OSMOSE

OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

WP2 Market designs and regulations for the optimal development of flexibilities with high RES shares

# Milestone 2.3: Improved methodology to represent flexibilities on the distribution grids from a transmission grid point of view

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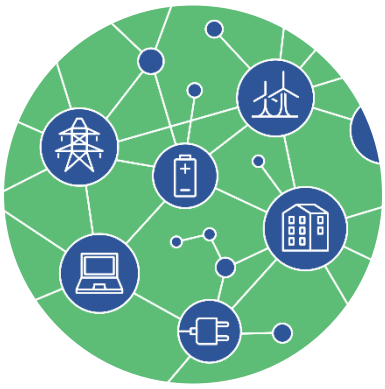

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# 1 Project background and context of the simulations

The OSMOSE project addresses the optimal development of flexibilities within the overall energy system in order to allow an increasing share of renewable energy sources within the power network.

In work package 1 (WP1), three different scenarios were developed for the future of the European energy system. For each of them, an optimal mix of flexibilities in load, generation, and power flows was identified. A description of WP1 scenarios and preliminary results is available in this presentation online.

WP2, led by RTE, aims to propose some market designs and regulations that would best enable these optimal flexibility mixes. Market simulations are carried out based on WP1 proposed flexibility mixes, which will allow, at the end of WP2, to assess the most suitable market and regulation options. A detailed introduction on WP2 is available here.

This document presents the contribution of partner ENSIEL to these quantitative assessments. It describes how ENSIEL's work will enable WP2 to model the distribution grid using synthetic models and estimate the market potential of the distributed energy resources connected to such distribution networks.

# 2 Improved methodology to represent flexibilities on the distribution grids from a transmission grid's point of view

The methodology proposed by ENSIEL assesses to what extent the use of flexibility by the TSO can impact on the DSO activities, and which costs are to be expected. To this end, local distribution market models where the Distribution Energy Resources (DERs) offer flexibility to the DSO have been hypothesized. The final goal is to quantify the residual flexibility that can be bid to the TSO by the distribution networks.

Two complementary and interconnected tasks have been performed:

- The first task models the distribution network by using open data only. This task is useful for TSO and for stakeholders that do not know the distribution grid in detail;
- The second task quantifies the availability of flexibility products and the relevant costs by using "local market models" (see below) that optimize the DERs dispatching.

A "local market model" is a model of a market where local "products of flexibility" can be purchased from aggregators and producers by the Distribution system operators (DSOs) for fixing distribution network issues. The flexibility products are essentially variations of the

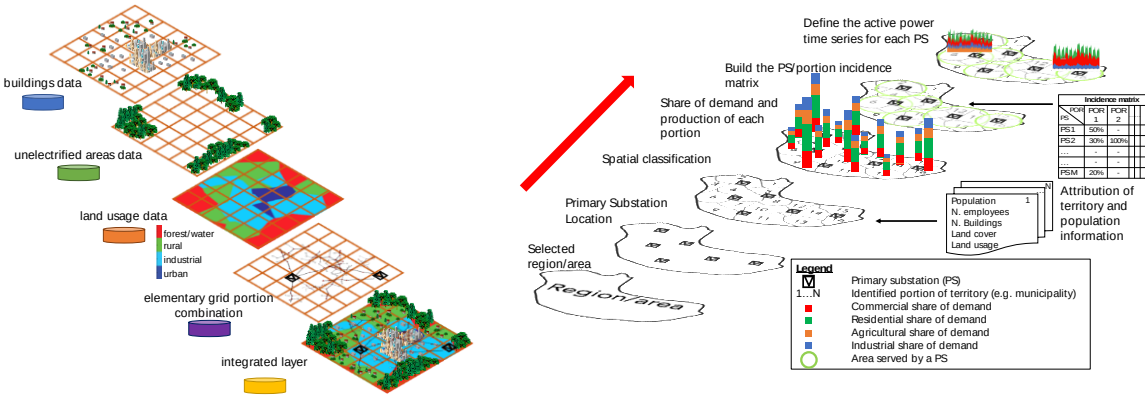
scheduled active and reactive power profiles of consumption or production at the point of connection to the grid. The services associated with these products can be useful for: reactive power support for reducing losses and voltage regulation, active power support for voltage regulation, local congestion mitigation, demand response and load modulation, etc. The model represents the translation of the rules and principles of the Local Market into mathematical equations; the result is an optimization problem, the solution of which is the economic optimum of the market and respects its rules and principles.

Both partners University of Cagliari (UniCA) and Politecnico di Milano (PoliMI) that are part of the ENSIEL lab use MILP (mixed-integer linear programming) for optimizing the available resources. UniCA focused on using local markets for estimating price-quantity curves for the centralized ancillary service market. PoliMI analyzed the DSO point of view by considering the most promising regulatory frameworks for studying the role of local markets and the integration with the market at a higher level.

UniCA developed a methodology for modelling the role of distribution systems in providing flexibility services both to DSO and TSO. With the compulsory assumption that in the distribution systems the grid limitations cannot be ignored, the methodology is capable:

(i) to obtain a distribution network model of the grid supplied by an HV node of the transmission network by using open data only (see the figure below) and,

(ii) to calculate the optimal operation of the distributed resources in the distribution network, for fixing issues such as excessive voltage variations, power congestions, etc. in the distribution network, and for offering flexibility to the TSO.




***From open data…*** ***… To a stylized model of the distribution network***

*Figure 1 Modeling the TSO-DSO Interface using open data only*

The end result of this methodology is the price/quantity curves of flexibility in upward and downward that a distribution network can offer to both TSO and DSO for local and system services, for each time interval on which is discretized the period of interest. Extra cost possibly

to be sustained or block imposed by the DSO for avoiding harmful impacts on the distribution network operators are also outcomes of the methodology. In Figure 2 it is shown an example of two price/quantity curves assessed for a model of distribution network derived by a real case in Italy, in as many intervals of two working days (wd) in winter (WIN) and summer (SUM). The grey zone highlights the blocked potential).

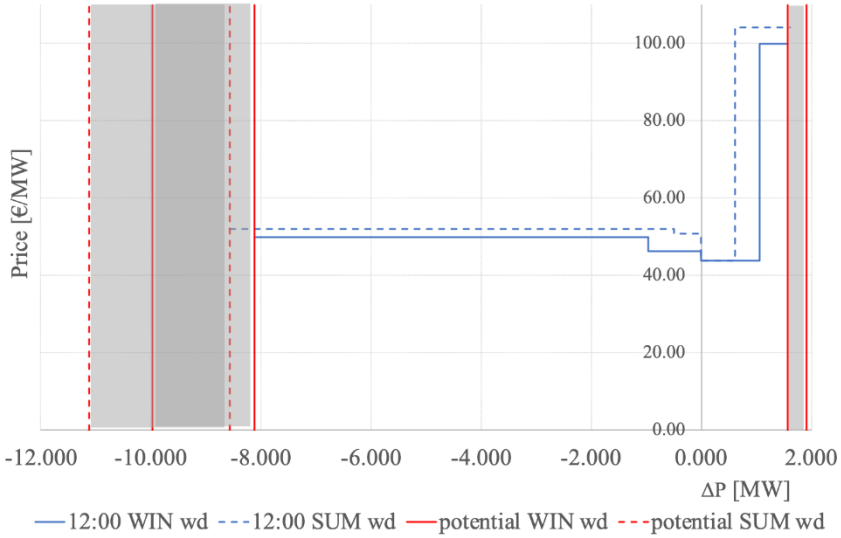



*Figure 2 Price/quantity curves (12:00 WIN and SUM wd)*

The methodology has been applied to six Italian regions that represent three of the six National Transmission Grid zones that subdivide the Italian territory (800 NTG nodes, 477 public primary Substation) and to approximately 200 French primary substations selected by RTE (spread in the central regions of France).

PoliMI, developed an efficient local market model that can be used at DSO level under various regulatory frameworks assumptions. Considering that future DSOs should ensure that locally available flexibility can be used at a centralized level without negative impact on the Distribution Network (DN), the most promising regulatory frameworks solutions are:

(i) a local flexibility market where the DSO first solves the local DN security issues and then aggregates the remaining flexibility for the centralized TSO, or

(ii) TSO-DSO balancing responsibility sharing, where the DSO solves a local market with the goal of following a defined schedule at the interface with the TSO while using the local flexibilities exclusively.

Both approaches require a local market model where the DN is accurately represented. Therefore, the market model is designed as a Mixed Integer Linear Programming (MILP) optimization model where different resources (including storage and electric vehicles) can be handled. The DN is modelled adopting an efficient sensitivity based linear approximation

technique that mitigates the disadvantages of the common linearization techniques encountered in the literature, like the use of complex approximations for the square of the decision variables, or neglecting of important network parameters such as the cable's capacitance. The use of a linear optimization model allows the use of discrete variables along with continuous variables and, thus, allows the detailed representation of the technical characteristics of the assets providing flexibility, e.g. unit commitment constraints representation, or of equivalent economic bids, e.g. block orders. Thus, the model is designed for real-time operation of the market.

The proposed model is employed in realistic DNs and for real-time operation scenarios. The performance of the algorithm is evaluated through simulations over a significantly long period of times. The results will identify the main characteristics of the tested regulatory frameworks emphasizing their advantages-disadvantages.

# 3 Next steps

The public deliverables D2.3 and D2.4, integrating the above-mentioned results, will be released in March 2021. They will address:

- Models for market mechanisms simulation taking into account space-time downscaling and novel flexibility technologies
- Quantitative analysis of selected market designs based on simulations.

You will find these deliverables in the "resource center" section of the OSMOSE website.