Coordination between DSOs and TSOs, market platforms, congestion management and balancing

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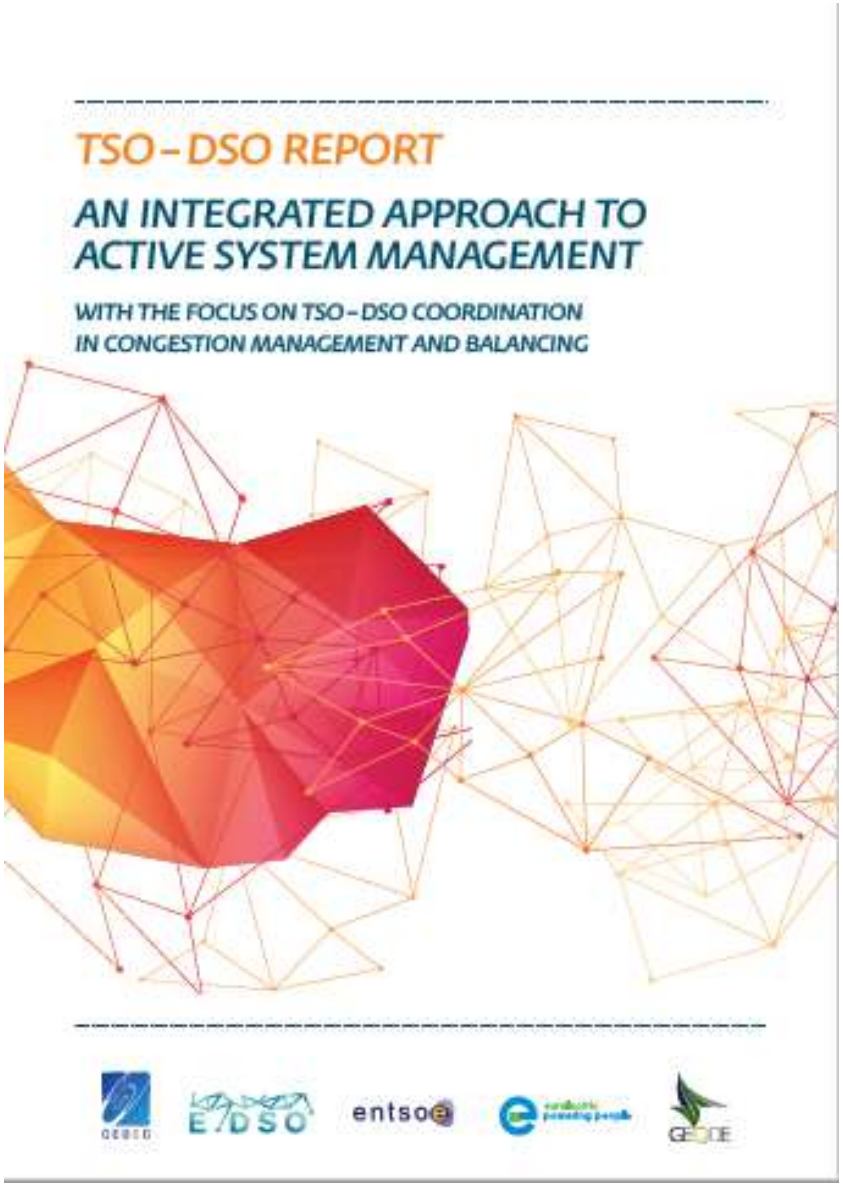
PART I

We analyze and discuss together this report that focuses on ways to exploit flexibility bids for congestion management and balancing, with a focus on the roles assigned to DSO and TSO.



1. Introduction

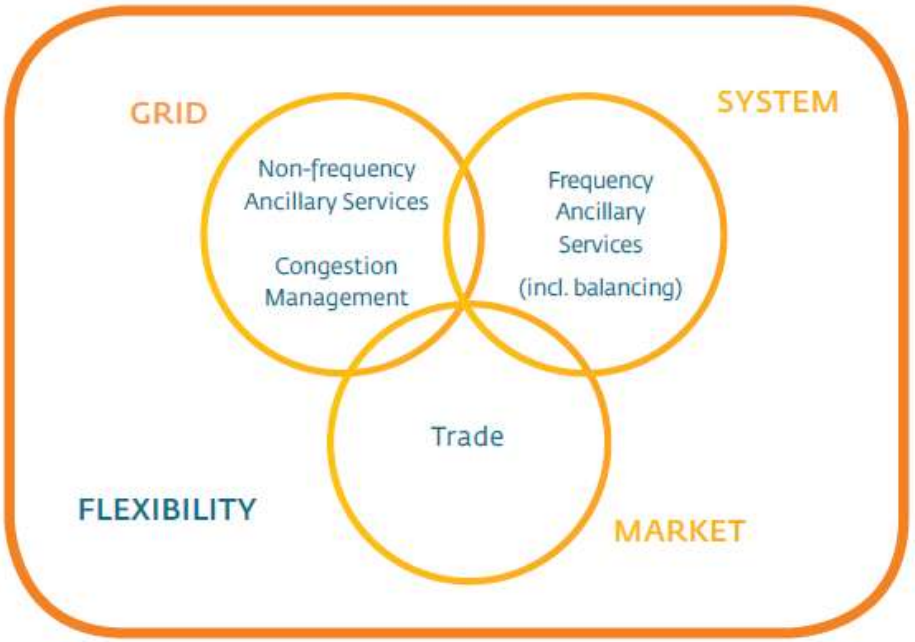
Increase in distributed renewable generation and in storage. Increase in e-mobility.

Question: how to integrate the flexibility services provided by these new assets and actors into the energy market and use their services for congestion management and further in balancing, while ensuring efficient and reliable system operation and enabling the market uptake for flexibility resources?

5.88 million of cars in BE. If all cars were electric with a 80 kWh battery pack => 0.47 TWh of storage capacity. Huge potential for flexibility that makes the question very relevant.

Active system management (ASN)

Active Systems Management (ASM) is a key set of strategies and tools performed and used by DSOs and TSOs for the cost-efficient and secure management of the electricity systems. It involves the use and enhancement of smart and digital grids, operational planning and forecasting processes and the capacity to modulate, in different timeframes and distinct areas, generation and demand encompassing **flexibility instruments (toolbox)** to tackle challenges impacting system operation, thus ensuring proper integration of Renewable Energy Sources (RES) anda high share of Distributed Energy Resources (DER), as well as the integration with energy markets.



The different uses of flexibility.

Flexibility is defined as the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) to provide a service within the energy system.

Distributed generation and storage provides as well as improvements and cost reduction in ICT provide offer the opportunity to perform active power and reactive power management in the distribution grids.

Distributed generation and storage should have equal opportunities as transmission-connected generation to increase their value and their revenue by participating in balancing and congestion management in the transmission grid, through proper coordination mechanisms agreed between TSOs and DSOs and market parties.

A toolbox for ASN

DSOs and TSOs have a toolbox comprising different types of solutions for undertaking congestion management, balancing and other grid-related issues (e.g., voltage control)

1. *Technical solutions using grid assets*: reconfiguration of the grid topology to alter power flows, including reactive power flows, and achieve a more desirable system state.

2. *Tariff solutions*: the use of grid tariffs to trigger implicit flexibility that is able to react to prices. These tariffs can take many forms and can include aspects such as time, direction, capacity and location.

3. *Market-based solutions*: market-based activation of explicit flexibilities that are able to alter power flows in all directions.

4. *Connection agreement solutions*: connection agreements with certain grid users so that they provide a certain service needed.

5. *Rule-based solutions*: rule-based curtailments as a consequence of the implementation of technical requirements from connection codes that are available in last-resort or emergency situations.

The focus of this report

Focus on *market-based solutions*, specifically on exploring the needs and options for implementing this solution and the corresponding required DSO – TSO coordination.

Coexistence with other ASM solution not analyzed (complex problems).

Reactive power management has been left out of the report to concentrate only on congestion management and balancing services provided by third parties.

2. Congestion management process

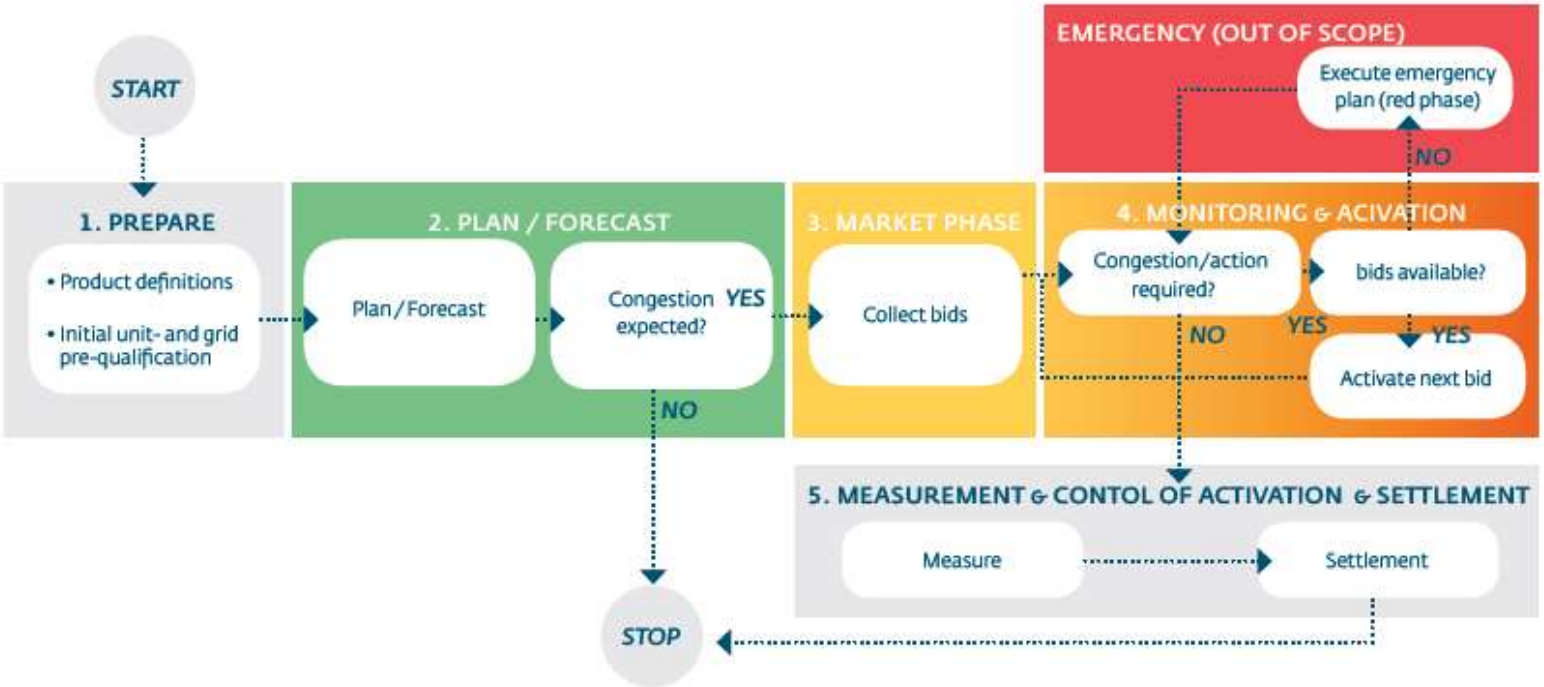
We focus on the use of flexibility for congestion management through market-based solutions.

Different types of congestion according to the EU regulation:

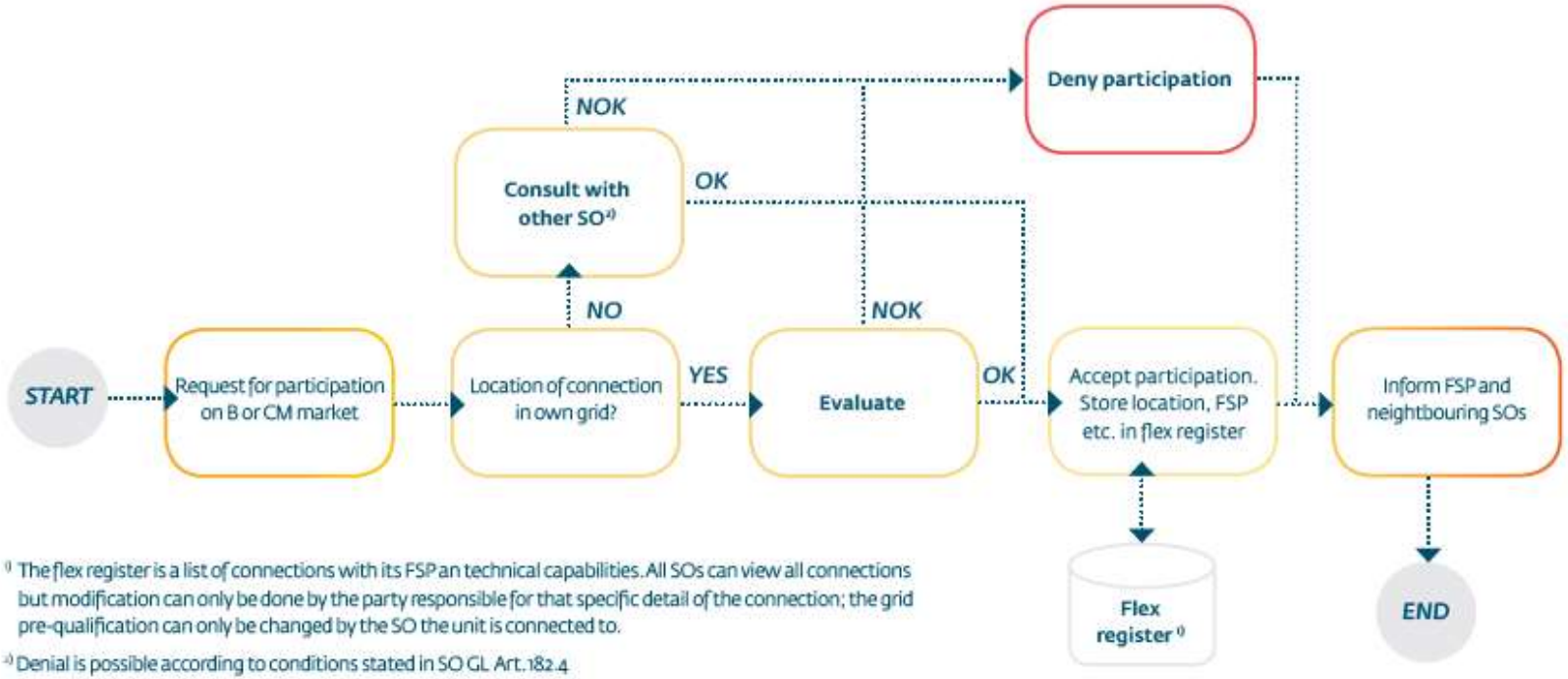
1. Congestion : situation in which an interconnection linking national transmission networks cannot accommodate all physical flows resulting from international trade requested by market participants, because of a lack of capacity of the interconnectors and/or the national transmission systems concerned.

2. *Market congestion*: a situation in which the economic surplus for single day-ahead or intraday coupling has been limited by cross-zonal capacity or allocation constraint.

3. *Physical congestion*: means any network situation where forecasted or realised power flows violate the thermal limits of the elements of the grid and voltage stability, or the angle stability limits of the power system.


START
1. PREPARE
• Product definitions
• Initial unit- and grid pre-qualification
2. PLAN / FORECAST
Plan / Forecast
Congestion expected?
YES
NO
3. MARKET PHASE
Collect bids
EMERGENCY (OUT OF SCOPE)
Execute emergency plan (red phase)
NO
4. MONITORING & ACIVATION
Congestion/action required?
bids available?
NO
YES
YES
Activate next bid
5. MEASUREMENT & CONTOL OF ACTIVATION & SETTLEMENT
Measure
Settlement
STOP

1. Prepatory phase



[1] The flex register is a list of connections with its FSP an technical capabilities. All SOs can view all connections but modification can only be done by the party responsible for that specific detail of the connection; the grid pre-qualification can only be changed by the SO the unit is connected to.

[2] Denial is possible according to conditions stated in SO GL Art. 182.4

2. Forecast

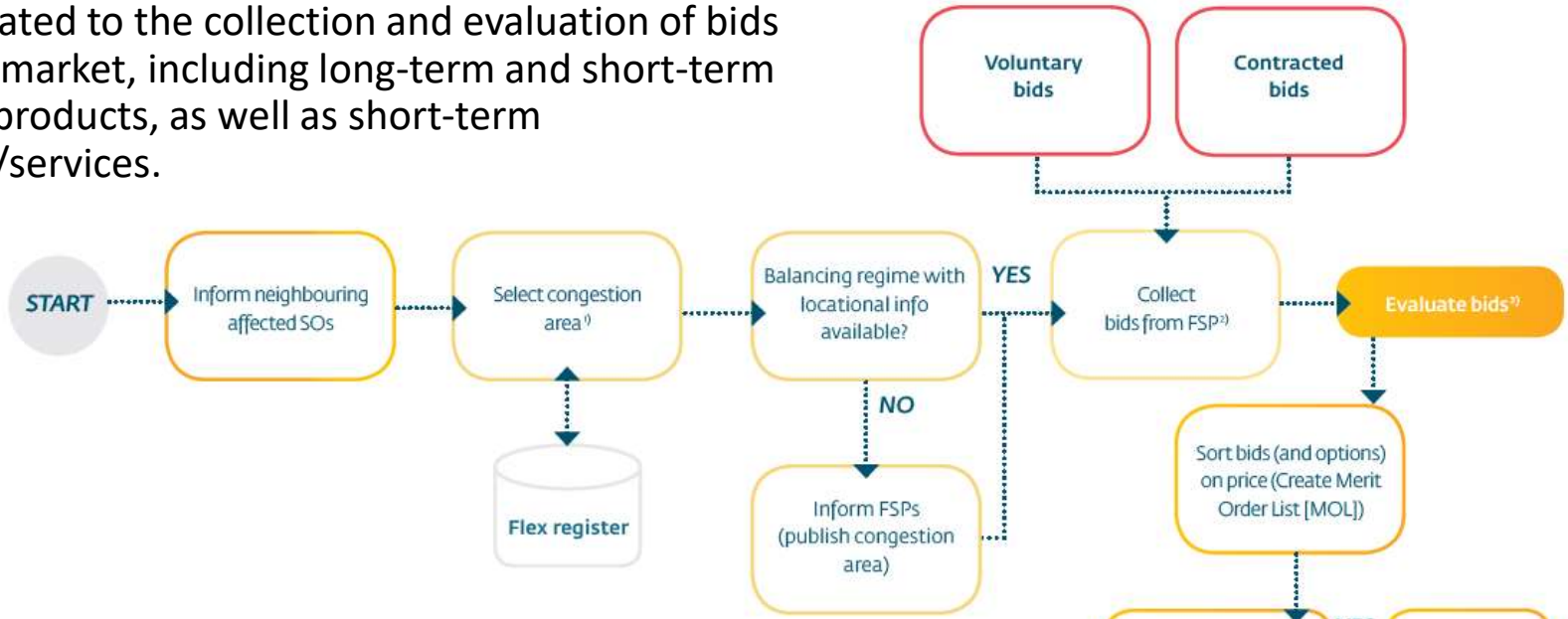
Forecasting is undertaken in different timeframes. The accuracy of the predicted flow of electricity in a certain area typically improves with the time passed.

Some forecasts are updated and performed up until real time (for example using real-time weather data and remote monitoring devices on the grids).

Necessary for system operators to have access to good schedules with relevant locational information, to perform proper forecast for congestion management and make efficient and secure decisions.

3. Market phase

Phase related to the collection and evaluation of bids from the market, including long-term and short-term capacity products, as well as short-term products/services.

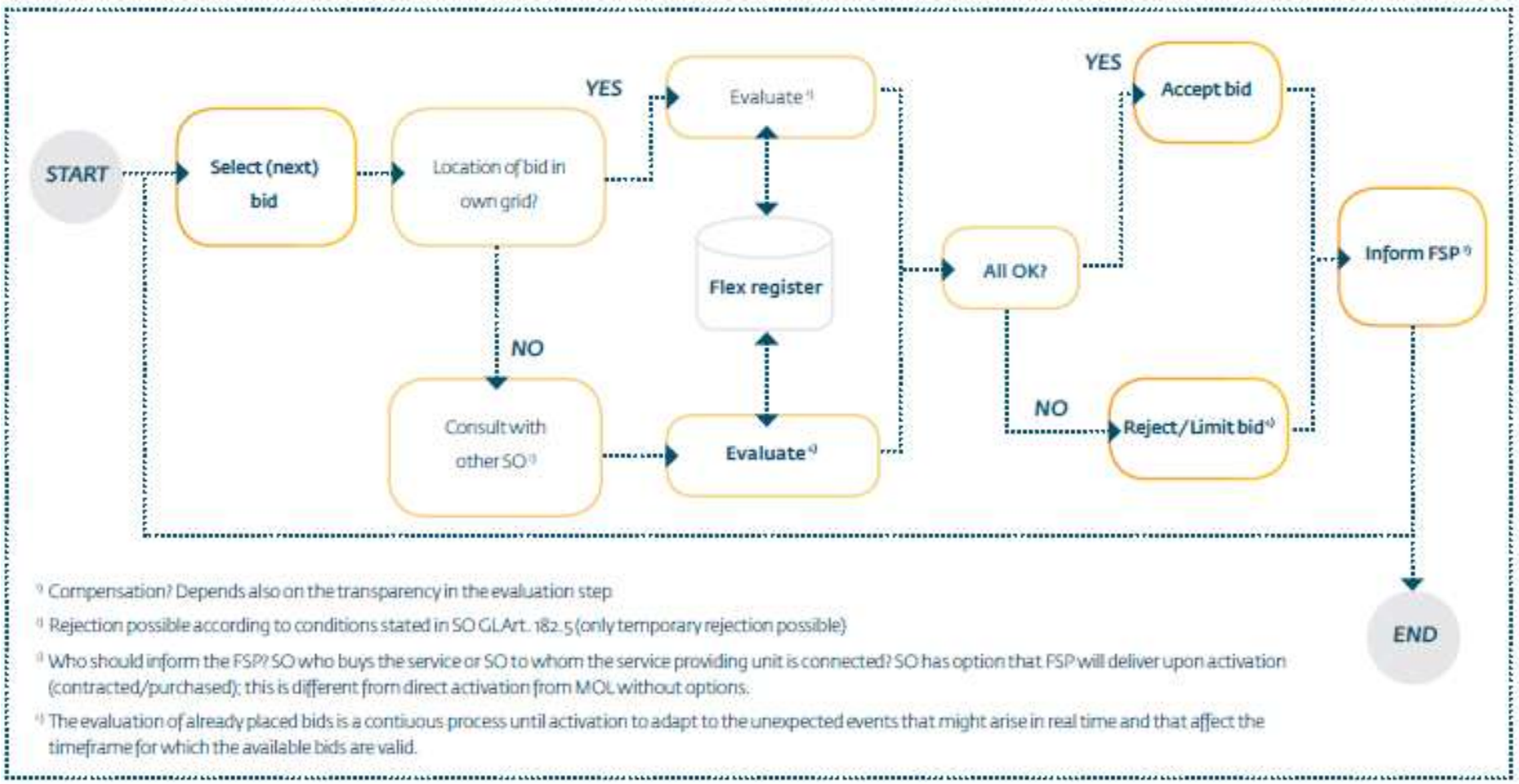


1) Select congestion area: Definition of congestion area through list of metering points/connection code (EAN) of pre-qualified connections!

2) **Identify the need for coordination with balancing and information to TSOs.** In balancing regimes with locational info balancing bids can be used for CM. Otherwise seperate MOL needs to be created with CM bids. Note: there could be other options to get locational information with portfolio-based balancing.

3) See next process (evaluate bids)

4) Lack of market liquidity!



[2] Compensation? Depends also on the transparency in the evaluation step

[1] Rejection possible according to conditions stated in SO GL Art. 182.5 (only temporary rejection possible)

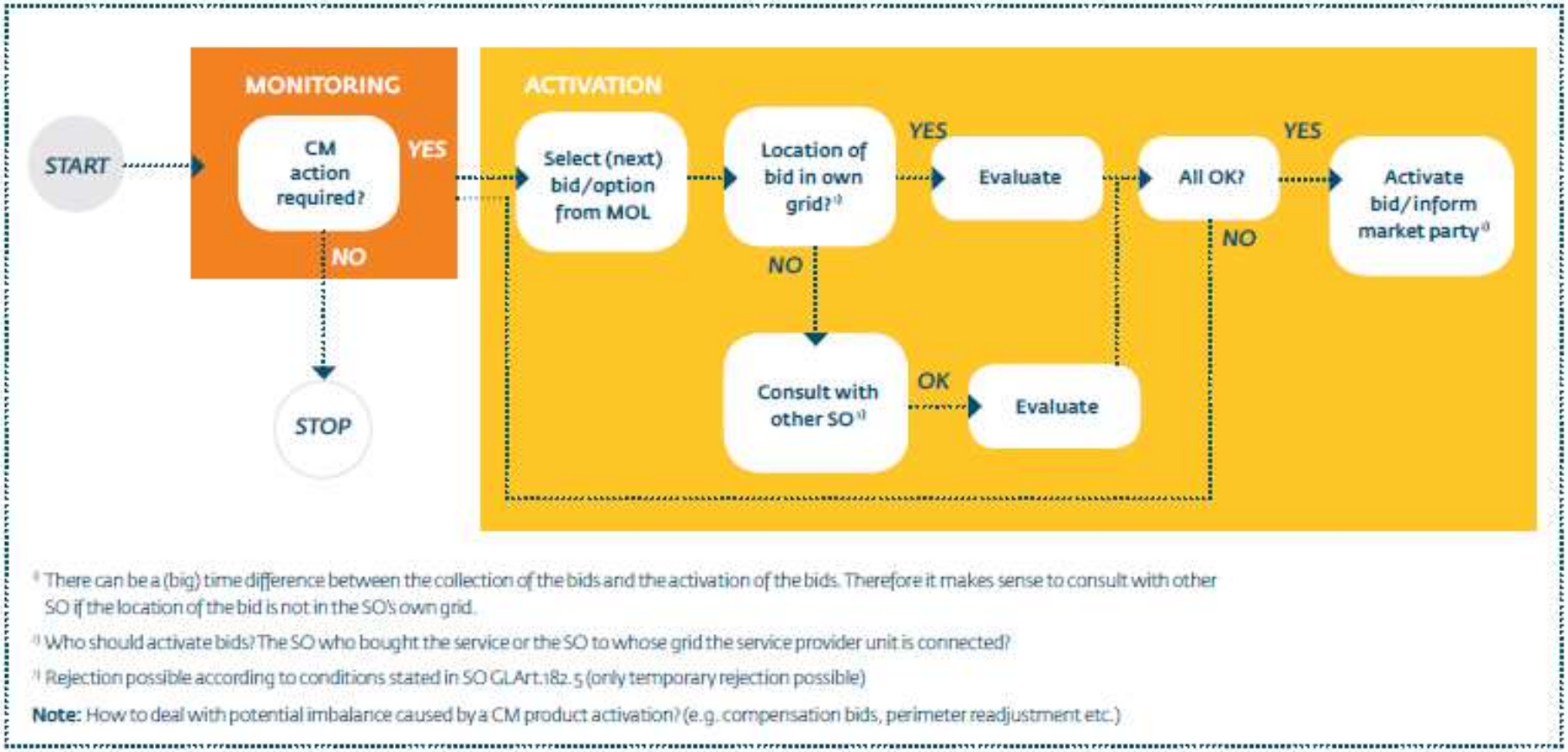
[3] Who should inform the FSP? SO who buys the service or SO to whom the service providing unit is connected? SO has option that FSP will deliver upon activation (contracted/purchased); this is different from direct activation from MOL without options.

[4] The evaluation of already placed bids is a contiuous process until activation to adapt to the unexpected events that might arise in real time and that affect the timeframe for which the available bids are valid.

Figure 5: Market phase – Evaluate bids

4. Close to real-time/real-time monitoring activation phase

Figure 6: Close to RT/RT monitoring & activation phase



[i] There can be a (big) time difference between the collection of the bids and the activation of the bids. Therefore it makes sense to consult with other SO if the location of the bid is not in the SO's own grid.

[ii] Who should activate bids? The SO who bought the service or the SO to whose grid the service provider unit is connected?

[iii] Rejection possible according to conditions stated in SO GLArt.182.5 (only temporary rejection possible)

Note: How to deal with potential imbalance caused by a CM product activation? (e.g. compensation bids, perimeter readjustment etc.)

5. Measurement & control of activation & settlement phase (validation of delivery)

When a service is delivered by an FSP, the amount of flexibility must be established, and the flexibility must be paid for by the system operator. If the service is not delivered or does not respect the agreed parameters, a penalty is possible. The amount of flexibility delivered is determined by evaluating the meter reading at the connection point and compared with a baseline or a schedule.

Baseline important when both a supplied and a FSP are active at the same time on one connection.

3. Information exchange

Information exchange should be carried out following the two objectives:

1. Avoid actions that would put operations of either transmission grid, distribution grid or system security/frequency at risk.

2. Enable the participation of market parties from all grid connection levels.

1. Flexiblity resources register

The flexibility resources register contains structural information on the location of connection points that can provide flexibility services to system operators.

The flexibility resources register would, as a minimum, contain data as agreed and evaluated in the pre-qualification process. This is technical information on the flexibility resource and includes information such as location, approved capacity limits, duration, ramp rates, mode of activation, flexibility provider, baseline information.

2. Traffic light concept

Possible method for signaling congestion in the grid.

- If the traffic light is green, there is no congestion expected.
- When the traffic light is orange, a congestion is expected. In that case the system operator requires the services from the FSPs to steer the affected area of the grid back to the green state.
- The red state is the emergency state. In this state, system operators follow different rules.

4. Products and bids

Flexibility products for portfolio optimisation, balancing and congestion management should be sufficiently aligned to permit the market-based allocation of flexibility between these different purposes with the objective of an efficient allocation that maximises the value of the flexibility services.

Should be standardized enough. Can be defined through a list of attributes – see next slide for an example.

Any product standard that can be used for congestion management must necessarily include locational information.

- Minimum/maximum bid size
- Direction of deviation (up/down)
- 'partial' or 'all or none' bid
- Minimum/maximum duration (e.g. 15 min/60 min)
- Definition of congestion point (identification of the congested area/locational information)
- Bidding period: time granted to the market parties to offer bids
- Selection period: time required by the system operator to select the bids which will be activated
- Activation period: time before activation signal and ramp up period (1 h, 15 min, 0 s)
- Maximum ramping period (15 min, 5 min, …)
- Minimum full activation period (15 min, 30 min, …)
- Mode of activation (automatic, manual)
- Availability window (per day, per week, per year)
- Frequency: Maximum number of activations (per day, per week, per year)
- Recovery time: Minimum time between activations
- Recovery conditions
- Baseline methodology
- Measurement requirements
- Unit-based or portfolio-based within a certain geographical area
- Penalty for non-delivery (fixed or dependent on the bid size and/or duration, …)
- Certificate of origin
- Level of availability of the bid (due to the uncertainty of RES)

5. Pre-qualification

Product pre-qualification. Defined as checking whether the unit can (technically) deliver the product it wants to sell/deliver.

Grid-prequalification. Defined as checking whether the grid can manage the delivery of the product that the unit wants to sell/deliver. More flexible options exist: (i) Dynamic grid pre-qualification, which re-examines the possibility of improved grid access for flexibility resources at regular intervals (ii) Conditional grid pre-qualification, which grants improved grid access for flexibility resources according to criteria clearly specified in advance.

6. Marketplace for congestion management

Key principles. Distributed flexibility resources should be used where they provide the most value to the whole electricity system, while guaranteeing quality of service and security of supply: whether it be in portfolio optimization and trading for market parties at day-ahead and intraday markets, in congestion management for solving transmission and distribution grid issues, or as balancing resources for TSOs.

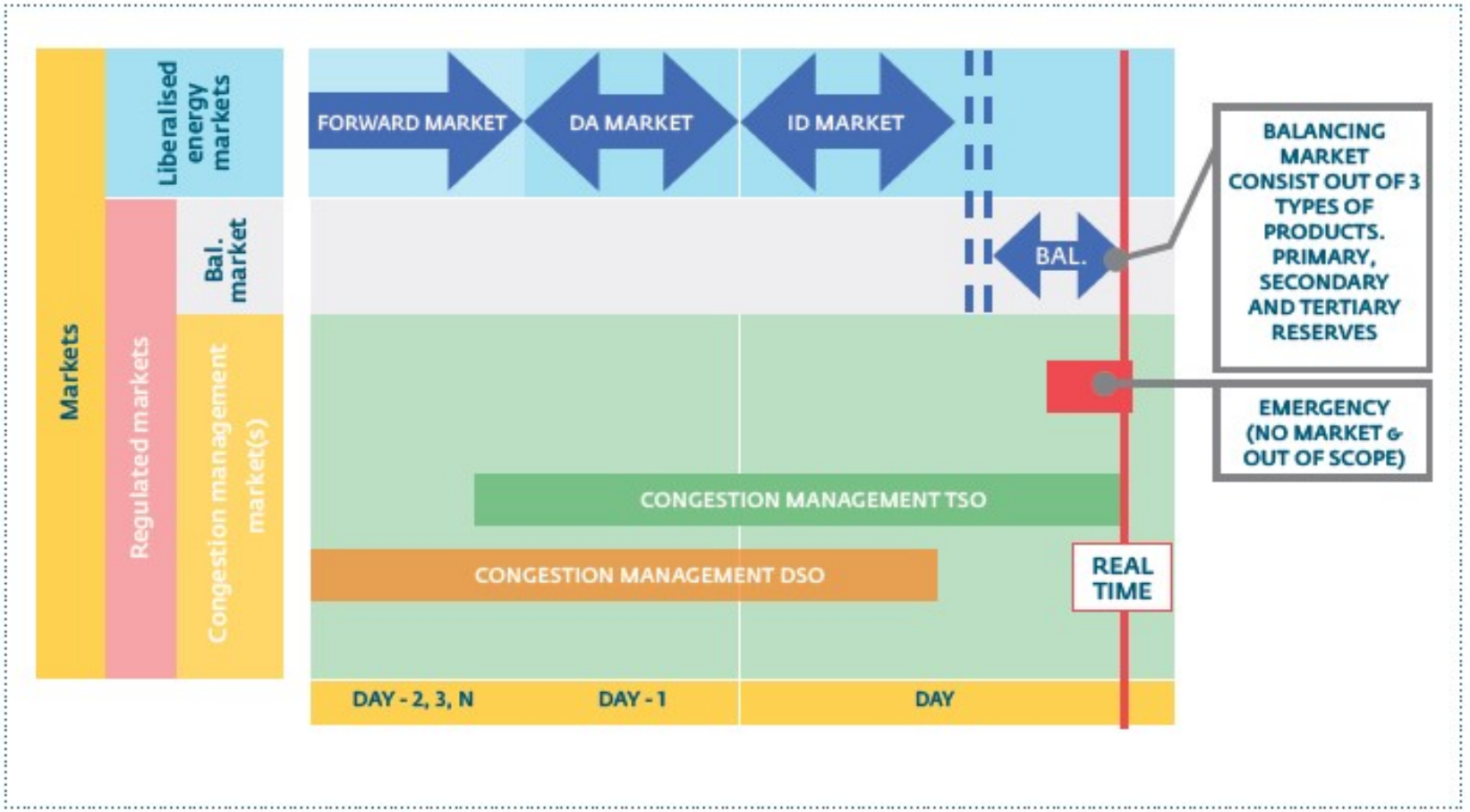
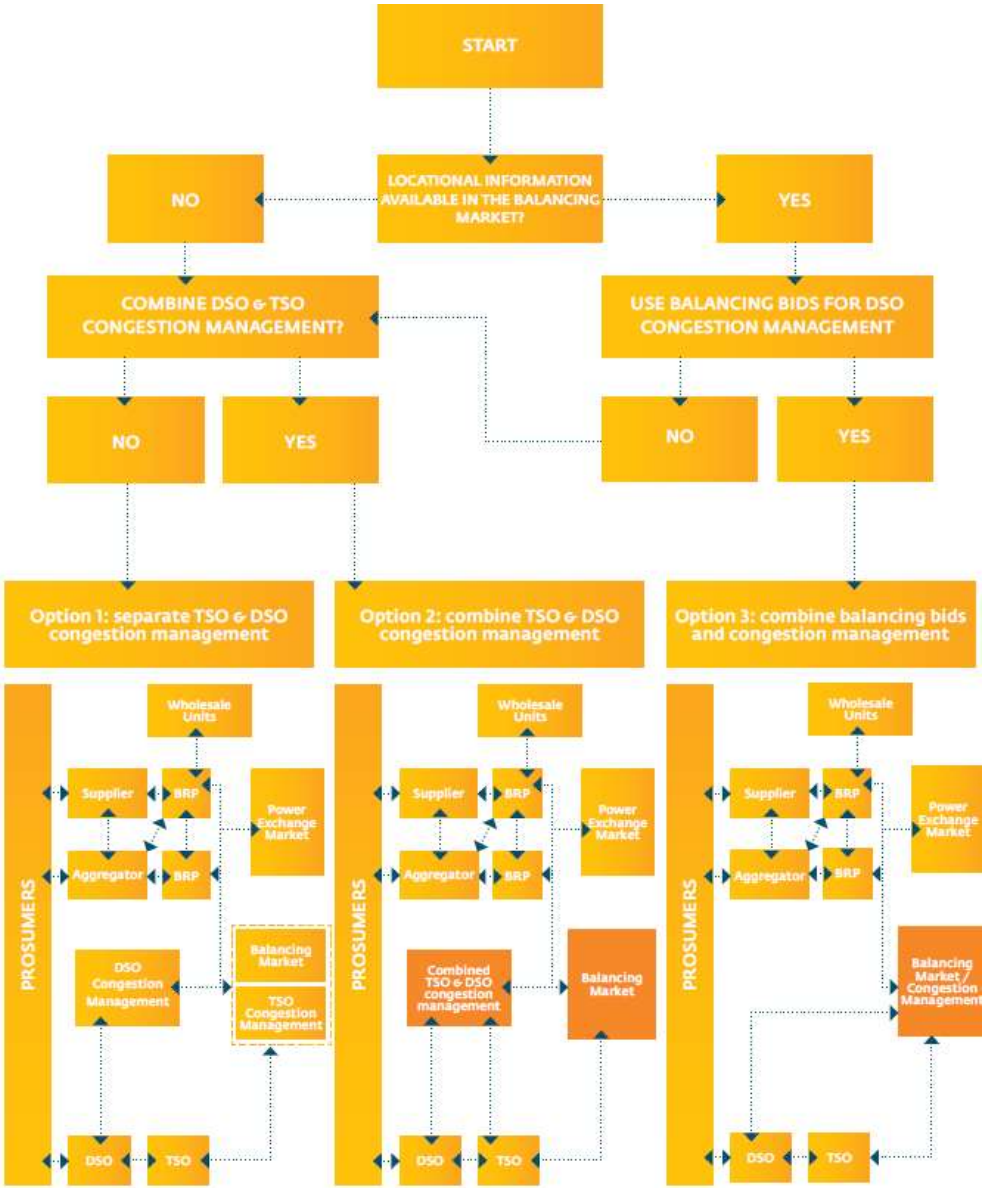


Figure 8: Different markets in the different timeframes



1. Markets models for balancing and congestion management

OPTION 1: local congestion management markets possible; coordination between market processes (CM, BM, ID) should be a focus to avoid market fragmentation in the long run.

OPTION 2: specific congestion management market process is created, gathering TSOs' and DSOs' needs, which may overlap.

OPTION 3: all balancing and congestion management bids and actions are combined in an integrated marketbased Process. Using balancing bids for congestion management is only possible when there is locational information available, as the case for example in Norway, Spain or France, to allow the combination with congestion management.

OPTION 1: SEPARATED TSO AND DSO CONGESTION MANAGEMENT

ADVANTAGES:

- Flexibility to change product requirements and timing: congestion management products can be tailored per voltage level specificities without mutual interference.
- Clear division between the two processes of balancing and congestion management.
- Separated governance (no agreement is needed between TSO and DSOs).
- Low entry barriers for small local market parties (aggregators) and technical solutions.
- Clear congestion management costs.

DISADVANTAGES:

- Probably less liquidity in small markets, and probably higher prices: market parties can only participate in the TSO or DSO congestion management market. Participation for aggregators on TSO and other DSO congestion markets is more difficult: participating in the TSO market for congestion management results in other product definitions and interfacing with other IT systems.
- Market fragmentation: when DSOs build several different local markets that are not interoperable, flexibility resources may be 'locked' in local markets (especially if long-term availability products are agreed), and therefore not available for other market services.
- Coordination between TSO and DSO is more difficult: coordination between TSO and DSO requires interaction between two MOLs. Discrepancies such as possible double activation of the same asset bidding in two separated market processes.
- Possibly extra interfaces (e.g.: IT) for existing market parties (because of different bidding systems).

OPTION 2: COMBINED TSO AND DSO CONGESTION MANAGEMENT, WITH SEPARATED BALANCING

ADVANTAGES:

- Flexibility to change product requirements and timing dedicated to congestion management.
- More flexibility and competition leading to lower costs.
- It provides a single-entry gate to market parties for congestion management services.
- Easier participation for the market parties (no coordination by themselves between two congestion management processes).
- Coordination between TSO and DSO is more efficient.
- Clear division between the two processes of balancing and congestion management and clear congestion management costs.

DISADVANTAGES:

- Need to agree on product specifications applicable for both TSO and DSO needs, which may differ.
- Governance to be shared.
- When the balancing regime contains locational information, this option could have less liquidity than in option 3 and probably higher costs for congestion bids.
- Possibly one extra systems interface (e.g.: IT) for existing market parties is required.

OPTION 3: COMBINED BALANCING AND CONGESTION MANAGEMENT FOR ALL SYSTEM OPERATORS

ADVANTAGES:

- When the balancing regime contains locational information, this option may appear as a practical answer to different challenges (at least from the TSO perspective): ensuring liquidity, building a level playing field for different service providers and allowing the coordination of different market processes such as balancing and congestion management.
- Easy access for existing market parties: existing market parties are familiar with this market, therefore, they have an easy access to the congestion management market; the product specifications and the rules for the provision of services are unique. It provides a single-entry gate to market parties for system and grid services and it avoids a myriad of markets.
- Liquidity: the balancing market is well established, therefore, the liquidity is high, however, that does not mean that every bid can be used to solve a congestion.
- Cost of congestion bids: because congestion management bids can be merged with a well-established balancing market, the costs for congestion management bids are likely to be low.

DISADVANTAGES:

- Complex governance: because the balancing market is well established and agreement between market parties, TSOs and DSOs could be complex (although this also depends on the existing scheme in each country); moreover, the implementation of European balancing platforms would add complexity.
- Complex implementation: it would require an overall optimisation and bid selection system that may be very cumbersome to achieve starting from scratch.
- Product definition: need to agree on product specifications applicable for both TSOs' and DSOs' needs, which may differ, and consider existing balancing products which cannot be changed. This excludes capacity products for congestion management.
- Mixing balancing costs and congestion management costs: clear settlement rules are needed because financing balancing and congestion bids is different. The imbalance is paid by the market party who creates the imbalance, whereas the redispatch is paid by the system operator. Mixing bids will create confusion and trigger debates from market parties.
- Timing: balancing is usually close to real time, and the congestion management process needs to start further ahead.
- It is not a solution for the Member States with a balancing regime without locational information.

2. Models for coordination between balancing and congestion management

Coordination by flexibility service providers. In option 1 and 2. The flexibility service provider chooses the market process in which to bid (could be several in parallel)and takes the responsibility to install the related devices/systems to be sure that there is coherence between all congestion management and balancing bids submitted to prevent any double activation in opposite directions.

Coordination by the party operating the market: This is the rule where the market processes are co-ordinated or combined (options 2 and 3). A flexibility service provider submits its bids only once, and the market process ensures it is used where most valued through coordination or combination of MOLs. Two main options for coordination:

(i) Skipping bids: In case the activation of a specific balancing bid can cause a congestion (only possible to know when locational information is available), the balancing bid could be skipped in the MOL and the next cheapest bid activated instead.

(ii) Co-optimisation of the processes: When both congestion management and balancing are performed in the same timeframe, an overall assessment can be done using both balancing and congestion management bids.

3. Options for counterbalancing congestion management actions

Three possible option for doing it: (i) the service provide (if possible) (ii) the system operator using the flexibility product (TSO or DS0) (iii) the TSO.

With option (ii), we could prevent a correction that directly contravenes the original product, for example by being activated in the same area that is affected by the congestion. This option is often used in the current systems of redispatch for congestion management on the TSO level if the market party cannot compensate by itself because the transport prognoses are fixed.

7. Implementation of market platform options

A digital platform in this context is defined as a (distributed) software functionality, needed by actors to perform their tasks, corresponding to their roles and responsibilities, which as part of an ecosystem interacts with other relevant actors in the energy system.

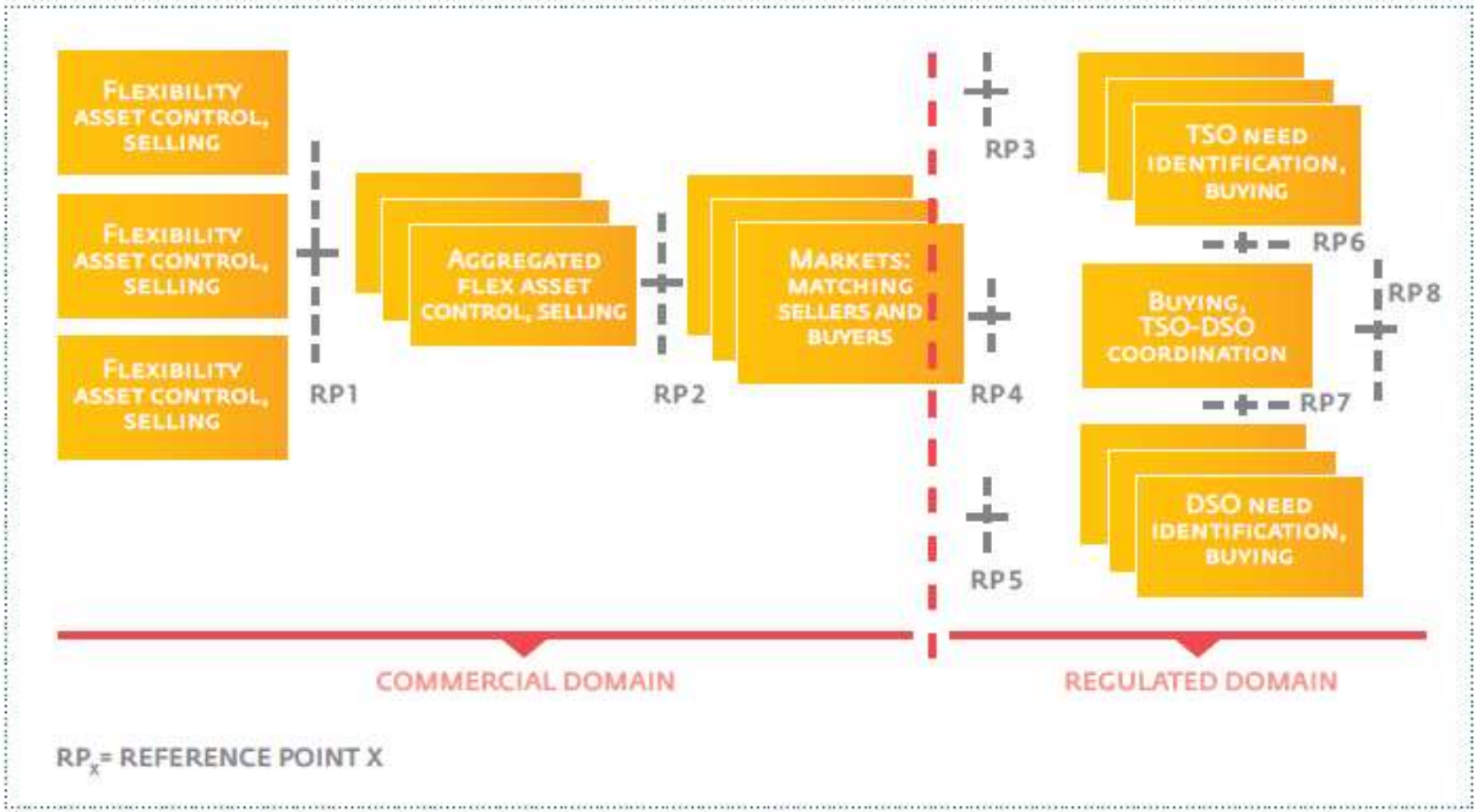


Figure 11: Reference points (RPs) identifying data exchanges in both the commercial and regulated domain

Platform options in the regulated domain:

OPTION A:

DSOs and TSOs interact via their own separately developed platforms (D-CM, T-CM, BAL platforms) with FSPs in the market, directly or via market trading platforms (e.g. in the day-ahead or the intraday timeframe). Coordination between TSOs and DSOs is realised by direct information exchange between these platforms.

OPTION B:

DSOs interact with FSPs in the market directly or via market trading platforms through their own separate platform (D-CM), and the TSO uses the balancing platform also for T-CM. Coordination between TSOs and DSOs is realised by direct information exchange between these platforms.

OPTION C:

DSOs and TSOs interact with the market via a combined platform for D-CM and T-CM, through which TSO–DSO coordination for congestion management might also be realised (e.g. algorithms to avoid conflicts and double-dispatch of flexibility). TSOs operate a separate platform for balancing. The coordination between TSOs and DSOs is realised by direct information exchange between the balancing and congestion management platforms.

OPTION D:

TSOs and DSO interact with market FSPs or market trading platforms via a joint platform for D-CM, T-CM and BAL. This platform could still consist of decentralised TSO and DSO data requirements and a defined and secured data exchange.

PART II

Summary of the consumer-centric market design.

From a market model made for today's reality

Epicenter around the Supplier

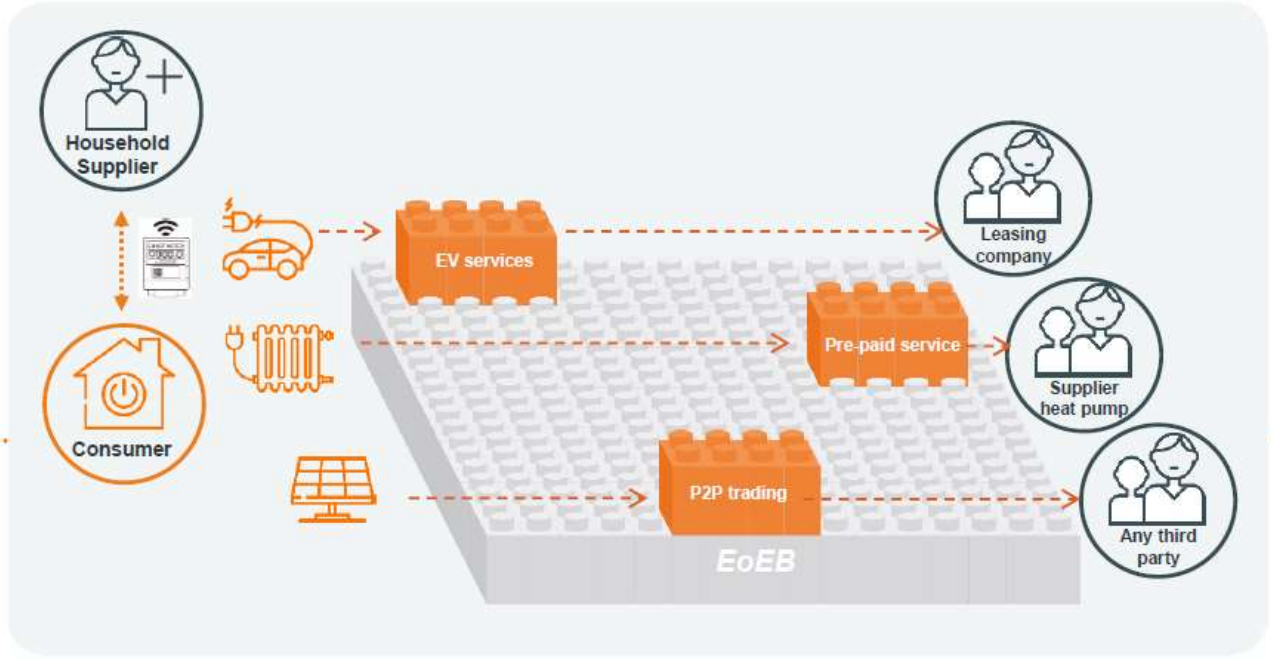
Supplier Centric

End-consumer must delegate all responsibility to BRP/Supplier in order to inject or offtake electricity

- **Passive end consumers**
  Consumers not allowed to exchange electricity with other parties without supplier/BRP consent
- **Limited degree of freedom**
  One party (supplier) is handling / optimising all load on access point level. Not possible to perform P2P trading or have multiple suppliers per access point.
- **High entry barriers for new entrants**
  New players need workaround to develop new services and face complex mechanism (e.g. Transfer of Energy).

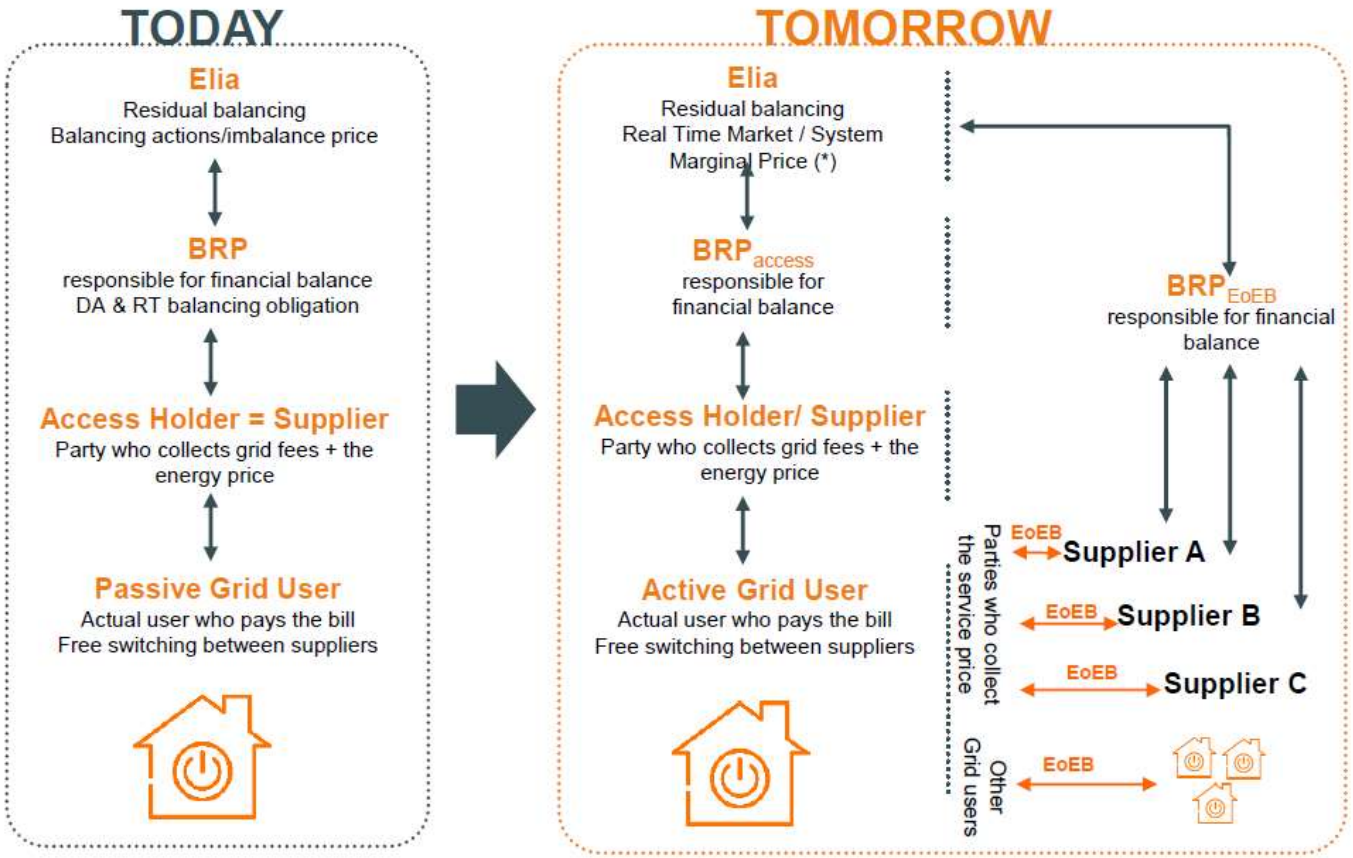
With the “Exchange of Energy Blocks” (EEoB) as key digital enabler

Allowing consumers to consume, produce or trade energy the way they want



- **Regulated infrastructure** accessible to any grid user and market party
- **Giving freedom to consumers** to enter into commercial relations with parties (inc. other consumers), and get access to multitude of services behind the meter on appliance level
- **Transactional mechanism** allowing multiple service providers without requiring standardised sub-metering or complex data validation

A gradual evolution to our target model



New market model

- **Keeping the same functional roles** as in the current market model but;
- **Changes relations** between the different roles in the market and;
- **Give grid users freedom** to engage in services and transaction with multiple parties via an "Exchange of Energy Block"

(* incl possibly price adders)

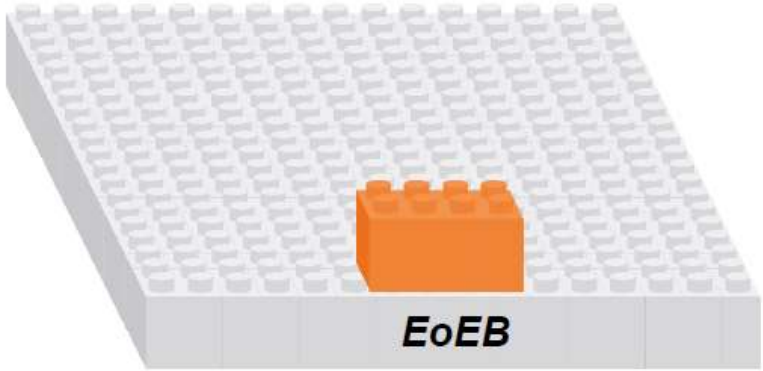
Allowing consumers to keep one single supplier

BRP Access Holder = Supplier A

Party who collects grid fees (+ settles the open position of grid users at real-time price)

Grid User

Actual user who pays the bill & has default financial balancing obligation



No 3th Party

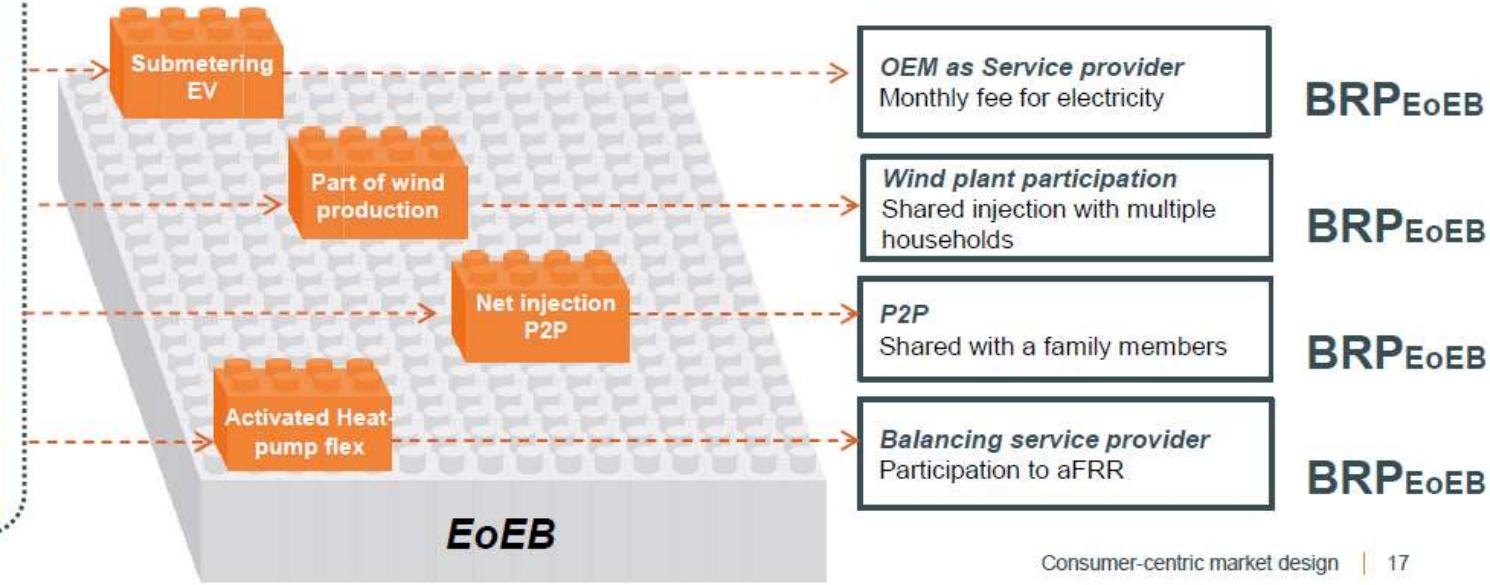
Or go for multiple services & providers

BRP Access Holder

Party who collects grid fees (+ settles the open position of grid users at real-time price)

Grid User

Actual user who pays the bill & has default financial balancing obligation



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