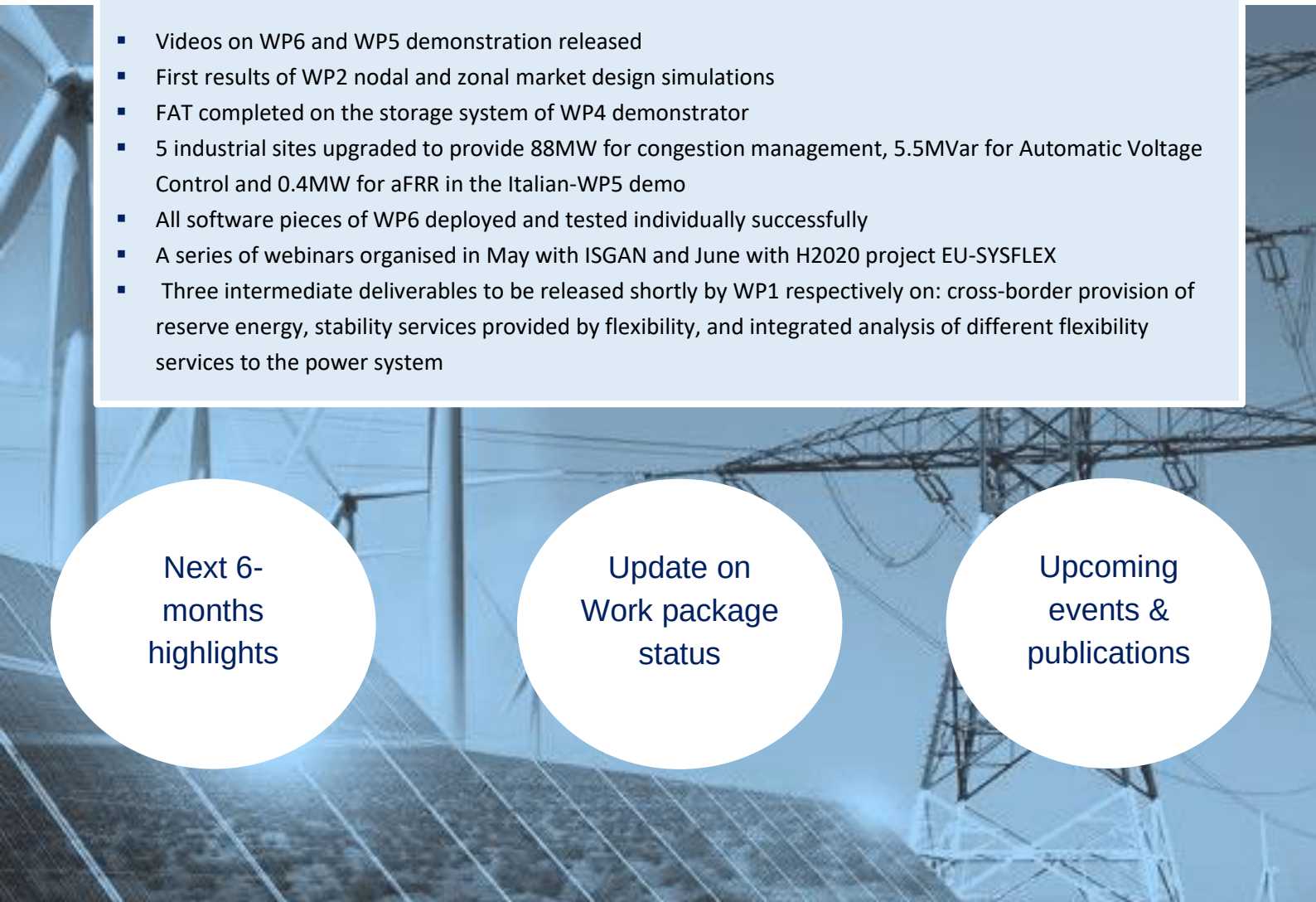
Dear partners and colleagues from the power system community,

We are now entering the final year of our project and producing more and more interesting results. Our models and methods developed to assess flexibility in long-term scenarios and related market designs are delivering preliminary results. On field, all the equipment of our WP5 Italian demo are installed and first tests are ongoing. The different software pieces of our WP6 demo between Italy and Slovenia are deployed and currently tested. Our WP3 demos on grid forming have produced significant results leading to scientific publications. We are accelerating the dissemination of our work thanks to planned webinars and up-coming conferences, we are looking forward to meet you there!

Nathalie Grisey, RTE, OSMOSE coordinator

Latest news in brief:

- Videos on WP6 and WP5 demonstration released
- First results of WP2 nodal and zonal market design simulations
- FAT completed on the storage system of WP4 demonstrator
- 5 industrial sites upgraded to provide 88MW for congestion management, 5.5MVar for Automatic Voltage Control and 0.4MW for aFRR in the Italian-WP5 demo
- All software pieces of WP6 deployed and tested individually successfully
- A series of webinars organised in May with ISGAN and June with H2020 project EU-SYSFLEX
- Three intermediate deliverables to be released shortly by WP1 respectively on: cross-border provision of reserve energy, stability services provided by flexibility, and integrated analysis of different flexibility services to the power system



Next 6-months highlights

Update on Work package status

Upcoming events & publications

Upcoming events

Joint webinars with EU-SYSFLEX

A series of webinars is organised jointly with the EU-SYSFLEX consortium to present and discuss the results of both projects, from 15th to 17th June 2021. The webinars address:

- High variable RES scenarios: from adequacy to stability challenges and new solutions
- IT challenges to activate and monitor flexibilities
- Demonstration of flexibility provision by distributed resources

Agendas and registration link.

Webinar on market design simulations

WP2 will hold a webinar on May 27th to present its first simulation results on nodal and zonal market design to meet the flexibility scenarios defined in WP1.

Registration link.

CONFERENCES

- Two papers by RTE regarding WP2 (market design) and WP3 (grid forming demonstration) have been accepted to the POWERTECH 2021 conference.
- RTE will present OSMOSE activities in WP3 (grid forming) at the next IEEE Power & Energy Society General Meeting in July
- OSMOSE will participate to ENLIT Europe in November 2021, let's meet you there!

Update on work packages

WP1 – Flexibility scenarios development

WP1 deals with the identification and quantification of flexibilities in three scenarios by year 2050.
Based on the flexibility options identified for these scenarios and using the simulations results performed by RTE and EKC with ANTARES to optimize them at pan-European scale, task 1.4 assessed them in more details along three dimensions introduced below.

Regarding ***cross-border provision of reserve***, REN successfully applied its PSMORA model to the Continental South West (CSW) region to analyze security of supply criteria from the perspective of operational reserve assessment. The impact of short-term RES uncertainty (forecast error) on CSW system operation was assessed for the scenarios "Current Goals Achieved" 2030 and 2050, and the respective flexibility needs calculated, completed by sensitivity analysis. The 2030 scenario was also updated to include the Portuguese National Energy and Climate Plan (NECP) ambitions on RES installed capacity.

As for the ***provision of stability services by flexibility options***, ENSIEL studied future scenarios designed by WP partners for a portion of the European system, namely the Sicilian system, detailed up to the sub-transmission level. Large and small perturbation angle stability and voltage stability were assessed for most critical cases and the possibility to introduce flexibility options showed its effectiveness for both 2030 and 2050 scenarios. A sensitive analysis was carried out for a few scenarios showing critical conditions where the system stability cannot be guaranteed, and additional options were identified.

With regard to the ***integrated analysis of different flexibility services*** to the power system, it includes capturing possible synergies across (A) the balancing of energy demand and supply, (B) the use of flexibility options for the provision of system-services and (C) the impact of the use of flexibility options on operation and planning of transmission and distribution grids. UDE performed a broad assessment of possible technical combinations and the current implementation of such setups. Furthermore, literature concerning modeling the consequences of such system setups was identified and discussed.

Three related deliverables will be released publicly by July 2021 to present these different results.

Finally, a paper on the ***methodologies for time series generation*** is under submission process by TUB, whose preprint is available in Arxiv. It evaluates the adequacy of time-series reduction when modelling energy systems with fully renewable generation and a consequent dependency on storage.

WP2 – Market design & regulation

WP2 aims at proposing some zonal and nodal market designs and regulations that would best enable the optimal flexibility mixes assessed in WP1.

Regarding ***zonal market simulations***, the results of adequacy simulations performed with the ANTARES tool using WP1 data were converted to feed the ATLAS model (Agent-based short-Term eLectricity mArkets Simulation). This ATLAS model is run under the PROMOTHEUS tool, inspired from the past European Project OPTIMATE. The first market simulations were produced, providing spot market prices, and are now being analysed and upgraded to consider uncertainties (forecast errors on generation and loads).

Regarding ***nodal market simulations***, the same process is followed, except more data pre-processing was necessary on the nodal level. The first analysis performed allow to quantify the difference between forecast error at zonal and nodal scale (dependent on spatial granularity). In the meantime, UDE is using other models to perform complementary simulations, exploring in more detail a longer time frame (whole year simulations).

The related deliverables (D2.3 focused on models and D2.4 focused on simulation results) are under preparation.

Also, A 4-page presentation introduces the ***methodology*** developed by ENSIEL ***to model the interface between TSOs and DSOs,*** to better assess the economic potential of distributed energy sources. The approach relies on 1/ modelling the distribution network by using open data only; and 2/ quantifying the availability of flexibility products by using "local market models" that optimize the DERs dispatching. ENSIEL is now testing this methodology on data provided by RTE in order to finetune their models.

Finally, Deliverable D2.1.2 provides an analysis of ***Key Performance Indicators*** to assess and compare the performance of possible electricity market designs targeting optimized flexibilities.

WP3 – Demo Grid Forming

The WP3 includes two demonstrators that are studying and experimentally validating advanced grid forming controls integrated into the power electronics interfacing utility-scale electrochemical energy storage systems to the power grid. The demonstrators are on the EPFL campus (hosting a 720kVA/560 kWh Lithium-Titanate-Oxide battery) and at an RTE 600-20kV substation (hosting a 1000kVA hybrid Lithium/supercapacitor storage system).

In December 2020, a major failure occurred on RTE's demonstrator inside the storage container during the site acceptance tests (Factory Acceptance Tests - FAT - had been previously completed with success). The resulting damages will prevent the RTE demonstrator to continue during the project lifetime. The analysis of the causes is still ongoing but shows so far no relation with the innovative part of the demo (i.e. the grid forming control implemented at the AC/DC converter). The project partners are still very confident on the relevance of the work performed so far. Indeed, during the design and FAT phases, already significant results were obtained on: 1) ***the assessment of the robustness of grid forming contro***l in the presence of large grid disturbances; 2) the ***portability of the control strategies*** over different hardware platforms. In addition, the EPFL is currently validating the developed ***multi-service algorithm*** of the grid forming control on their demonstrator (an activity originally conceived to be validated on the RTE demonstrator). Regarding the KPI defined to quantify the grid forming effectiveness, tests were already conducted successfully at EPFL.

The ***method designed to compare the effectiveness of multi-services algorithm*** on grid-forming vs grid-following controls will be presented at the coming IEEE POWERTECH 2021 in Madrid.

WP4 – Demo Storage + FACTS for multi-services

WP4 demonstrator aims to develop and test a novel Hybrid Flexibility Device (HFD) installed at CENER grid-connected facilities. The HFD is designed to provide different flexibility services that support secure grid operation (inertia emulation, fast-fault current injection, power-frequency regulation, voltage control, etc.). The HFD combines a STATCOM, supercapacitors and a 1500V High Voltage Lithium-Ion battery, all of them optimally coordinated by a novel Master Control system.

The battery, developed by Saft, was successfully completed and verified by last December and it is ready to be integrated in the HFD. The container that integrates the STATCOM and the supercapacitors is under development by GPTECH. Despite some delays in the manufacturing, it is planned to be

completed by July 2021. Current works focus on ***installation and connection of all components in the container*** as well as the preparation of the ***Factory Acceptance Tests***. With regard to Master Control implementation, control strategies for operation of the HFD are under development by CENER and REE.

In the meantime, scope-of-work for installation of the demo has been defined under CENER's leadership and in collaboration with all partners. The company responsible for installation has been already selected. On field installation works are planned for August-September 2021.

Figure 1 : SAFT High Voltage Lithium-Ion battery for WP4 demonstrator

WP5 – Demo Demand Response / DTR / wind farms controls

WP5 targets multiple grid services for the Italian grid based on coordinated RES, Demand Response and dynamic thermal rating (DTR). The zonal Energy Management system is now fully deployed in Terna's operational environment. The DTR installation is completed, as well as the related software installation on master nodes (by ENSIEL) and the data integration in Terna system (Terna, ENG, IBM).

Five Industrial load sites have been upgraded successfully, and two will soon follow. This task has been very challenging because of the number and variety of the industrial plants involved, the complexity of the sites themselves and the number of suppliers to be involved for each site in order to have the equipment installed and tested properly. Thanks to those significant efforts, ***88MW for congestion management, 5.5MVar for voltage control and 0.4MW for aFRR will be available*** for the demo!

At the same time, ***first local tests on Automatic Voltage Control*** on the two wind power plants were successfully conducted. More local and remote tests will follow in the upcoming months. Then, provision of Synthetic Inertia will be tested as well.

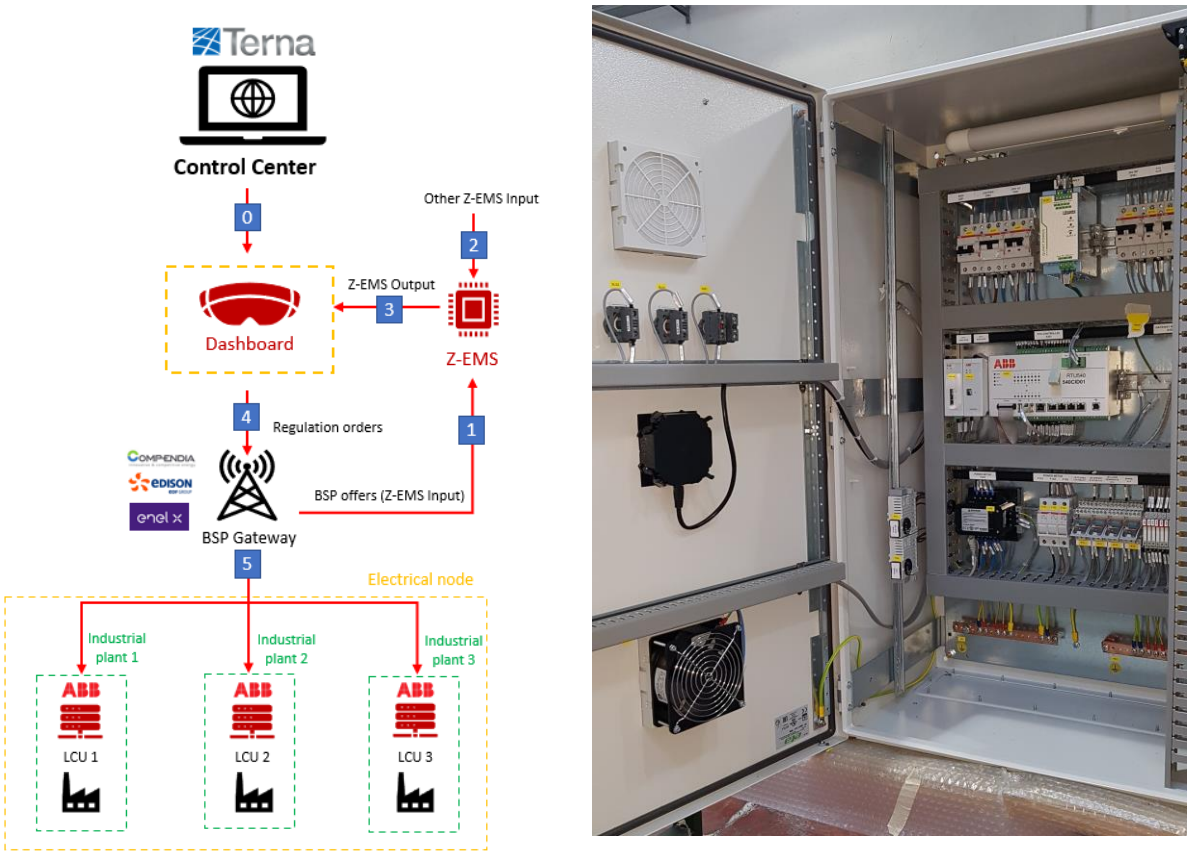


Figure 2 : Communications for congestion management with industrial sites (left); Local control unit installed by ABB in one of the sites (right)

With regards to the ***participation of the wind parks to Automatic Voltage Control***, the Vaglio plant has started the experimentation phase with the first local tests addressing the primary regulation with Q set-points locally sent, according to a test specification elaborated by Terna. These tests are aimed to address both the static and dynamic capability of the plant in providing the requested reactive power. The remote test planned afterwards will involve the TSO control rooms. The Pietragalla plant is now ready also for the communication tests and the experimentation will begin with local tests.

Regarding the provision of synthetic inertia, a Synthetic Inertia control device has been developed by Enel Greeen Power and installed on its Pietragalla plant premise. Further analysis has been carried out on the adoption of the proper filter parameters that will allow the identification of real frequency fluctuation events avoiding false positive due to electromechanical signal disturbances. On its side, E2i is managing the activity with Siemens-Gamesa (SGRE) which has developed a Wind Turbine Generator (WTG) Control upgrade to be installed on the WTG nacelle in Vaglio. The WTGs control system and power electronics have been reconfigured to use WTG available mechanical inertia to reduce or inject an instantaneous ΔP.

WP6 – Demo Near-real-time cross-border market

WP6 demonstrates the close-to-real-time optimization of RES utilisation) on both sides of the Italian-Slovenian border and set the proof of concept of the innovative mechanisms for future penetration of new RES in to the electric grid.

Check out the new video introducing the concepts implemented in WP6 demonstrator!

In the TSO IT environment, the EN4M software, FEB creation and OPT tools (see diagram below) have been installed and tested individually on ELES business environment. Sending the activation signal through ICCP channel towards HDE has been successfully tested. Similar tests are ongoing with the Italian side of the demo.

On the flexibility providers' side (ENEL, HDE, HSE), the local tests of the bidding generators were run conclusively. Coordinated tests are currently being conducted to ensure the simultaneous running of all platforms before proceeding to the final stage of the demo where real activations of the flexibility units will be tested 15 min to real time.

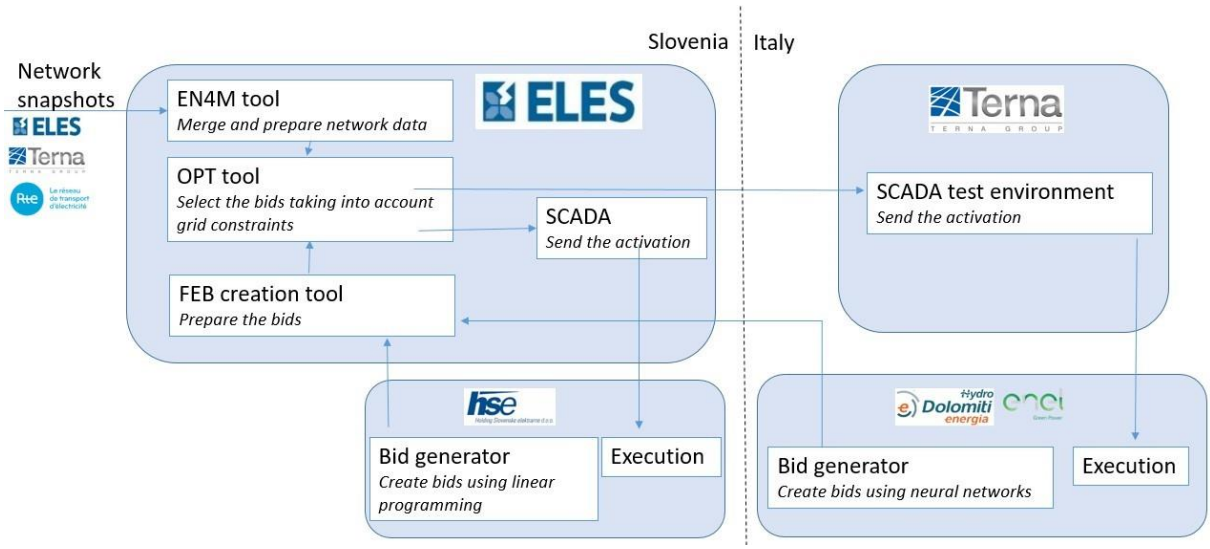


Figure 3 : simplified diagram of the WP6 demo

WP7 - Scaling up and replication

A webinar was held on May 3rd to introduce the ***IEC61850 standard*** and OSMOSE related developments regarding an optimized engineering process. The webinar recording is available here, and a second one ("deeper dive") is foreseen in fall 2021.

Task 7.2 develops a ***Flexibility Scheduler tool*** (FS) to help the DSOs exploit distribution level flexibilities whilst taking into account transmission-level constraints or latitude. EFACEC finalized the last updates on the Flexibility Scheduler tool. The laboratory tests are now ready to start, with the loading of transmission network model into the Opal HYPERSIM (Hardware in the loop) simulation tool and the development of scripts to interact with the Flexibility Scheduler. R&D Nester prepared the use-cases

to be simulated in HYPERSIM and the corresponding files for the Flexibility Scheduler. 16 simulations are planned according to these use cases and 4 are already implemented.

Task 7.4 deals with the development of a ***database of feedback on BESS experiments***. The data from WP3 and WP4 demonstrations is currently being integrated into the database. A tool to calculate online the parameters of BESS' equivalent circuit model was also developed by EPFL and integrated within EPFL BESS' database and can be coupled with the BESS database interface developed in Osmose.

Publications

- EPFL published an article in the IEEE journal *Transactions on Smart Grid*, dealing with **Real-time Control of Battery Energy Storage Systems to Provide Ancillary Services Considering Voltage-Dependent Capability of DC-AC Converters. It** is on open access at the following link.
- Another article by EPFL team has been published in the Elsevier journal Sustainable Energy Grids and Networks, dealing with **Performance Assessment of Grid-forming vs Grid-following Converter-interfaced BESSs on Frequency Regulation in Low-inertia Power Grids.**
- Efacec, and it4power published an article in the *PAC World Magazine* addressing protection, automation and control: From Specification to the Substation – The OSMOSE Project Contribution to Improve the IEC 61850 Engineering Process
- The pre-print of WP2 paper for POWERTECH 2021 addressing **Optimal Transmission Topology for Facilitating the Growth of Renewable Power** is available on ArXiv.
- The preprint of WP1 Paper by TU Berlin on the **Adequacy of time-series reduction for renewable energy systems**, is available in Arxiv.

Follow the project activities:

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