

Session on: Approaches for DSO- TSO-PX coordination

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Meeting on TSO-DSO-PX Cooperation . Future Power Market Platform

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Contents

- Services and pricing at TSO and DSO (US vs EU)
- Possible phases for coordination
- Key coordination activities
- Example: balancing vs local congestion management
- Further research questions

Services and pricing at both TSO and DSO level

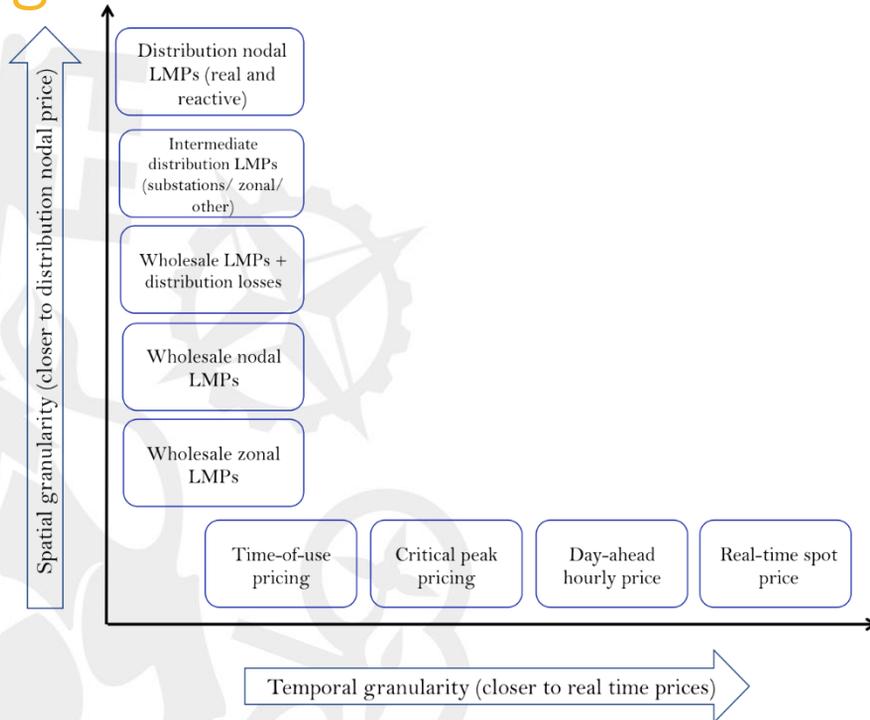
TSO services	ISO Services pricing in US	TSO Services pricing in EU
Electrical Energy	LMPs	Zonal
Transmission Losses		
Transmission Congestions		Redispatching/Congestion Management Markets
Reserves	Co-optimization with LMPs	Balancing markets
Reactive Power & voltage control	Regulated payments & bilateral contracts	Regulated payments & bilateral contracts
Blackstart		

Recent initiatives to procure DSO services are taking place

DSO services	First best pricing	Transitory phase	Current pricing
Electrical Energy	LMPs at distribution level		Regulated tariffs or bundled competitive retail tariffs
Distribution Losses			
Distribution Congestions			
Reactive Power & voltage control	Reliability auctions & cost-reflective network tariffs		Averaged network tariffs
Network Connection & reliability			
Network deferral			

*Birk, M., Chaves-Avila, J.P., Gómez, T., Tabors, R. (2016). TSO/DSO Coordination in a Context of Distributed Energy Resource Penetration. Presented at EEIC 2016.

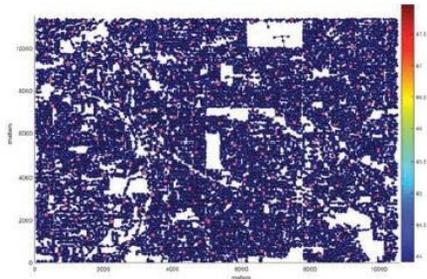
Choices in the Adoption of Temporal and Spatial Granularity in Energy Pricing



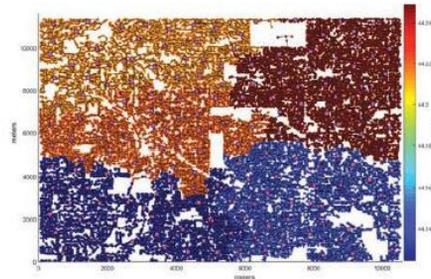
Source: MIT Utility of the Future Study.

Capturing the Cost of Losses with Varying Levels of Energy Price Granularity

4.15a: Wholesale LMPs



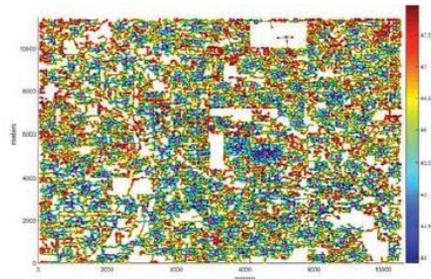
4.15b: Zonal LMPs for distribution users served by each HV/MV substation (substations indicated by arrows)



4.15c: LMPs with voltage-level distribution marginal loss approximations



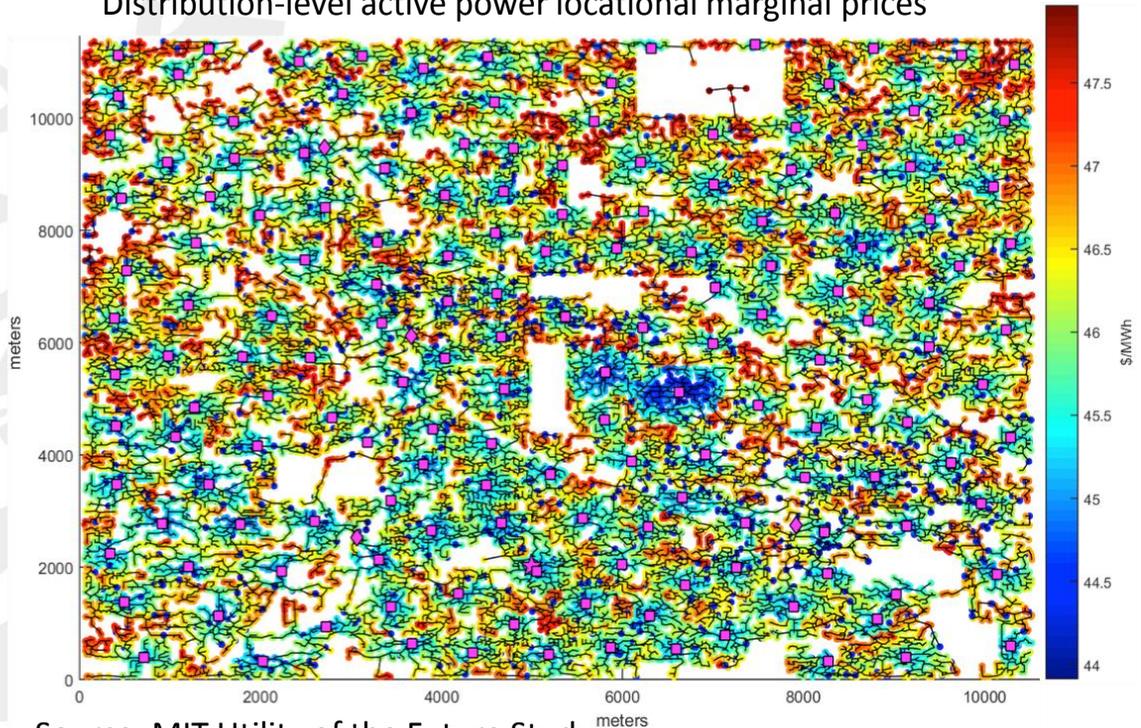
4.15d: Distribution-level active power LMPs



Source: MIT Utility of the Future Study.

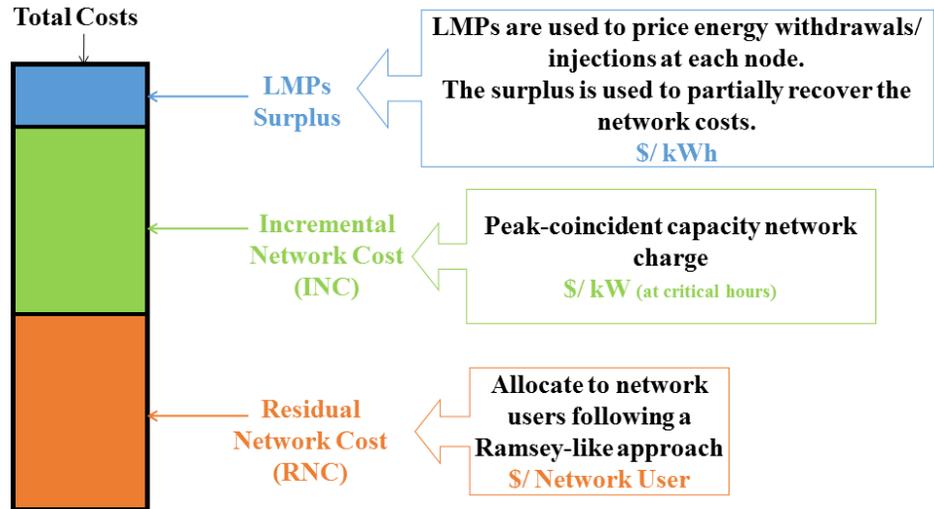
Need of computational tools to value services provided by DERs

Distribution-level active power locational marginal prices



Source: MIT Utility of the Future Study.

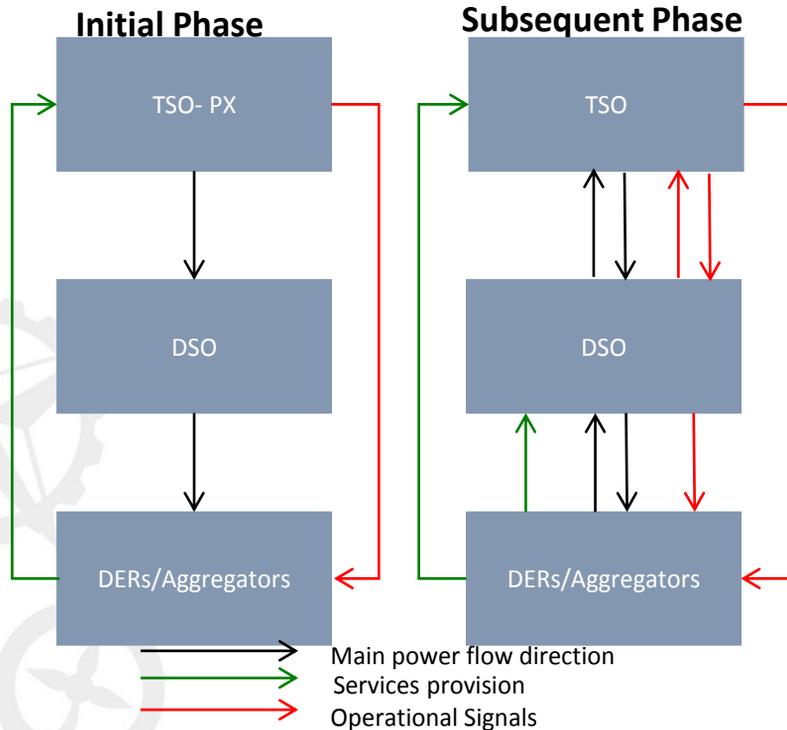
Efficient network charges that complements prices are also key



I. Abdelmotteleb, T. Gómez, J. P. Chaves Ávila, and J. Reneses, “Designing efficient distribution network charges in the context of active customers,” *Appl. Energy*, vol. 210, 815-826, Jan 2018

Possible pathways for TSO-PX-DSO coordination

- A future electricity system may have a high penetration of distributed energy resources (DERs)
- DERs can provide system-wide services
- DERs have market and operational impacts
- New roles for DSOs and TSOs
- Transition through 2 phases likely

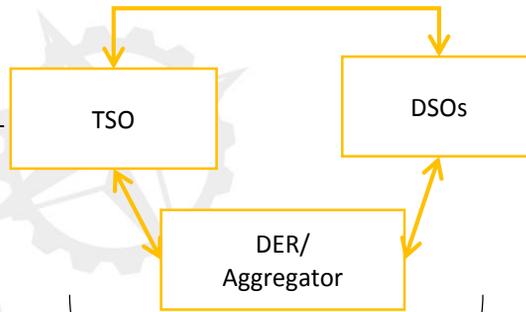


Source: Birk, M., Chaves-Ávila, J.P., Gómez, T., Tabors, R. (2016). TSO/DSO Coordination in a Context of Distributed Energy Resource Penetration. Presented at EEIC 2016.

Some key activities for key actors

Share/coordinate activities (TSO-DSO):

1. Plan transmission system
2. Forecast loads/generation
3. Run wholesale markets and computes price signals (PX in Europe for energy)
4. Operate wholesale system & activate resources
5. Settle wholesale transactions (TSO and PX in Europe)



1. Fulfill technical requirements
2. Computes bids to provide services
3. Deliver committed services

1. Plan local system
2. Forecast and monitor DERs
3. Computes locational price signals (in coordination with wholesale signals) and payments for local services
4. Operate local systems & activate resources
5. Settle local transactions

Example: balancing vs local congestion management (i)

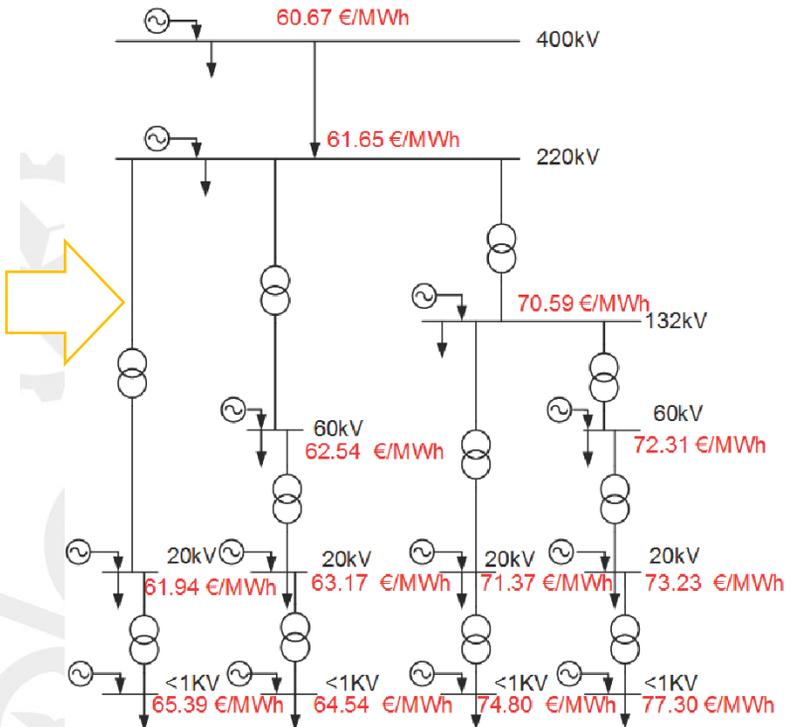
- Two services
 - Balancing is a system service of TSO responsibility
 - Congestion in distribution is a local service of DSO responsibility
- **Step 1:** Flexible resources connected at distribution may participate offering **balancing services to the TSO** in aggregated portfolios in a level playing field with centralized generators
- **Step 2:** DSOs should develop market based procedures for the participation of local flexible resources **in local congestion management**
- **Step 3:** Coordination between TSOs and DSOs in the prequalification and activation of flexibility resources that can
 - Offer simultaneously both services (balancing and local congestion management) but only used once in a timeframe
 - Offer and provide balancing but create local congestion problems

Example: balancing vs local congestion management (ii)

- Local congestion services procured by DSO should be
 - Defined in a **standardized format**. Progressive harmonization taking best practices. Role for the EU DSO entity.
 - Procured under **market-based mechanisms**, for instance auctions, that necessarily would be local in scope (low liquidity and fast decreasing profitability). **Coordination with TSOs** when the flexibility resources are offering balancing services (in the prequalification processes for units providing reserves)
 - **Activated and used in real-time in coordination with TSO** when the flexibility resources are providing services to both DSO and TSO (but only used once in a timeframe). Market based mechanisms should maximize welfare.
 - Activated and used in coordination with TSO when the flexibility resources are creating local problems (e.g. predefined limits before activation)

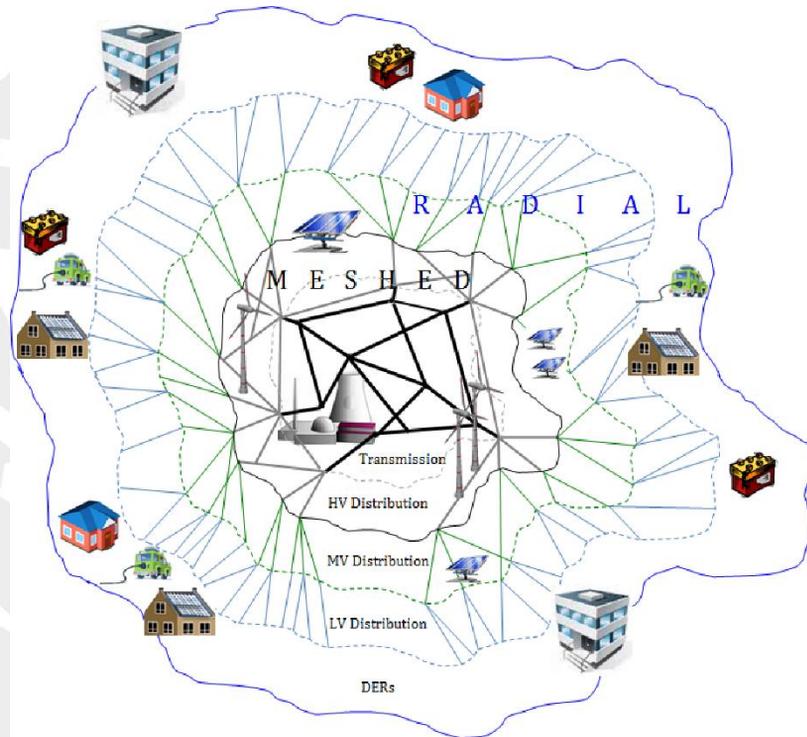
Is it possible to consider local price signals even when there is a single wholesale price (EU approach)?

Distribution Locational Marginal Prices when Aggregated Distribution Losses are Considered in the Spanish Power System. Yearly average prices for the current Spanish system



Source: MIT Utility of the Future Study.

Question: Where is logical / most efficient TSO/DSO Boundary?



Source: MIT Utility of the Future Study.

Further research areas

- Design market mechanisms (especially at DSO level) and determine price signals (prices and/or regulated payments) for all different services at both TSO and DSO levels
 - These mechanisms should complement current prices & efficient network charges
 - Compatible with the EU target model (or proposed modifications if needed)
- Create a level playing field between centralized and distributed resources & between wires and non-wires solutions (update incentives for DSOs & TSOs)
- Establish a operational procedures to coordinate different functions of TSO-DSO, including the need for information exchange and data management for coordinated activities

Thank you for your
attention

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