A European research project to study TSO-DSO coordination for ancillary services provision from distribution networks

Migliavacca Gianluigi, Daan Six, Mario Dzamarija, Seppo Horsmanheimo, Marco Rossi
Giacomo Viganò
Agenda

- General project overview
- Scenario analysis
- Use cases
- ICT analysis
- Simulation analysis
- Pilots
Introduction Video

- [https://vimeo.com/220969294/73d98edde6](https://vimeo.com/220969294/73d98edde6)
Overall project layout

Reference architectures definition
- Network model
- Market model
- ICT model

SCENARIO ANALYSIS 2030
- National scenarios definition
- Personalization with three National cases
- CBA with different architectures
- Lab test with HW controller

Formal specifications
Simulation platform realization

Three pilots:
- DSO area data monitoring
- Flexibility from thermal inertia
- Flexibility from Radio Base Stations

Regulatory Analysis (guidelines)
Return of experience
Scenario analysis
Analysis of present and future European scenarios

Overview of the procurement mechanisms used for each type of ancillary service relevant to DER participation per country.

Current situation of TSOs and DSOs contracting AS in the surveyed countries.

Deliverables 1.1 – 1.3
Mapping and modelling of Distributed resources

Technical analysis of the future possible contribution from non-conventional resources

<table>
<thead>
<tr>
<th>Frequency</th>
<th>RESERVE NEED [MW]</th>
<th>NON CONVENTIONAL RESOURCES [MW]</th>
<th>DISTRIBUTION</th>
<th>TRANSMIISON</th>
</tr>
</thead>
<tbody>
<tr>
<td>aFRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DK1</td>
<td>262</td>
<td>5 000</td>
<td>49 %</td>
<td>51 %</td>
</tr>
<tr>
<td>IT</td>
<td>1 471</td>
<td>33 000</td>
<td>37 %</td>
<td>63 %</td>
</tr>
<tr>
<td>ES</td>
<td>783</td>
<td>19 000</td>
<td>62 %</td>
<td>38 %</td>
</tr>
<tr>
<td>mFRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DK1</td>
<td>426</td>
<td>4 000</td>
<td>50 %</td>
<td>50 %</td>
</tr>
<tr>
<td>IT</td>
<td>1 523</td>
<td>30 000</td>
<td>33 %</td>
<td>67 %</td>
</tr>
<tr>
<td>ES</td>
<td>5 473</td>
<td>15 500</td>
<td>58 %</td>
<td>42 %</td>
</tr>
</tbody>
</table>

Deliverable 1.2
Uses cases
5 possible coordination schemes TSOs & DSOs for AS by distributed flexibility resources

- Centralized AS market model
- Local AS market model
- Shared balancing responsibility model
- Common TSO-DSO AS market model
- Integrated flexibility market model
**Centralized AS market model**

### Benefits
- Aggregation could use resources from different DSO-areas.
- Few communication between system operators needed.
- One central market can function at low operational costs.

### Attention points
- DSO grid constraints not included.
- DSOs do not benefit from possible advantages of the use of flexibilities.
Local AS market model

Benefits
- DSO grid constraints included
- Nodal detail of transmission network

Attention points
- Complex market architecture, which can result in higher costs
- Risk of non liquid markets
Integrated flexibility market

Benefits
- All constraints included
- Most efficient solution in theory

Attention points
- Very complex market
- Numerical unfeasibility

Deliverable 2.3
Deliverable 2.4
Application of coordination schemes

From these analysis is already possible to draw a big picture of the pros and cons of each coordination scheme and the application of different services.
ICT analysis
Simulation analysis
Comparison of the national cases in a simulation environment and laboratory testing
2030 Scenario Data

Geographical allocation of the energy resources expected for 2030
2030 Scenario Data

Mapping of the geographical information on the electricity network
Analysis on the market structure

Timing Dimension

What are the market clearing frequency, time step and horizon?

optimisation window T

input from prediction

optimisation algorithm

output decisions

output decisions

= firm output decisions

= provisional output decisions
Analysis on the market structure

Bidding Dimension

How market actors can bid? What market products are proposed?
Analysis on the market structure

Network Dimension

How network constraints are taken into account in the market clearing?

Transmission grid

+ Accuracy
+ Numerical Complexity

MV distribution grid

+ Accuracy
+ Numerical Complexity

Photo source: Technical University of Munich (http://ens.ei.tum.de)
Analysis on the market structure

What are the objectives of the market clearing?

- Minimize activation costs
- Maximize welfare

**Clearing Dimension**

- Total TSO costs
- Sellers of $\Delta < 0$
- Sellers of $\Delta > 0$

![Graph showing market clearing with TSO balancing demand, activation costs minimization, welfare maximization, and sellers of different $\Delta$ values.](image)
Analysis on the market structure

- **Timing Dimension**: What are the market clearing frequency, time step and horizon?
- **Bidding Dimension**: How market actors can bid? What market products are proposed?
- **Network Dimension**: How network constraints are taken into account in the market clearing?
- **Clearing Dimension**: What are the objectives of the market clearing?
- **Pricing Dimension**: What price is paid to the activated bids?
Pilot results
**Pilot A: RES sources - Centralized market**

**Aggregation of information**
In real time at TSO-DSO interconnection (HV/MV transformer)

**Voltage regulation**
By generators connected at HV and MV levels

**Power frequency regulation/balancing**
By generators connected at HV and MV levels
Pilot B: Swimming pool – Common market

Common TSO-DSO AS market model

**Congestion Management**
To better integrate PV, EV and HP

**Price-based control**
Of thermal controllers of swimming pools in summer houses

**Balancing**
Of wind power with decreasing contribution of thermal units
Pilot C: radio-based station – Shared market

**Shared balancing responsibility model**

- SO/MO (TSO)
- Flexible resource @ HV (Flexibility owner)
- Aggregator (CMP)
- DER @ MV (DER owner)
- DER @ LV (DER owner)

**Congestion Management**
At DSO level

**Demand response aggregation**
By using storage flexibility (BS and EV)

**Power frequency regulation /balancing**
By respecting the exchange program at the TSO-DSO interconnection
KEY results

- Validated TSO-DSO interactions (technical + operational)
- Demonstrated interoperability and scalability to the whole European system.
- Identified barriers for real implementation and regulatory proposals
- Guidelines on best practices to implement the considered TSO-DSO schemes
Thank You

Giacomo Viganò

Contact Information

Affiliation: RSE S.p.A.
Phone: +39 02 3992 5151
Email: giacomo.vigano@rse-web.it