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

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TSO-DSO Coordination Schemes for the Integration of Distributed Flexibility

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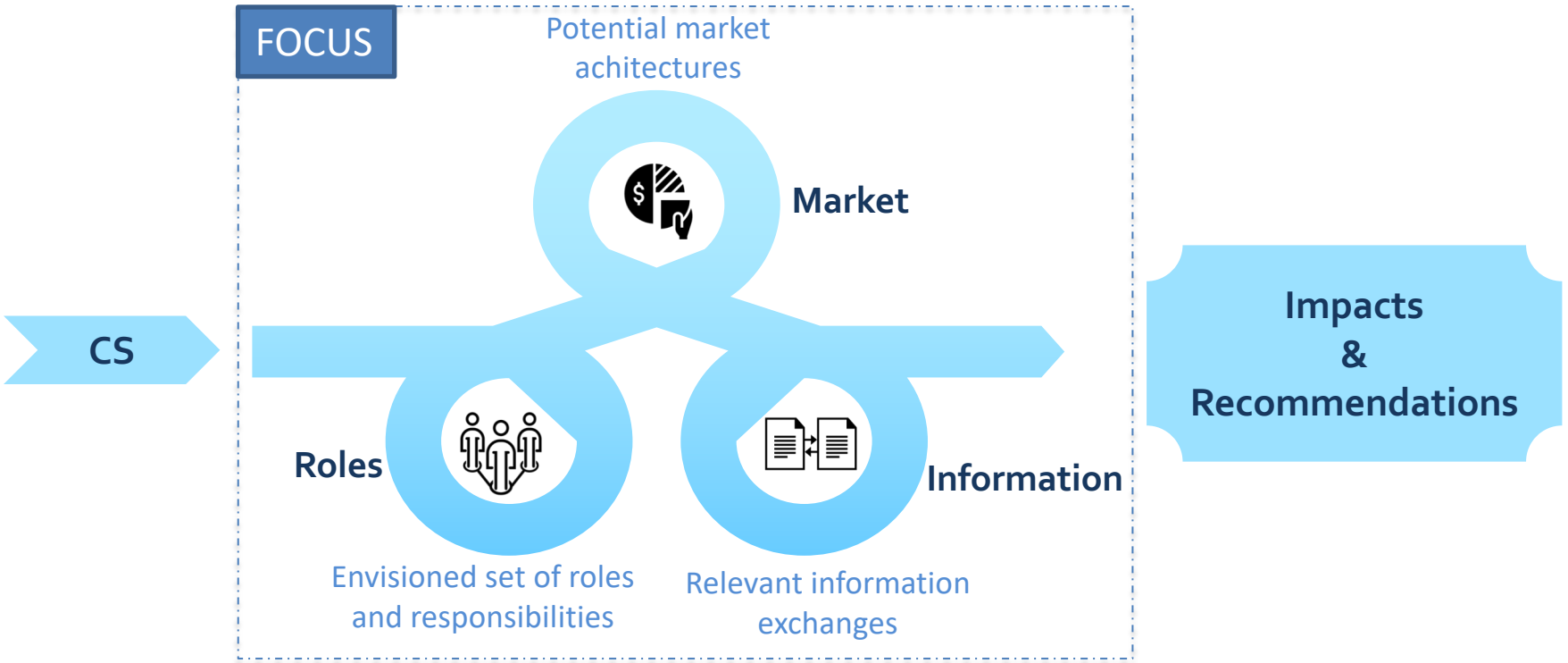
TSO-DSO coordination schemes: Scope

- **Objective**
  - Describe a set of potential TSO-DSO coordination schemes (CS) for the provision of flexibility-based system services by distributed resources (DG, DSM, …)

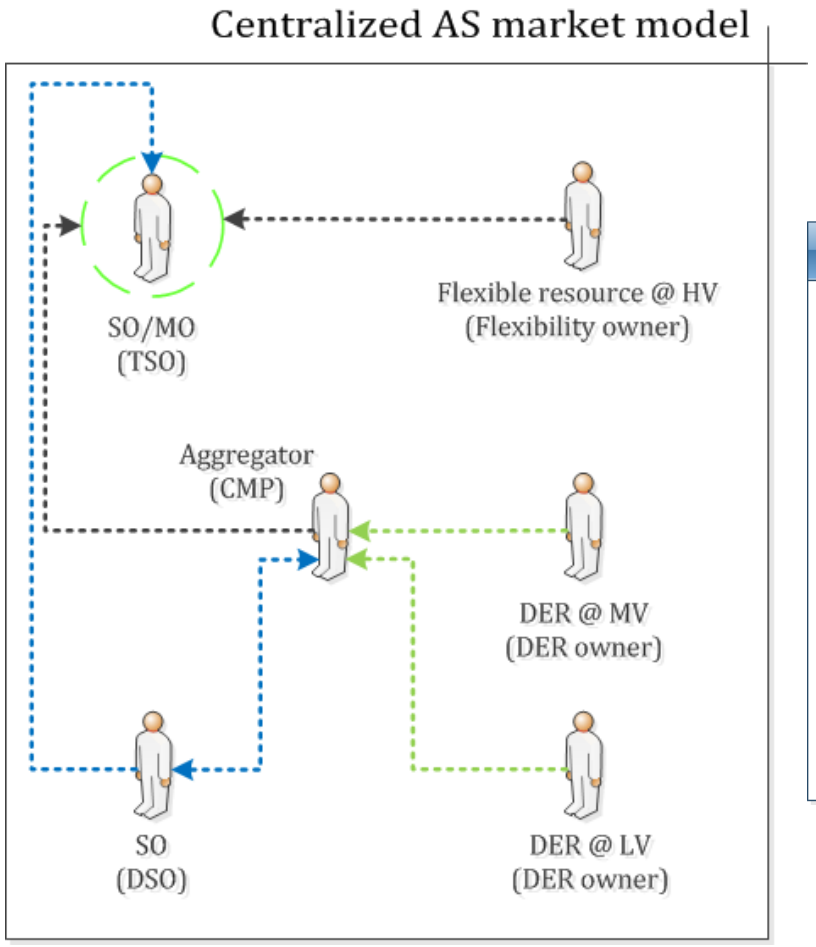


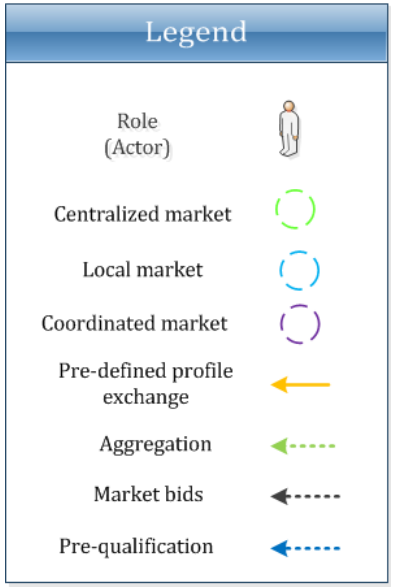
Icons created by Pravin Unagar, Eucalyp and Convoy from the Noun Project

Five potential TSO-DSO coordination schemes:

1) Centralized AS market model

- 1 common ancillary services market managed by TSO
- Separate DSO process for checking distribution constraints (e.g. prequalification)

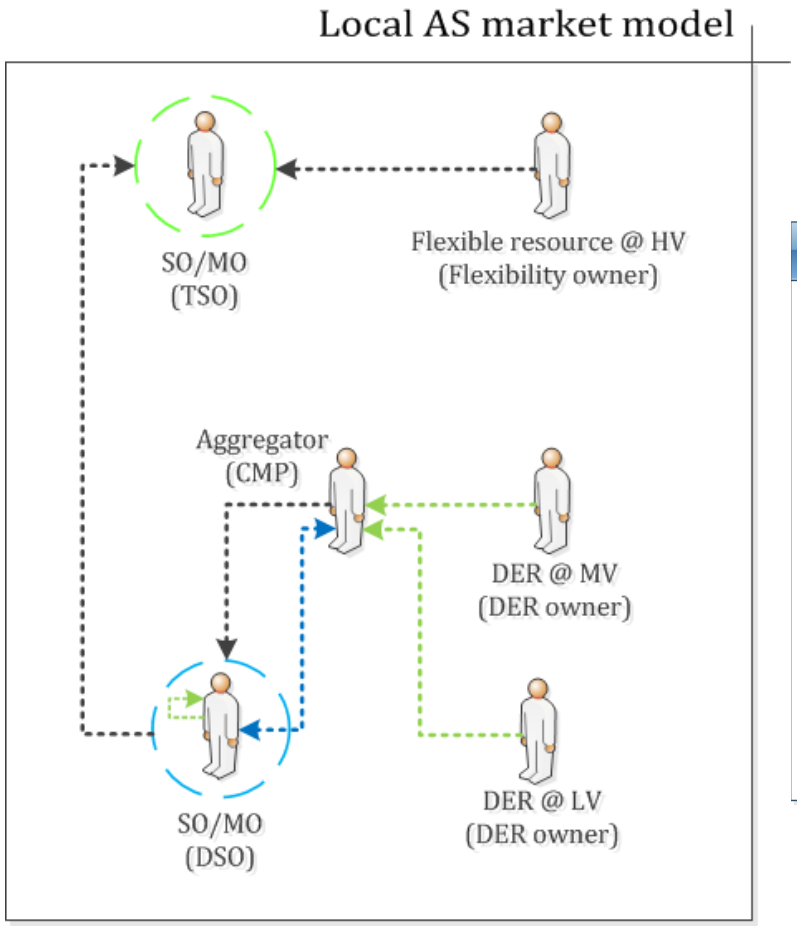


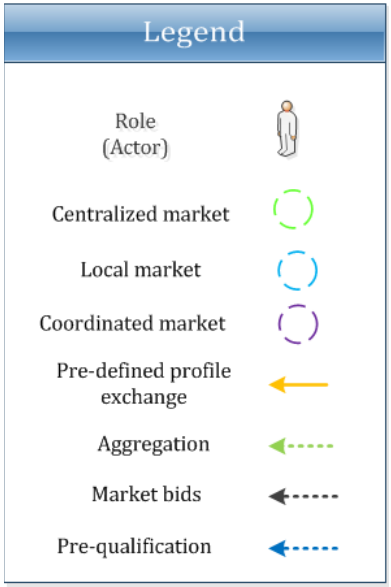


Five possible TSO-DSO coordination schemes:

2) Local AS market model

- Separate local market managed by DSO for local issues
- Transfer remaining flexibility to TSO ancillary services market level

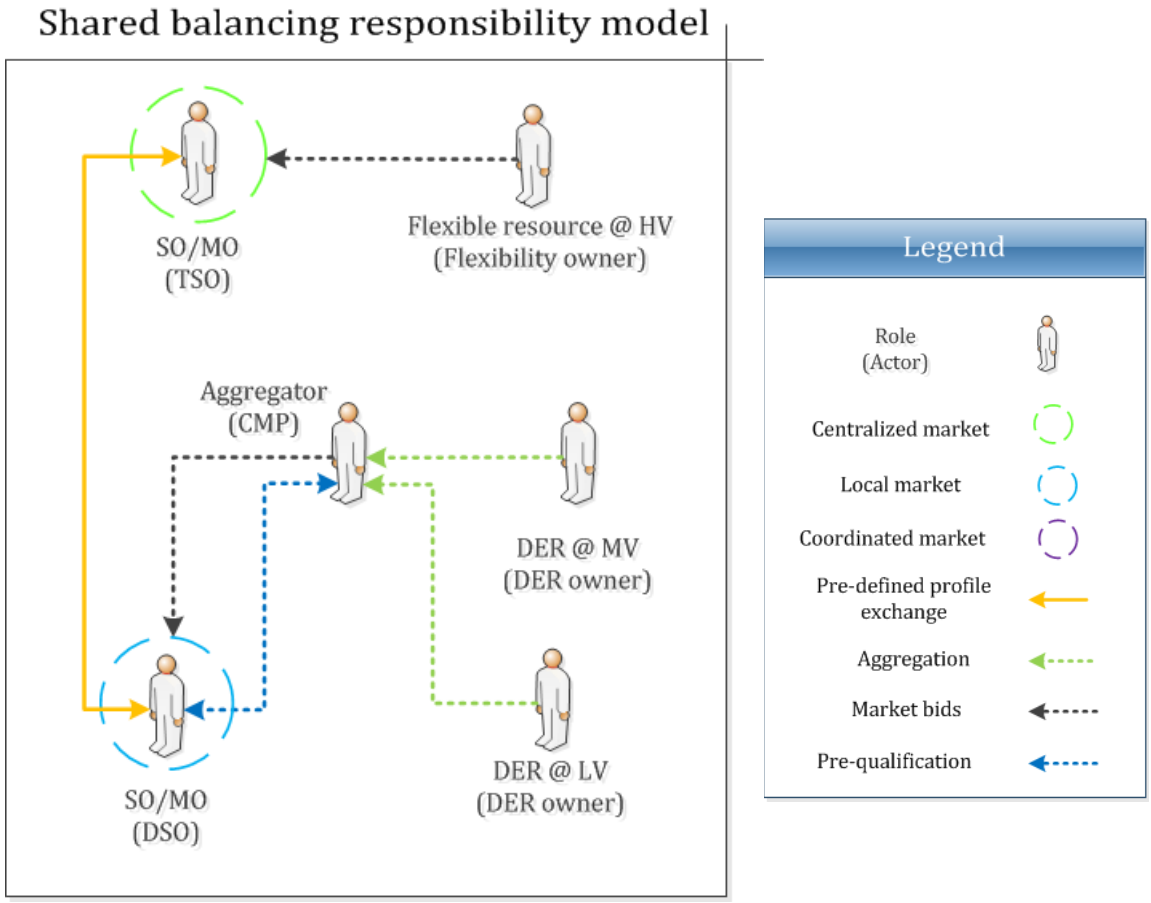




Five possible TSO-DSO coordination schemes:

3) Shared balancing responsibility model

- Ancillary services market for transmission grid-connected resources managed by TSO
- Local market for distribution grid-connected resources
- Agreed pre-defined TSO-DSO scheduled profile

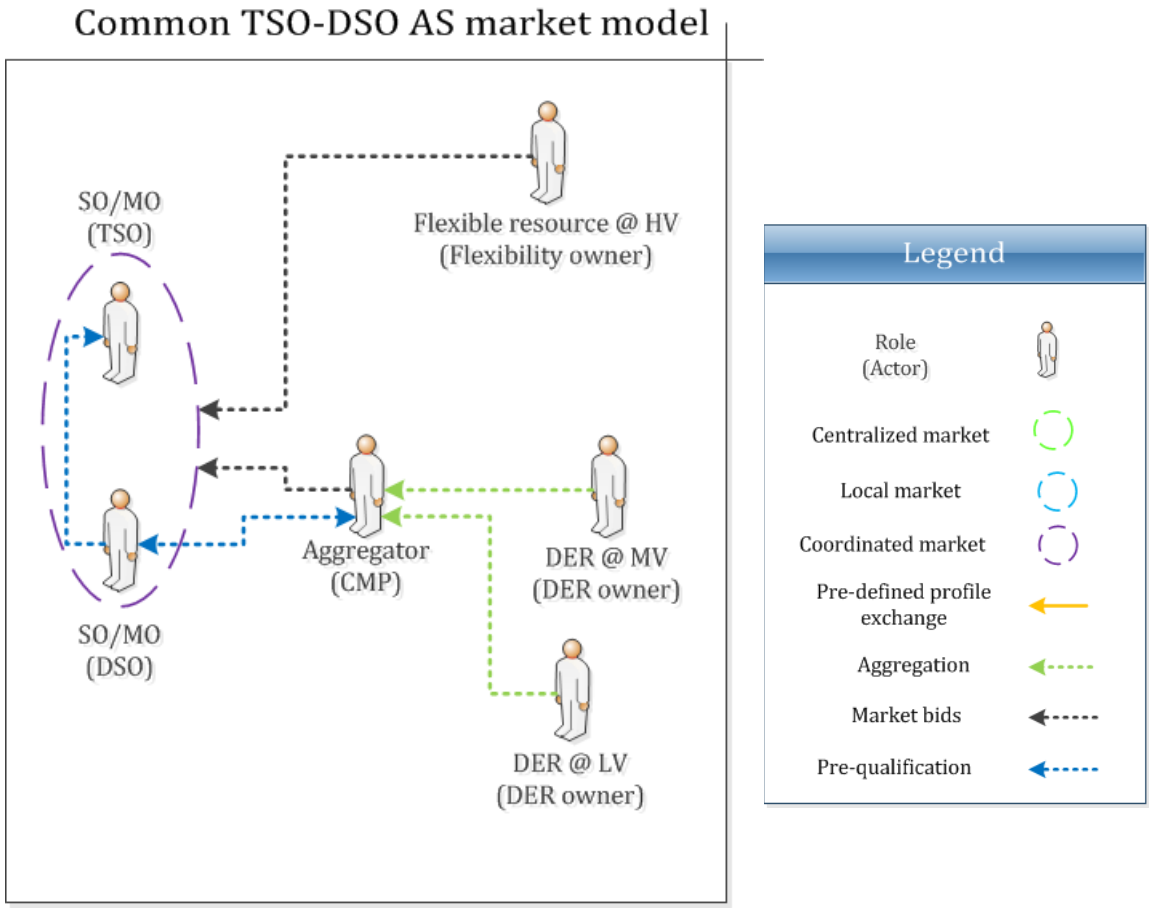


Five possible TSO-DSO coordination schemes:

4) Common TSO-DSO AS market model

- Common flexibility market managed jointly by TSO & DSO

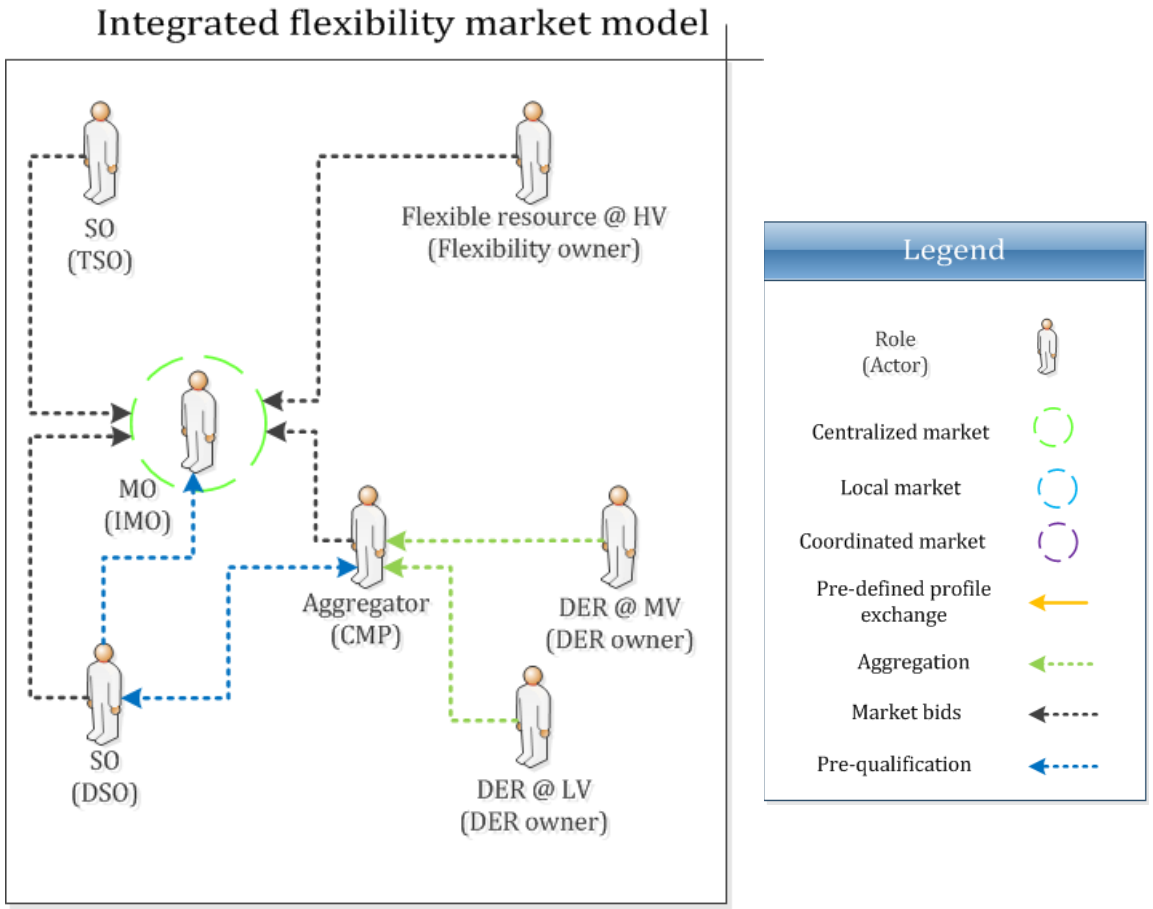
- Variants:
  - One optimization with all grid constraints
  - Two optimizations: distribution & transmission constraints



Five possible TSO-DSO coordination schemes:

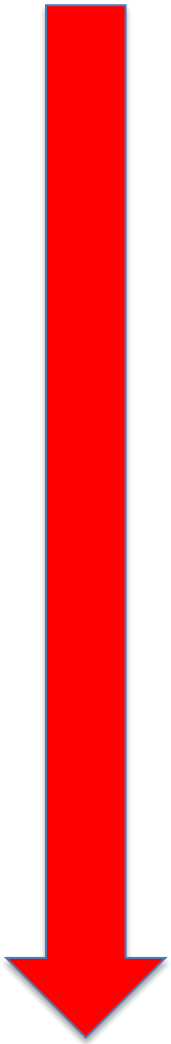
5) Integrated flexibility market model

- Common flexibility market managed by an independent / neutral market operator
- No priority for TSO, DSO or commercial market player



Summary coordination schemes

Coordination scheme	Role of the DSO
Centralized AS market model	• Limited to possible process of prequalification
Local AS market model	• Organization of local market • Buyer of flexibility for local congestion management • Aggregation of resources to central market
Shared Balancing Responsibility model	• Organization of local market • Buyer of flexibility for local congestion management and balancing
Common TSO-DSO AS market model	• Organization of flexibility market in cooperation with TSO • Buyer of flexibility for local congestion management
Integrated Flexibility market model	• Buyer of flexibility for local congestion management

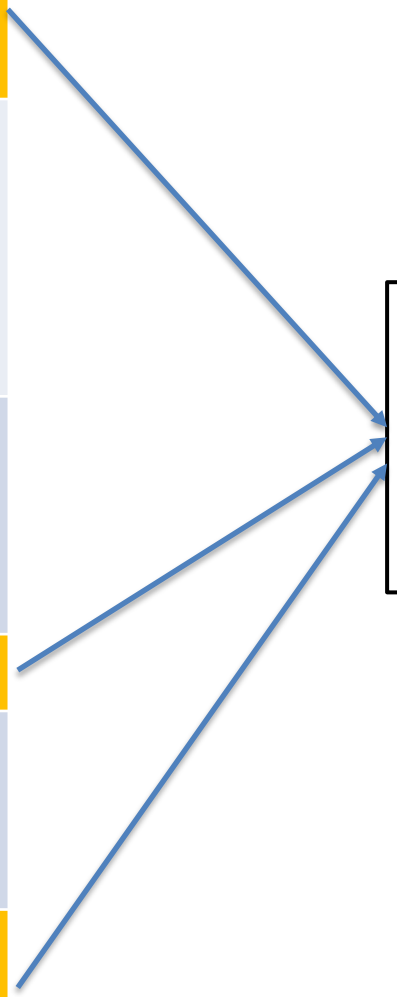


- ✓ Gradual increase of the role of the DSO
- ✓ Increased level of TSO-DSO interaction

Gerard, H., Rivero Puente, E.I., Six, D., 2018. *Coordination between transmission and distribution system operators in the electricity sector: A conceptual framework*. Utilities Policy 50, 40–48. doi: 10.1016/j.jup.2017.09.011

Summary coordination schemes

Coordination scheme	Market organization (market operator)
Centralized AS market model	Common market (TSO)
Local AS market model	Central market (TSO) Local market (DSO)
Shared Balancing Responsibility model	Central market (TSO) Local market (DSO)
Common TSO-DSO AS market model	Common market (TSO and DSO)
	Central market (TSO) Local market (DSO)
Integrated Flexibility market model	Common market (independent market operator)



✓ Concepts based on a common market for resources connected to the transmission and distribution grid

Gerard, H., Rivero Puente, E.I., Six, D., 2018. *Coordination between transmission and distribution system operators in the electricity sector: A conceptual framework*. Utilities Policy 50, 40–48. doi: 10.1016/j.jup.2017.09.011

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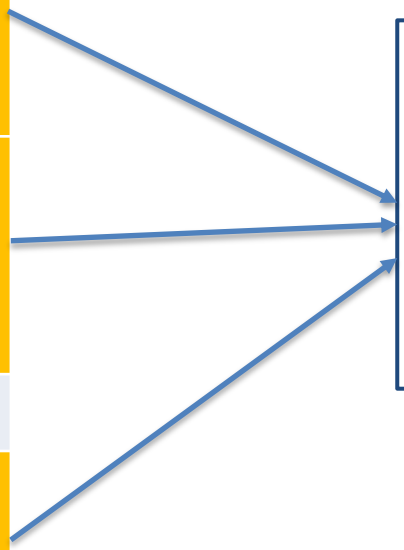
Common TSO-DSO AS market model	Common market (TSO and DSO)
	Central market (TSO) Local market (DSO)
Integrated Flexibility market model	Common market (independent market operator)



- ✓ Concepts based on a separate market for resources connected to the transmission and distribution grid -> smart coupling between markets

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Summary coordination schemes

Coordination scheme	Allocation principle of flexibility from the distribution grid
Centralized AS market model	Priority for the TSO
Local AS market model	Priority for the DSO
Shared Balancing Responsibility model	Exclusive use for the DSO
Common TSO-DSO AS market model	Minimization of total costs of TSO and DSO
Integrated Flexibility market model	Highest willingness to pay

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Benefits and attention points

Domain	Performance criteria	Coordination scheme				
		Centralized AS market model	Local AS market model	Shared Balancing Responsibility model	Common TSO-DSO market model	Integrated Flexibility market model
Interaction between system operators	Adequacy of existing communication channels, including the use of common data					
Grid operation	Respecting distribution grid constraints					
	Use of resources from the distribution grid by the TSO					
	Recognition of the evolving role of the DSO					
Market operation	Possibility to lower market operation costs					
	Liquidity of the market					
	Economies of scale					

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Benefits and attention points

Domain	Performance criteria	Coordination scheme				
		Centralized AS market model	Local AS market model	Shared Balancing Responsibility model	Common TSO-DSO market model	Integrated Flexibility market model
Interaction between system operators	Adequacy of existing communication channels, including the use of common data	High				
Grid operation	Respecting distribution grid constraints	Low				
	Use of resources from the distribution grid by the TSO	High				
	Recognition of the evolving role of the DSO	Low				
Market operation	Possibility to lower market operation costs	High				
	Liquidity of the market	Medium				
	Economies of scale	Medium				

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Benefits and attention points

Domain	Performance criteria	Coordination scheme				
		Centralized AS market model	Local AS market model	Shared Balancing Responsibility model	Common TSO-DSO market model	Integrated Flexibility market model
Interaction between system operators	Adequacy of existing communication channels, including the use of common data	High	Medium	Medium		
Grid operation	Respecting distribution grid constraints	Low	High	High		
	Use of resources from the distribution grid by the TSO	High	Medium	Low		
	Recognition of the evolving role of the DSO	Low	High	High		
Market operation	Possibility to lower market operation costs	High	Low	Low		
	Liquidity of the market	Medium	Low	Low		
	Economies of scale	Medium	Low	Low		

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Benefits and attention points

Domain	Performance criteria	Coordination scheme				
		Centralized AS market model	Local AS market model	Shared Balancing Responsibility model	Common TSO-DSO market model	Integrated Flexibility market model
Interaction between system operators	Adequacy of existing communication channels, including the use of common data	High	Medium	Medium	Low	Medium
Grid operation	Respecting distribution grid constraints	Low	High	High	High	High
	Use of resources from the distribution grid by the TSO	High	Medium	Low	High	High
	Recognition of the evolving role of the DSO	Low	High	High	High	High
Market operation	Possibility to lower market operation costs	High	Low	Low	Medium	Medium
	Liquidity of the market	Medium	Low	Low	Medium	High
	Economies of scale	Medium	Low	Low	High	High

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Conclusions

- The increase of DER offers opportunities for system operators to make use of flexibility available in the distribution grid.
- Coordination between system operators (TSO and DSO) is crucial to guarantee an efficient use of these flexible services.
- Different possible TSO-DSO coordination schemes have their own benefits and risks.
- The choice of the most suitable coordination scheme depends on several factors:
  - ✓ The type of flexibility service.
  - ✓ The current state of the grid.
  - ✓ The share of RES installed.
  - ✓ The existing market design.
  - ✓ The expected evolution of roles and responsibilities of system operators.
- The feasibility of each of the coordination schemes is dependent on the current and future regulatory framework.

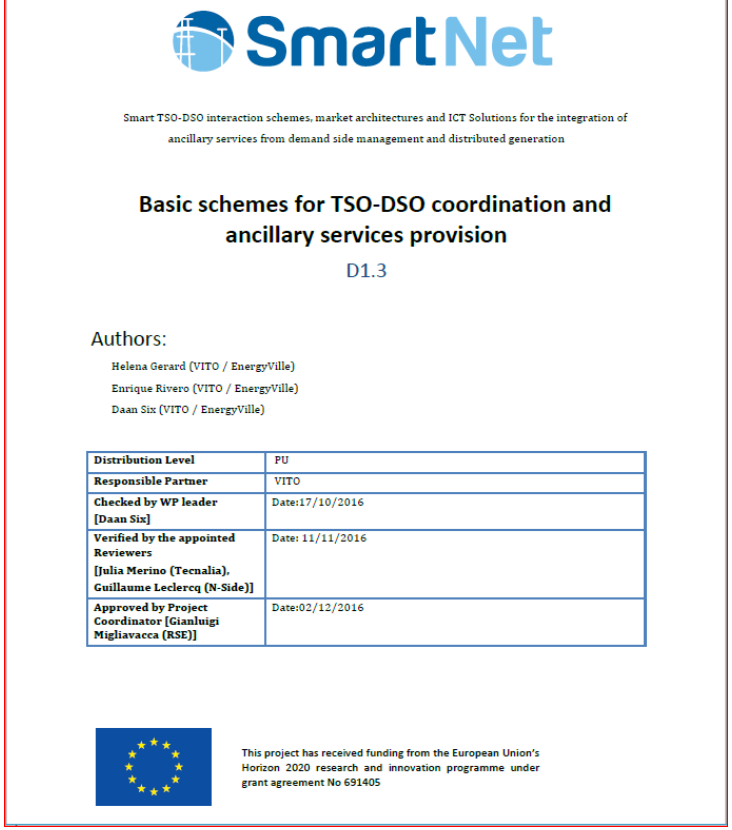
Conclusions

- The choice of any particular coordination scheme at any moment in time still allows the possibility to evolve to another coordination scheme in the future.
- A change from one coordination scheme to another is in principle a question of a change in roles, responsibilities and market design.
- It remains essential that the chosen national coordination scheme is embedded in the ongoing processes of harmonization and integration of power systems across the European Union.
- The increased interaction between system operators will impact business processes, information exchanges, communication channels and ICT infrastructure.

If they want to go fast, system operators could go alone,
If they want to go far, they should go together,
turning challenges into opportunities

Outcomes

Get it!



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

Basic schemes for TSO-DSO coordination and ancillary services provision

D1.3

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Coordination between transmission and distribution system operators in the electricity sector: A conceptual framework

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ABSTRACT

The increasing share of distributed energy resources in the distribution grid provides opportunities to use the resources for the overall benefit of both the Transmission System Operator (TSO) and the Distribution System Operator (DSO) to solve problems related to frequency control, congestion management, and voltage control. Consequently, coordination between system operators is needed to guarantee a safe, reliable, and cost-efficient use of flexibility-based services. This article presents five coordination schemes to enhance interaction between system operators. For each scheme, roles, responsibilities and market design are discussed. The advantages, disadvantages and feasibility of each coordination scheme are evaluated.

1. Introduction

The energy market is undergoing important changes, driven by the realization of the European internal energy market on the one hand and the increase of distributed energy resources (DER) on the other hand. The increase of DER not only results in a higher need for flexible services for system operators but provides new opportunities for system operators as well (Poudineh and Jamasb, 2014; Ruester et al., 2013; Dueñas, 2015). Both transmission system operators and distribution system operators could benefit from the use of flexible resources from the distribution grid. TSOs could use these resources for frequency control, voltage control or congestion management, while DSOs could acquire flexible resources for local congestion management and voltage control (Julia Merino, 2016; D'hulst et al., 2015; SWECO et al., 2015; Expert Group 3, 2015). However, it is not easy for TSOs and DSOs to make use of these flexibility services under the liberalization regime enacted in the Third Energy Package as this imposed the separation between transmission and distribution (Ferrante et al., 2015).

For both system operators to make optimal use of these resources, coordination is necessary (CIEP/PBL, 2014; Expert Group 3, 2015; Ruester et al., 2014). By increasing the level of coordination, system operators will be able to support each other in the efficient and cost-effective operation of their grid (Ochoa et al., 2016). Moreover, effective coordination will avoid that actions taken by one system operator will contradict actions taken by another system operator (CEER, 2016; CEDEC et al., 2015; Expert Group 3, 2015; Ruester et al., 2014; Eid et al., 2016b; Mallet et al., 2014). This means, among other things, that system operators could work together to improve the observability of the grid, including the quality and transparency of grid data (ENTSO-E, 2015a; CEDEC et al., 2015; Eurelectric, 2015; Expert Group 3, 2015; Dueñas, 2015; Mallet et al., 2014).

The need for increased cooperation between system operators is widely recognized, especially in a scenario with increasing renewable energy sources (RES) and increasing participation of DER to ancillary services markets (CEER, 2016; ENTSO-E, 2015b; CIEP/PBL, 2014; Ruester et al., 2014; Ochoa et al., 2016; Carlos Battle and Michael Rivier, 2012). EU regulation (network codes) provides a first framework in which different concepts of coordination among system operators could be further developed. The different network codes highlight the need for system operator interaction with respect to the exchange of data, operational procedures, and market design (ENTSO-E, 2015c; European Commission, 2016a; European Commission, 2016b; European Commission, 2016c; European Commission, 2016d; ENTSO-E, 2015d; ENTSO-E, 2014).

Earlier research has focused to a large extent on the impact and possibilities of RES and DER to provide services from the distribution grid to system operators, including pricing mechanisms and the relationship between the aggregator and the DSO (Eid et al.,

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Thank You

Q&A

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