Public workshop: Showcase and debate on the results six months away from project end
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Introduction to the SmartNet project

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Agenda

- Motivation, set up and consortium of the project SmartNet
- Year 1 – Year 2 – Year 3
- Five TSO-DSO coordination schemes
- Proposed AS market design
- Balancing market and aFRR
- Structure of the simulation platform
- Layout of three project pilots
- Some preliminary regulatory reflections
Motivations

- Increased reserve needs due to explosion of variable RES
- Opportunities from new DER in distribution?
- Five key questions:
  - Which ancillary services could be provided from entities located in distribution networks
  - How the architectures of dispatching services markets should be consequently revised
  - Which optimized modalities for managing the network at the TSO-DSO interface
  - What ICT on distribution-transmission border to guarantee observability and control
  - Which implications on the ongoing market coupling process

“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)
The SmartNet project

- **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).

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

Web site [http://SmartNet-Project.eu](http://SmartNet-Project.eu)
The SmartNet project
Year 1 – Year 2 – Year 3

Reference architectures definition

Network model
Market model
ICT model

Formal specifications
Simulation platform realization

National scenarios definition

Personalization with three National cases

CBA with different architectures

Lab test with HW controller

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

Regulatory Analysis (guidelines)
Return of experience
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
Proposed Market Design

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

- **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, SOCP 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.
Balancing market and aFRR

- aFRR volume already activated before T and not yet released
- Forecasted further aFRR volume activated to compensated imbalance between T and T+1
- Actual aFRR volume activated between T and T+1 (different from forecast due to forecast errors and CS imperfections in representing the system)
- Volume of tertiary reserve activated by the AS market at T+1

System imbalance not «seen» by the AS market (e.g. CS-A disregards congestion in distribution), is trapped by aFRR and economically penalized
**Structure of the simulation platform**

**The physical layer** simulates T&D and devices operation, including voltage regulation, reactive compensation, aFRR and network protections.

**The bidding layer** aggregates flexibility offers of a huge number of resources (electric storage, electric vehicles, distributed generation, demand response) into balancing market bids and transforms market clearing into activations.

**The market layer** carries out system balancing and congestion management while including voltage constraints.

Some innovative features are:
- **rolling optimisation** concept
- **network representation**: DC approximation for HV networks, SOCP for MV networks
- **market products**: typical multi-period and logical constraints of flexibility providers
- **arbitrage opportunities between cascading markets** (day-ahead, intraday, AS market).

**Cost benefit analysis** compares the 5 coordination schemes over 3 national scenarios on the basis of:
- total AS market cost
- aFRR cost due to congestion not “seen” by AS market, forecasting errors, transmission losses (neglected by AS market).
- ICT deployment costs

Sensitivity factors:
- emission savings
- unwanted measures

Further “micro” cash flows analysis.

**Simulation scenarios at 2030** for Italy, Denmark and Spain. Very large datasets (Italian scenario: 655,323 photovoltaic panels, 31 wind farms, 20 large CHP plants, 1,833 run-of-river hydropower plants, 308 conventional fuel-based generators, 13 pumped hydro stations, 212,704 electrical cars, 1,489,193 residential wet appliances, 68,481 residential heat pumps, 33,783 dimmable street-lights, as well as non-controllable loads in all distribution grids and some transmission nodes.

**Hardware-in-the-loop simulations** to test in real-time-simulated scenarios the performances of real equipment (controllers for flexible devices, SCADAs, etc.) and the effects of non-ideal information transmission channels.
Pilot A: Distribution monitoring and control

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

Concentration 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

Balancing
Scheduled profile

DSO

DSO Flexibility manager

Monitoring (metering data)

NON-REGULATED MARKET

Aggregator

Other flexibility aggregators

Smart Houses

EVs (V2G)

ESCOs

PV/Wind plants

Simulated

Aggregators

DR optimisation

Vodafone Network

Narrowband IoT technology

Point of delivery connection

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

20 base stations

ENDESA

Shared balancing responsibility model

Producer/Consumer (EEX)

(Controllable)

DER (EEX controllable)

Vodafone

MID-approved Sub-meters

Vodafone

SUMMARY
Some preliminary regulatory reflections

• If the contribution from entities in distribution will grow, DSOs should implement real time network monitoring and TSOs could need to share with DSOs part of responsibility for the provision of AS.
• Whatever coordination scheme is implemented, it is important that that actions taken by the TSO and DSO don’t cause counteracting effects (e.g. between local congestion management and balancing) – see CEER Position Paper on Future DSO-TSO Relationship
• between the different AS markets, “common marketplace” (see ENTSO-E working paper on Distributed Flexibility and the value of TSO/DSO cooperation) is preferable in order to avoid duplicating bids and avoiding double activations.
• before implementing a separate market for a given AS, it should be attentively considered if it can be sufficiently liquid (e.g. local congestion management in distribution).
• restructuring national AS markets should take into account possibility of a seamless integration with preceding energy markets (DAM, ID) so as to avoid providing gaming opportunities (e.g. between non-nodal energy markets and nodal AS market)
• new AS architectures should integrate with on-going transnational integration process (ENTSO-E platforms): sharing reserve between Countries is a key for allowing further RES integration.
• a balance has to be sought for between local optimality (e.g. for a given Country) and the implementation of a harmonized pan-European design.
• smaller DSOs have to integrate their efforts in order to be fit for the new responsibilities.
• real-time market architectures must take into account the characteristics/constraints of the potential flexibility providers connected to distribution grids
• aggregators must be able to provide a simplified interface towards the market, hiding details of flexibility providers, and deliver efficient price signals to incentivize participation from distribution.
• viable business models must be available for all market participants, including DERs, aggregators and other customers.
• network planning will also have to facilitate better utilization of RES exploiting flexibility.
This presentation reflects only the author’s view and the Innovation and Networks Executive Agency (INEA) is not responsible for any use that may be made of the information it contains.
Thank You

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