



Smart TSO-DSO interaction schemes, market architectures and ICT
Solutions for the integration of ancillary services from demand side
management and distributed generation

Final public workshop | 16. 05.2019

Introduction to the SmartNet Project

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Agenda

- Today's meeting
- The SmartNet project
 - Project motivations
 - Project set-up
 - Consortium
 - Five TSO-DSO coordination schemes
 - Reference AS market design
 - Structure of Cost-Benefit Analysis

- 09.00 – 09.15 Introduction (Gianluigi Migliavacca - RSE– project coordinator)
- 09.15 – 10.15 Ancillary services from distribution networks and TSO-DSO coordination modalities: the view of the stakeholders
- 09.15 – 09.30 – Matti Supponen – former European Commission
 - 09.30 – 09.45 – Norela Constantinescu – ENTSO-E
 - 09.45 – 10.00 – Florian Gonzalez – EDSO
 - 10.00 – 10.15 – Andrea Galliani – Italian regulatory authority ARERA
- 10.15 – 10.45 Presentation of final simulations and CBA results (Marco Rossi – RSE, Carlos Madina, TECNALIA)
- 10.45 – 11.00 Coffee break
- 11.00 – 12.00 Presentation of final lessons from the three pilots (Carlos Madina – TECNALIA)
- 11.00 – 11.20 – Luca Ortolano – Italian TSO TERNA
 - 11.20 – 11.40 – Henrik Madsen – DTU
 - 11.40 – 12.00 – Miguel Pardo – Spanish DSO ENDESA
- 12.00 – 12.30 Presentation of regulatory guidelines (Ivana Kockar – University Strathclyde, Dario Siface - RSE)
- 12.30 – 12.45 Project outcast: impact assessment and exploitation plan (Gianluigi Migliavacca - RSE– project coordinator)
- 12.45 – 13.30 Debate with stakeholders: the way forward
- 13.30 – 14.30 Lunch

- 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 on-going 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)

Article 32

Tasks of distribution system operators in the use of flexibility

1. Member States shall provide the necessary regulatory framework to allow and incentivise distribution system operators to procure services in order to improve efficiencies in the operation and development of the distribution system, including local congestion management. In particular, regulatory frameworks shall enable distribution system operators to procure services from resources such as distributed generation, demand response or storage and consider energy efficiency measures, which may supplant the need to upgrade or replace electricity capacity and which support the efficient and secure operation of the distribution system. Distribution system operators shall procure these services according to transparent, non-discriminatory and market based procedures.

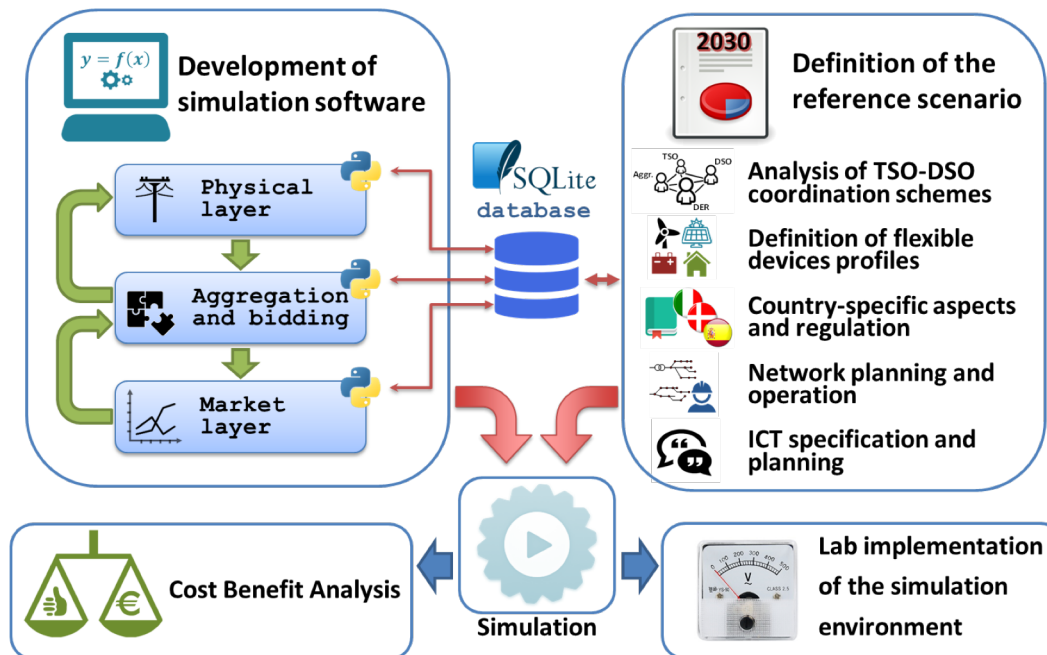
Distribution system operators shall define standardised market products for the services procured ensuring effective participation of all market participants including renewable energy sources, de
operators shall exchange all n
system operators in order to
secure and efficient operation

EC (2016) Proposal for a DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on common rules for the internal market in electricity

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

Project video: <https://vimeo.com/220969294/73d98edde6>

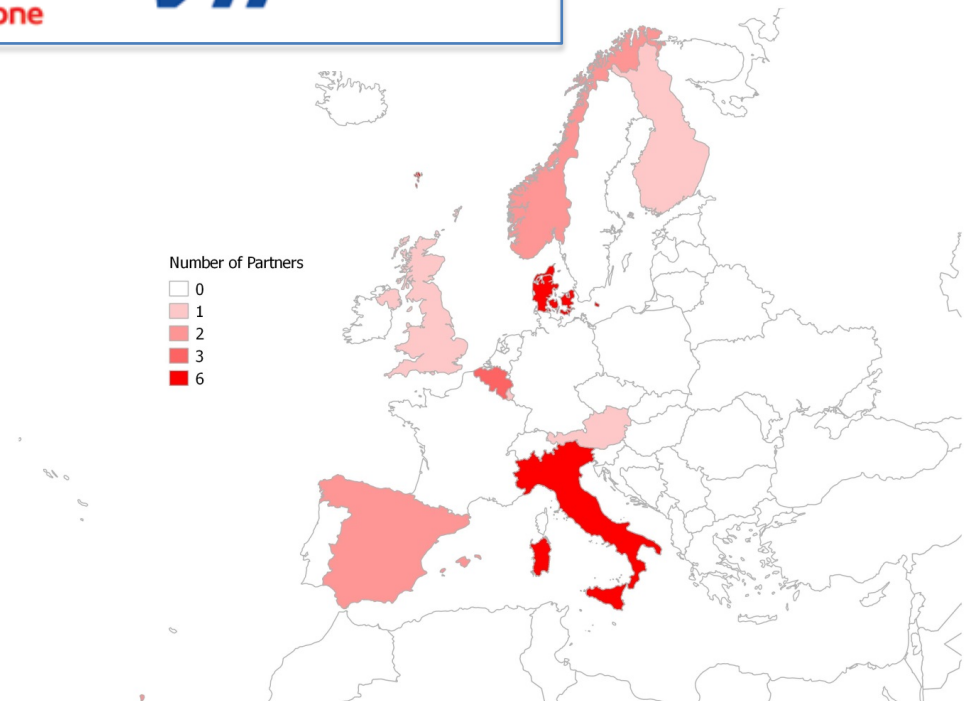
- **architectures for optimized interaction between TSOs and DSOs** in managing the purchase of ancillary services from subjects located in distribution.
- **three national cases** (Italy, Denmark, Spain);
- **ad hoc simulation platform** (physical network, market and ICT)
- **CBA** to assess which TSO-DSO 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

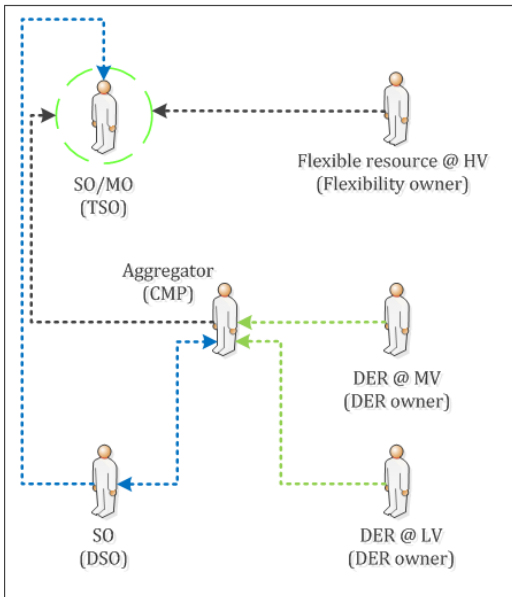


<http://SmartNet-Project.eu>



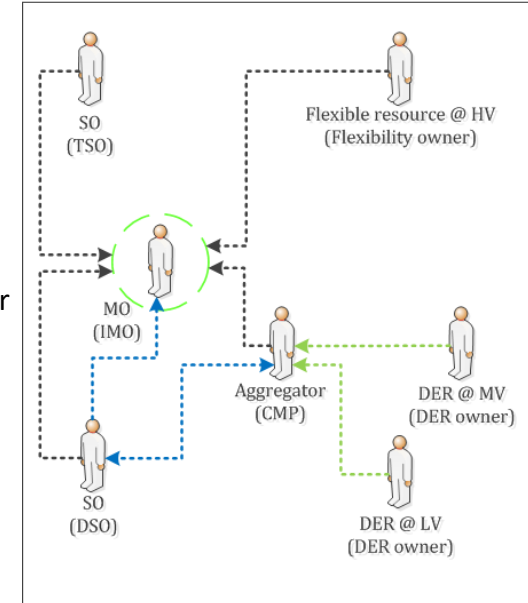
TSO-DSO coordination schemes

Centralized AS market model

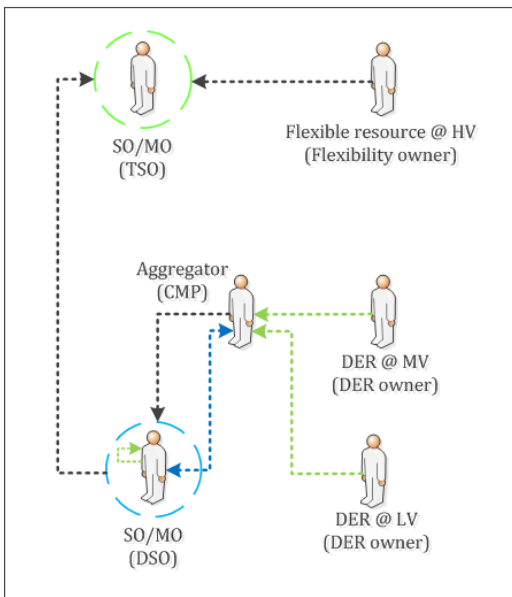


5 possible coordination schemes TSOs & DSOs for AS by distributed flexibility resources

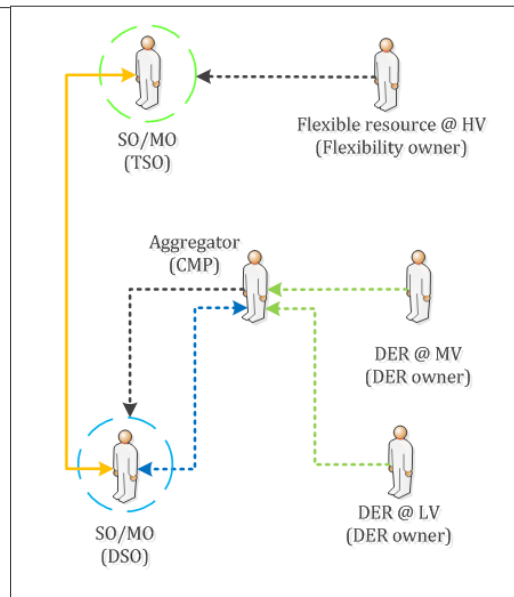
- Centralized AS market model
- Local AS market model Local DSO re-balance after congestion management
- Shared balancing responsibility model
- Common TSO-DSO AS market model
- Integrated flexibility market model



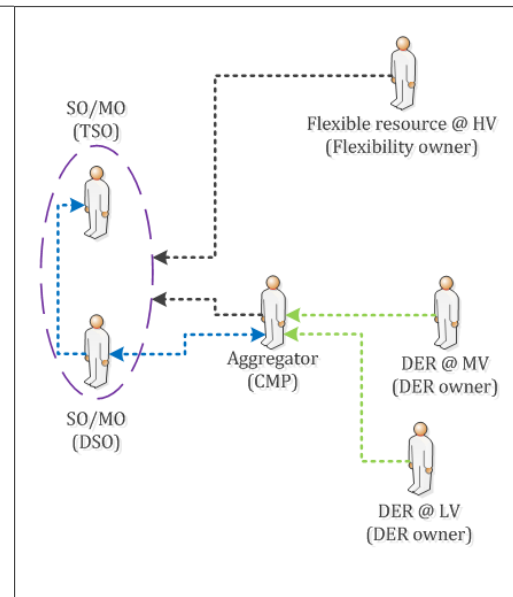
Local AS market model



Shared balancing responsibility model



Common TSO-DSO AS market model



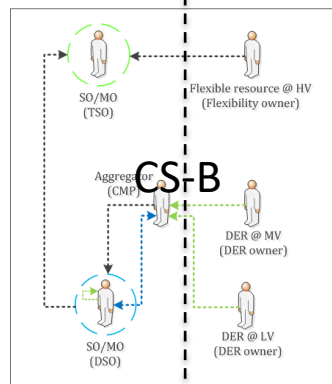
Legend

Role (Actor)	
Centralized market	
Local market	
Coordinated market	
Pre-defined profile exchange	
Aggregation	
Market bids	
Pre-qualification	

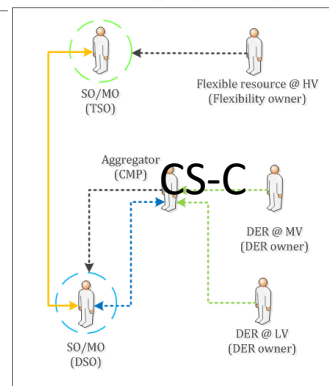
Yes

Local DSO market

Local AS market model

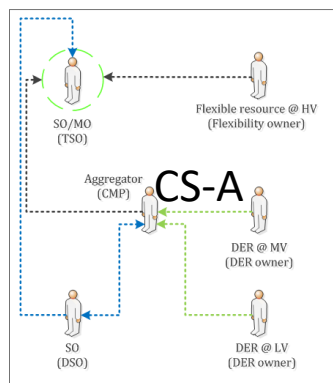


Shared balancing responsibility model

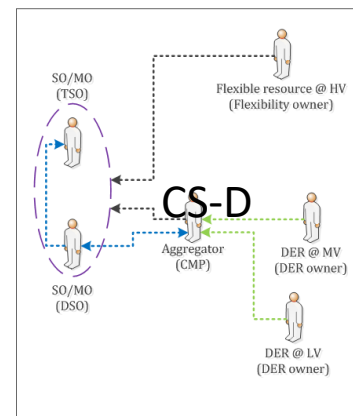


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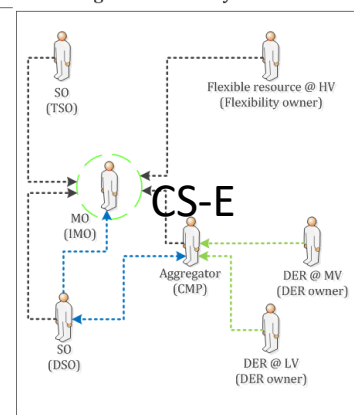
Centralized AS market model



Common TSO-DSO AS market model



Integrated flexibility market model



Low

High

DSO engagement

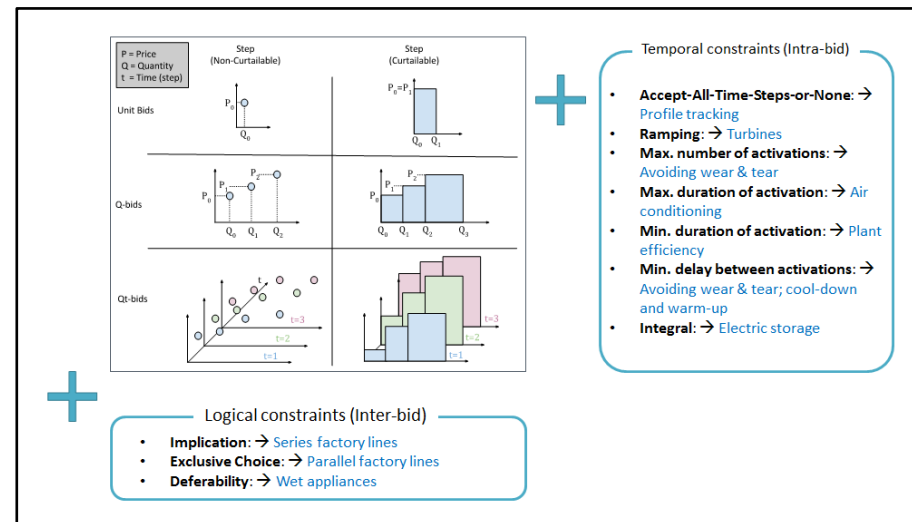
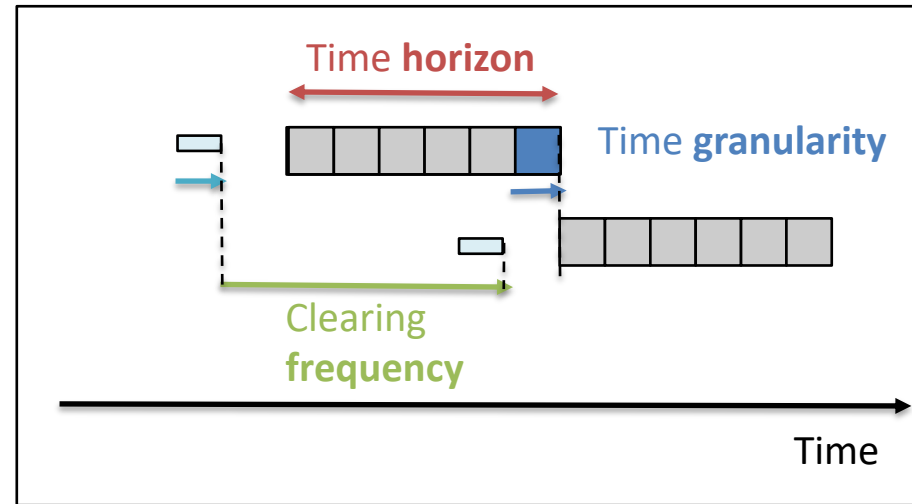
TSO-DSO coordination schemes: a comparison

Coordination Scheme	Benefits	Attention points
Centralized AS market model	<ul style="list-style-type: none"> ▪ Efficient scheme in case only the TSO is a buyer for the service ▪ A single market is low in operational costs and supports standardized processes ▪ Most in line with current regulatory framework 	<ul style="list-style-type: none"> ▪ No real involvement of DSO ▪ DSO grid constraints not always respected
Local AS market model	<ul style="list-style-type: none"> ▪ DSO has priority to use local flexibility ▪ DSO supports actively AS procurement ▪ Local markets might create lower entry barriers for small scaled DER 	<ul style="list-style-type: none"> ▪ TSO and DSO market cleared sequentially ▪ Local markets might be rather illiquid ▪ Need for extensive communication between the TSO market and the local DSO markets
Shared balancing responsibility model	<ul style="list-style-type: none"> ▪ The TSO will need to procure a lower amount of AS ▪ Local markets might create lower entry barriers for small scaled DER ▪ Clear boundaries between system operation TSO and DSO 	<ul style="list-style-type: none"> ▪ Total amount of AS to be procured by TSO and DSO will be higher in this scheme ▪ BRPs might face higher costs for balancing ▪ Small local markets might be not liquid enough to provide sufficient resources for the DSO ▪ Defining a pre-defined schedule methodology agreed by both TSO/DSO might be challenging
Common TSO-DSO AS market model	<ul style="list-style-type: none"> ▪ Total system costs of AS for the TSO and local services for the DSO are minimized ▪ TSO and DSO collaborate closely, making optimal use of the available flexible resources 	<ul style="list-style-type: none"> ▪ Individual cost of TSO and DSO might be higher compared to other schemes ▪ Allocation of costs between TSO and DSO could be difficult
Integrated flexibility market model	<ul style="list-style-type: none"> ▪ Increased possibilities for BRPs to solve imbalances in their portfolio ▪ High liquidity and competitive prices due to large number of buyers and sellers 	<ul style="list-style-type: none"> ▪ Independent market operator needed to operate the market platform ▪ Negative impact on the development and liquidity of intraday markets ▪ TSO and DSO need to share data with IMO



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



Tertiary market mFRR
(balancing + congestion management)

Cost mFRR

Paid according to the
settlement of the tertiary
market (marginal price)

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

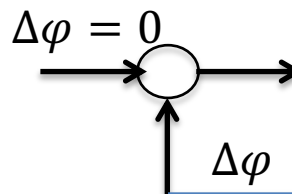
Unwanted measures
(re-dispatching to remove residual congestion)
creating further imbalance

Cost Unwanted
Measures

Paid at tertiary market bid
price (emergency measure)

Residual imbalance

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



Cost aFRR, higher
than mFRR:

$$P_{\text{mFRR_BID}} * k$$

$$k < 1 \text{ if } P_{\text{mFRR_BID}} < 0$$

$$k > 1 \text{ if } P_{\text{mFRR_BID}} > 0$$

SmartNet



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Thank You

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