Introduction to the SmartNet Project

Gianluigi Migliavacca (RSE)

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 691405
Agenda

- Today’s Special Session

- The SmartNet project
  - Project motivations
  - Project set-up
  - Consortium
  - Five TSO-DSO coordination schemes
  - Reference AS market design
  - Structure of Cost-Benefit Analysis
  - The three project Pilots
EP 3 | H2020 SmartNet – “How to get flexibility from resources connected to distribution grids? The results of the SmartNet project”

Wednesday 26th June | 8:30-10:10

Organizer:
- Gianluigi Migliavacca | RSE

Abstract:
The session presents the results of the Horizon2020 project SmartNet, aimed at investigating the possibility for flexible resources connected to distribution grids to provide system services. Scenario studies at 2030 for Italy, Denmark and Spain, three technological pilots and a hardware-in-the-loop test complete each other to provide a comprehensive analysis. Finally, project results are put in relationship to the present regulatory trends in Europe and in the three mentioned Countries and regulatory guidelines are elaborated.

Presentations:
- Introduction to SmartNet - Gianluigi Migliavacca (RSE) - 15 min.
- Results of the simulations at 2030 for Italy, Denmark and Spain - Marco Rossi (RSE) – 20 min.
- Results for the three project pilots - Carlos Madina (TECNALIA) – 20 min.
- Results for the hardware-in-the-loop activities - Filip Pröstl-Andren (AIT) – 15 min.
- Regulatory Guidelines - Ivana Kockar (University of Strathclyde) – 15 min.
- Project exploitation and impact - Gianluigi Migliavacca (RSE) – 15 min.
Motivations of SmartNet

- Increased reserve needs due to explosion of variable RES
- Opportunities from new DER in distribution?
- Five key questions:

<table>
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<tr>
<th>Which ancillary services could be provided from entities located in distribution networks</th>
<th>How the architectures of dispatching services markets should be consequently revised</th>
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<td>Which optimized modalities for managing the network at the TSO-DSO interface</td>
<td>What ICT on distribution-transmission border to guarantee observability and control</td>
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<td>Which implications on the on-going market coupling process</td>
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“Some actions can have a negative cross-network effect. For instance, TSO use of distributed resources for balancing purposes has the potential to exacerbate DSO constraints. Equally, whilst DSO use of innovative solutions, such as active network management, can deliver benefits to customers, if not managed properly they may in some cases counteract actions taken by the TSO” (CEER Position Paper on the Future DSO and TSO Relationship – Ref. C16-DS-26-04 – 21.09.2016)

Winter package assigns a role to DSOs for local congestion management, but not for balancing.

The SmartNet project [http://SmartNet-Project.eu](http://SmartNet-Project.eu)

Project video: [https://vimeo.com/220969294/73d98edde6](https://vimeo.com/220969294/73d98edde6)

- architectures for optimized interaction between TSOs and DSOs in managing the purchase of ancillary services from subjects located in distribution.
- three national cases (Italy, Denmark, Spain);
- ad hoc simulation platform (physical network, market and ICT)
- CBA to assess which TSO-DSO coordination scheme is optimal for the three countries.
- use of full replica lab to test performance of real controller devices.
- three physical pilots to demonstrate capability to monitor and control distribution by TSO and flexibility services that can be offered by distribution (thermal inertia of indoor swimming pools, distributed storage of radio-base stations).
The SmartNet project

http://SmartNet-Project.eu
5 possible coordination schemes

TSOs & DSOs for AS by distributed flexibility resources

A. Centralized AS market model
B. Local AS market model
C. Shared balancing responsibility model
D. Common TSO-DSO AS market model
E. Integrated flexibility market model
### TSO-DSO coordination schemes: a comparison

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<tr>
<th>Coordination Scheme</th>
<th>Benefits</th>
<th>Attention points</th>
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<tr>
<td>Centralized AS market model</td>
<td>Efficient scheme in case only the TSO is a buyer for the service</td>
<td>No real involvement of DSO</td>
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<td>A single market is low in operational costs and supports standardized</td>
<td>DSO grid constraints not always respected</td>
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<td>processes</td>
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<td>Most in line with current regulatory framework</td>
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<td>Local AS market model</td>
<td>DSO has priority to use local flexibility</td>
<td>TSO and DSO market cleared sequentially</td>
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<td>DSO supports actively AS procurement</td>
<td>Local markets might be rather illiquid</td>
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<td>Local markets might create lower entry barriers for small scaled DER</td>
<td>Need for extensive communication between the TSO market and the local DSO markets</td>
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<td>Shared balancing responsibility model</td>
<td>The TSO will need to procure a lower amount of AS</td>
<td>Total amount of AS to be procured by TSO and DSO will be higher in this scheme</td>
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<td>Local markets might create lower entry barriers for small scaled DER</td>
<td>BFRs might face higher costs for balancing</td>
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<td>Clear boundaries between system operation TSO and DSO</td>
<td>Small local markets might be not liquid enough to provide sufficient resources for the DSO</td>
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<td>Defining a pre-defined schedule methodology agreed by both TSO/DSO might be challenging</td>
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<td>Common TSO-DSO AS market model</td>
<td>Total system costs of AS for the TSO and local services for the DSO are minimized</td>
<td>Individual cost of TSO and DSO might be higher compared to other schemes</td>
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<td>TSO and DSO collaborate closely, making optimal use of the available flexible resources</td>
<td>Allocation of costs between TSO and DSO could be difficult</td>
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<td>Integrated flexibility market model</td>
<td>Increased possibilities for BFRs to solve imbalances in their portfolio</td>
<td>Independent market operator needed to operate the market platform</td>
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<td>High liquidity and competitive prices due to large number of buyers and</td>
<td>Negative impact on the development and liquidity of intraday markets</td>
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<td>sellers</td>
<td>TSO and DSO need to share data with IMO</td>
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Reference Market Design

- **Considered services:** balancing and congestion management at transmission (HV) and distribution level (MV), including voltage constraint at MV.

- **Optimized function:** minimizing total cost to purchase the needed services (VS maximizing social welfare: arbitraging between up- and down- bids is prevented).

- **Rolling optimisation concept:** Results for the first time step are a firm decision. Results for the next time steps are advisory decisions.

- **Network representation:** DC approximation for HV, simplified Dist-Flow optimization for MV.

- **Market products:** implementation of typical constraints of flexibility providers (extension to multi-period bids with temporal and logical constraints).

- **Representation of arbitrage opportunity between cascading markets:** day-ahead, intraday, AS market.
**Structure of Cost-Benefit Analysis**

- **Tertiary market mFRR**
  - (balancing + congestion management)

- **Residual congestion and imbalance**
  - *congestion not detected by tertiary market and imbalance/congestion due to forecasting errors*

- **Unwanted measures**
  - (re-dispatching to remove residual congestion)
  - creating further imbalance

- **Residual imbalance**

- **aFRR in physical layer**
  - (system balancing: by controlling flows with neighbouring countries)

- **Cost mFRR**
  - Paid according to the settlement of the tertiary market (marginal price)

- **Cost Unwanted Measures**
  - Paid at tertiary market bid price (emergency measure)

- **Cost aFRR, higher than mFRR:**
  - \( P_{mFRR\_BID} \cdot k \)
  - \( k < 1 \) if \( P_{mFRR\_BID} < 0 \)
  - \( k > 1 \) if \( P_{mFRR\_BID} > 0 \)
Pilot A: Distribution monitoring and control

Flow to be implemented (IEC 61850)
Existing flow (IEC 61850)
Existing flow (IEC 60870-5-104)
Flow to be implemented (104/Web service)

**Aggregation of information**
in RT 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: Ancillary services from indoor swimming pools

**Common TSO-DSO AS market model**

**Receive Grid Load**
- Day-ahead
- Intraday
- Real-time

**Market Management System**
- Calculate residual capacity
- Clear market

**Energy Trading**
- Day-ahead market
- Intraday market
- Real-time market

**CMP Trading System**
- Send price signal incl. forecast

**Technical aggregation**
- DER services
- Value-added services

**EMS-SCADA**
- DER aggregator

**DER**
- DER gateway
- DER trading system

**DSO**
- Trading System
- EMS-SCADA
- Congestion management
- Local Frequency control
- Local Voltage control

**TSO**
- Trading System
- Frequency control
- Congestion management
- Voltage control

**Convergence 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: Ancillary services from radio-base stations

**REGULATED MARKET**
- TSO
- DSO
- Aggregator
- Monitoring (metering data)
- Balancing
- Congestion management
- Demand response

**NON-REGULATED MARKET**
- Smart Houses
- EVs (V2G)
- ESCOs
- PV/Wind plants

- Aggregator
- DR optimisation
- Vodafone Network
- Narrowband IoT technology
- 20 base stations

**TSO**
- Shared balancing responsibility model

**DSO**
- Flexibility manager
- Congestion management

**Aggregator**
- Other flexibility aggregators

**Simulated**
- Endesa
- Vodafone
- MID-approved Sub-meters

**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**
The official web site of the SmartNet project is: [http://smartnet-project.eu](http://smartnet-project.eu)
All project news and other information are posted there.

The project *booklet*, containing synthetic description of SmartNet activities, and results, can be downloaded from: [http://smartnet-project.eu/wp-content/uploads/2019/05/SmartNet-Booktlet.pdf](http://smartnet-project.eu/wp-content/uploads/2019/05/SmartNet-Booktlet.pdf)

All project deliverables are public and can be downloaded from: [http://smartnet-project.eu/publications/#tab-id-2](http://smartnet-project.eu/publications/#tab-id-2)
Thank You

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