White Paper

Flexibility Platforms

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This publication is partly based on interviews we have conducted with representatives from the three examined initiatives.

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While we have tried to capture and reflect all perspectives and views on emerging flexibility markets, the final product is a USEF publication and should be considered as expressing USEF's point-of-view only.

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1 Introduction

The rise of renewables and general shift towards electrification are dictating a need for demand-side flexibility (DSF), where prosumers could be rewarded for deciding that part of their energy use is either not critical or not time dependent. If this flexibility is pooled, it can be used for better balancing of supply and demand, and to solve a wide range of problems experienced by system operators, such as avoiding congestion and avoiding or deferring grid reinforcements. This approach creates a more efficient and cost-effective system.

Where flexibility was traditionally delivered by large utilities, utilizing central power plants for (e.g.) balancing or congestion management services, increasingly smaller organisations and end-users are seeking to valorise their flexibility. This is strongly supported by the EC, whose 'Clean energy for all Europeans' package dictates that end-users should have access to all organized markets and products, either directly ('explicit demand response'), or indirectly through variable energy retail prices ('implicit demand response').

With strong growth in the numbers of flexibility providers (resulting from end-user access to energy markets), and an increasing number of flexibility requesters (i.e. DSOs), the concept of the *flexibility platform* emerges. In this paper, a flexibility platform is defined as an IT platform capable of facilitating and coordinating the trade, dispatch and/or settlement of demand-side flexibility. The paper begins by identifying the different types of flexibility platform and then focuses on market places allowing different market players to participate and trade different products.

1.1 Definitions

Before diving into flexibility platforms, let's first explain what we mean by flexibility:

Flexibility is the ability to purposely deviate from a planned / normal generation or consumption pattern. This ability can be deployed either directly, by an external signal, or indirectly as a response to a financial incentive such as energy prices and tariffs. Explicit flexibility can be **remunerated** in three ways:

- payment for guaranteed availability based on available power(MW)
- payment for energy transaction, triggered by the activation and based on the amount of activated energy (MWh)
- payment for activation as a service, possibly remunerated in proportion with the amount of activated energy (MWh)

Flexibility is an ability; its actual value is only determined when it is applied in a specific product. For example, flexibility traded in wholesale markets takes the form of an energy block; flexibility used for Frequency Containment Reserves (FCR) transforms into regulating power. Flexibility is always sold in the context of a specific product rather than as a separate commodity.

A **flexibility platform** is an **IT platform** where the trading, dispatch and / or settlement of flexibility is facilitated or coordinated.

1.2 Existing and emerging flexibility platforms

Many initiatives focused on (demand-side) flexibility either design or create flexibility platforms but these can have quite different objectives e.g. as a market place, market facilitation, virtual power plant, TSO-DSO coordination, etc. As a result, it is easy to get confused about their purpose and function(s). The table below aims to provide clarity by categorising flexibility platforms by type.

Category	Main functionality	Current use	Future use
Market platform	Place where buyers and sellers of flexibility meet to trade flexibility.	Power exchanges provide platforms where buyers and sellers of energy can close deals anonymously. Currently, only energy traders (BRPs) use these platforms, and the product is limited to blocks of energy (+ derivatives). Esp. intraday markets provide increasing opportunities for flexible resources.	Flexibility products with specific characteristics may be developed, targeting e.g. the TSO or DSO as a customer.

Category	Main functionality	Current use	Future use
TSO or DSO operational platform	Platform to operate balancing or grid management mechanism. Here flexibility can be offered as part of TSO or DSO ancillary services.	TSO is currently acquiring flexibility for its balancing products (via balancing platform), as well as for congestion management (via congestion management platform).	The DNO is expected to transform into a DSO, where flexibility is acquired from the market (next to other mechanisms) for Active System Management (ASM).
TSO / DSO coordination platform	Platform where TSOs and DSOs coordinate the tendering, trading, activation and/or settlement of flexibility for their own purposes (i.e. ancillary services).	Not yet in existence as the use of flexibility by the DSO is not yet common practice. However, the topic of TSO-DSO coordination on ASM is a subject to attention throughout Europe.	This platform can facilitate the interaction between the DSO and TSO, ensuring that the objectives of both roles are taken into account and the use of flexibility for system purposes happens efficiently and effectively, without mutual harmful interferences.
Market facilitation platform (a.k.a. data exchange / data hub)	To support the commercial energy market through gathering, validating, enriching, storing and distributing market data, as well as wholesale settlement.	Currently both wholesale and retail processes (e.g. customer switching) are facilitated by neutral parties, typically TSOs and DSOs. In some member states, a central data hub is operational.	Flexibility processes, such as the coordination of flexibility deployment, measurement, validation and settlement of flexibility services need to be facilitated by a 'flex register'. The concept of value stacking[1] provides a strong argument for a central platform.
Technology platform / VPP / MicroGrid Controller	Platform to monitor and control flexible assets in a confined portfolio or location, possibly combining several control objectives, yet operated by a single (market) party.	Several trials study flexibility platforms as a means to optimize wholesale markets and system operations through combined optimizing models. Although relevant on smaller scale (e.g. on islands or grids in island-mode), this technology is normally not scalable to national level.	Different optimization objectives typically meet at the service provider, who is serving different customers at the same time. Therefore, the Aggregator is typically the operator of such a platform, to optimize its portfolio and to monitor and control flexible assets.
Community Services platform	Platform to support a community, often within a regional boundary, to facilitate P2P trading and local optimization (often in the context of sustainability).	Local energy communities are emerging fast in the EU. Next to investment in local renewable energy sources, local optimization based on P2P trading is also being pursued. Platforms are primarily focused on energy generation and supply.	Flexibility will mostly become relevant in relation to optimizing self-consumption within the community. With a lack of earning (or cost coverage) models for local self-consumption, scalability is low.

[1] *Cf.* USEF's white paper *Flexibility Value Stacking 2018 - Recommended processes, rules and interactions to enable value stacking for portfolios of flexible demand-side resources*

Category	Main functionality	Current use	Future use
BRP/Supplier trading platform	Platforms run by BRPs / energy Suppliers to allow customers to source their energy.	Several Suppliers, using pass-through contracts, offer their (large) customers direct access to futures and spot markets without the need to become a Balance Responsible Party. Even balancing costs (and benefits) can be transferred to the customer.	A well-proven mechanism for implicit demand-side flexibility but there is uncertainty about whether these platforms will also move towards explicit mechanisms (DSO/TSO ancillary services).
Energy Management platform	Platform that controls devices and appliances within the home, building or factory.	Many EMS solutions are available, either integrated with thermostat, dedicated device or implemented in a cloud environment.	EMSs are expected to increasingly interact with technology (Aggregator) platforms and trading platforms.

Table 1: Categorisation of flexibility platforms

1.3 Scope of this paper

The USEF framework describes a system in which flexibility can be standardized and traded without dictating how, and where, this trading should take place (bilateral or through an exchange). USEF's flexibility value chain shows how demand-side flexibility can be sold in different markets and products through explicit mechanisms. Currently, most markets and products within the value chain are operated on separate platforms. Integrating markets and products on platforms may bring advantages, as well as separating the market operator role from the product owner (TSO and DSO). As flexibility market platforms continue to emerge, we aim to describe their possible value and limits and, in turn, address the concept as a whole within a USEF context. The questions that we want to address in this paper are:

- What benefits can be gained from using a flexibility market platform?
- Which flexibility market platforms are being developed within the EU and what are their main characteristics?
- What is the relationship between flexibility market platforms and USEF, and what value can USEF offer to the further development of the concept?

2 Market platforms for flexibility

2.1 Understanding the position of market platforms

The flexibility value chain is introduced in USEF's white paper *Flexibility Value Chain* (update 2018) with top level visualization shown below in Figure 1. This is a simplified version as it does not demonstrate all applications e.g. flexibility can also be used in adequacy mechanisms.

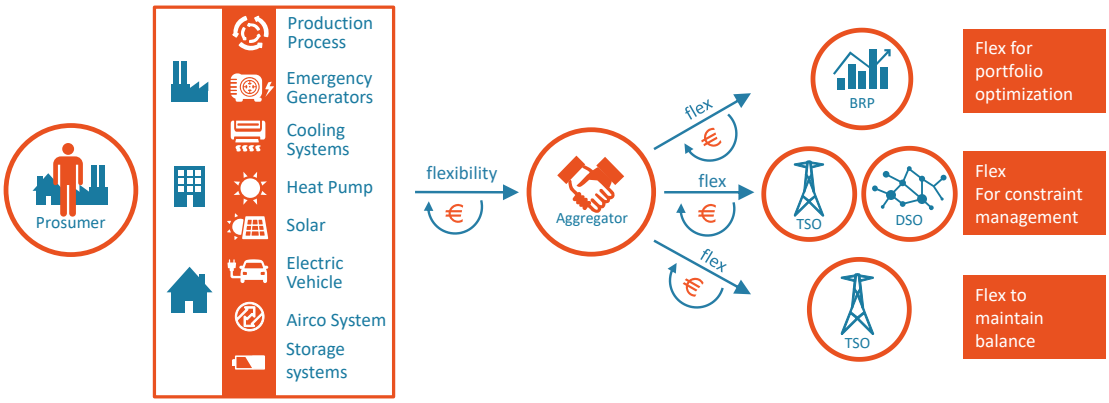


Figure 1: Flexibility value chain

In our definition (see also our list of definitions in Appendix B – glossary), *grid management* includes both *congestion management* (regulated mechanism imposing trade and/or dispatch restrictions, possibly non-voluntarily) and *grid capacity management* (using flexibility as an alternative to grid reinforcement without trade or dispatch restrictions and always offered on voluntary basis). *Ancillary services* include both *balancing* services and *grid management* services.

The flexibility value chain itself does not show platforms as it is focused on roles. However, these platforms can be plotted, by examining which roles operate which platforms for their own products.

We start by examining how flexibility is currently traded within existing markets and products. In most EU member states, all markets and products are operated on separate platforms as shown in Figure 2. The *Balancing platform* and *Congestion management platforms* are both regarded as TSO operational platforms (cf. Table 1).

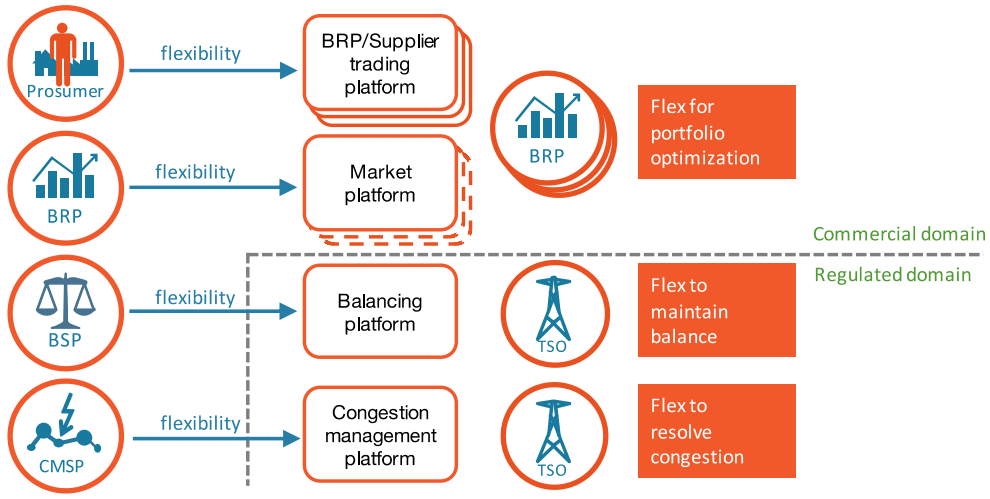


Figure 2: Current flexibility services

The market platforms shown in Figure 2 are operated by power exchanges or Nominated Electricity Market Operators (NEMOs). Currently, congestion management services are typically provided by a BRP. As congestion/capacity services demand specific functions, USEF proposes the introduction of the Congestion / Capacity Management Service Provider role (*CMSP*) as an analogy to the Balancing Service Provider (BSP) role.
Market parties combining the roles of BRP and BSP already face the complexity of needing to interface with different platforms, although their numbers are relatively small (at least on a national level).

The products and markets shown in Figure 2 are traditionally served by flexible central generation units e.g. gas-fired power plants. The increasing need for flexibility (mainly caused by RES) and declining availability of central flexibility mean that there will be a strong need and incentive for DSF in these markets and this is where the role of *Aggregator* emerges - to contract and operate DSF with end-users, and pool flexibility to optimize a portfolio of flexible assets.

Figure 3 shows how an Aggregator can participate in existing markets provided the technical characteristics of these products allow DSF to participate.

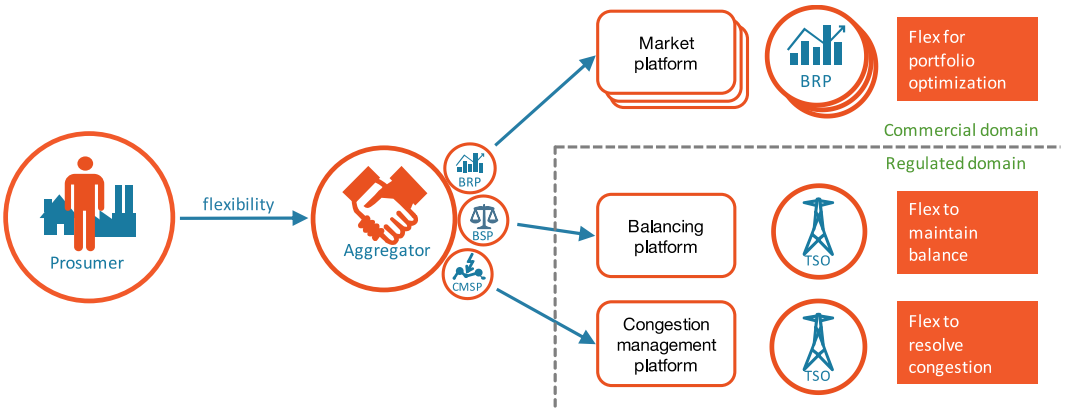


Figure 3: Aggregator accessing existing markets and products

USEF positions the Aggregator *role* on the retail side. If an Aggregator *market party* wishes to access wholesale markets or balancing / congestion management products, it should combine the *role* of Aggregator with BRP, BSP and / or CMSP[2] (or outsource this role).
Note that the BRP/Supplier platforms are not shown in this figure since these platforms allow end-users (indirect) access to wholesale markets through implicit mechanisms. An Aggregator selling aggregated flexibility (often not limited to the portfolio of one single Supplier) through explicit mechanisms is not likely to access this specific type of platform.

2.2 Options when DSOs start acquiring grid management services

Developments like the electrification of heat and transport, and distributed generation, are expected to have significant impact on the peak loads in distribution grids. DSOs are currently exploring the use of flexibility as a (mostly temporary) alternative to grid reinforcement, with two main drivers:

- Flexibility may prove to be more cost efficient, providing financial benefits associated with the deferral of grid reinforcement (also mandated by the European Commission's *Clean energy for all Europeans* package, Electricity Directive Article 32).
- Due to decentralisation of generation and the electrification of both heat demand and transportation, DSOs and TSOs may not have the capacity to reinforce the grid at the required pace and will therefore need alternatives to bridge the gap.

As with TSO grid management, a platform will be required to enable each DSO to acquire grid management services. The next subsections describe three possible scenarios for the development of these platforms:

[2] *Note that when active in balancing services (BSP role) or grid management services (CMSP role), the Aggregator still needs to take (or assign) balance responsibility, dependent on the* Aggregator Implementation Model *(*cf. *USEF work stream on aggregator implementation models) used for that product.*

- Option 1: DSO will operate its own platform, similar to current TSO-operated platforms for balancing
- Option 2: A single market platform will be developed and operated
- Option 3: Multiple market platforms will be developed and operated by third parties

2.2.1 Option 1: Separate platforms

If all DSOs develop their own flexibility platform, the architecture below will be created (this figure assumes that the TSO will perform grid capacity management as well as congestion management).

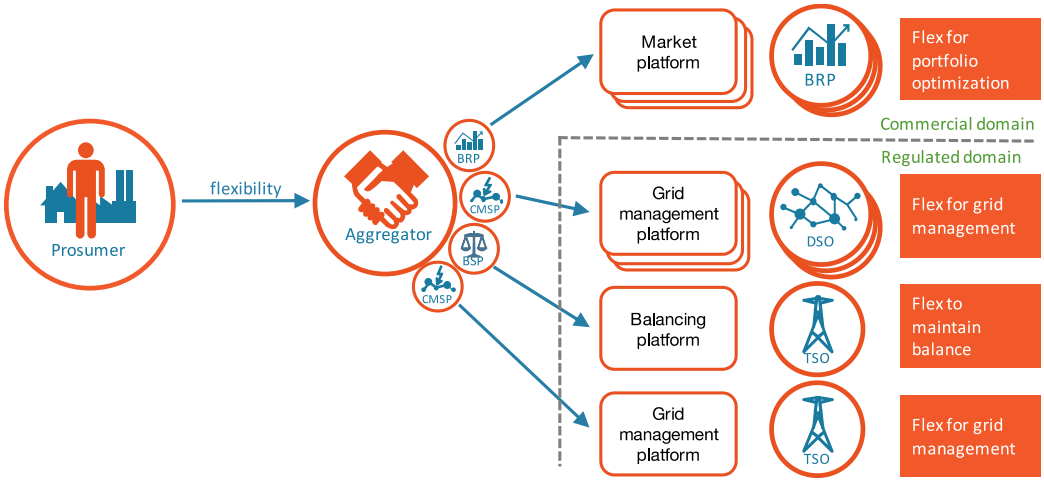


Figure 4: Option 1: Separate platforms for all markets and products

As DSOs have only just begun exploring the possibilities of DSF for grid management, developing an own platform seems like a logical start, especially since in the short-term the emphasis will be on acquiring availability rather than creating liquid intraday markets. It will also offer the DSO the opportunity to design a product that favours its own specific needs.
Longer-term, this could lead to both high IT costs for the Aggregator and DSO, and fragmentation of flexibility over different markets and products. The knock-on effect would be inefficient markets, where coordination of grid operators could prove challenging, and this would be exacerbated at a European (internal) market level.

Several markets players in Europe, the current Power Exchanges (electricity market operators) in particular, realise that they could play an important role in helping to avoid the fragmentation of flexibility supply and ensure cost efficiency, as they can provide a market place for both wholesale market players to buy and sell flexibility, and for ancillary services. Quite how this should be organized, especially considering the clear separation of regulated and commercial activities, is not yet clear. Options 2 and 3 examine possible structures for integration models.

2.2.2 Option 2: Fully integrated platform

In this option the Aggregator, in the role of Flexibility Service Provider (FSP)[3], only needs to access a single integrated platform to offer its flexibility. Both the power exchange and all regulated products are combined in one platform.
This option raises a question about whether only one platform is allowed (per bidding zone, country, synchronous area or even EU), or multiple platforms.

- If the answer is a single platform (one system approach), the platform function should be regulated which also implies regulation of power exchanges, a direction not supported by the EC[4]. This approach would also require a level of harmonisation across products and market organisation which may not be feasible in the short-term.
- If multiple integrated platforms are allowed, how does the TSO manage its balancing product across the different platforms? Balancing per platform is inefficient/ suboptimal and balancing across all platforms would require an additional platform, moving the concept away from the integrated platform concept.

[3] *The FSP role is a generalization, since the FSP role will be either a BRP, BSP or CMSP role, depending on the service delivered.*
[4] Cf. Commission regulation (EU) 1222/2015 establishing a guideline on capacity allocation and congestion management

Although several academic and H2020 projects study the possibilities of integrated platforms (cf. Table 1), we believe this is not a suitable solution for functional, deregulated markets.

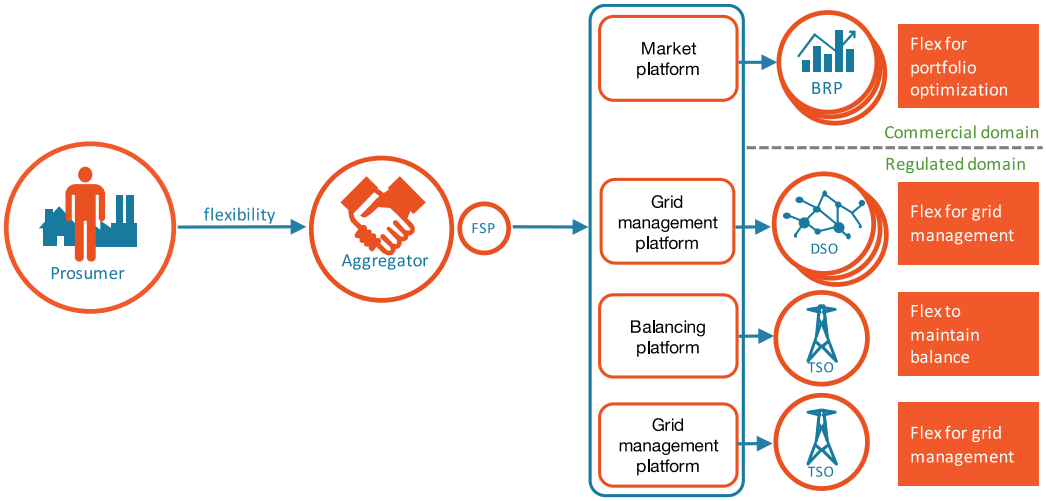


Figure 5 Option 2: Fully integrated platform

2.2.3 Option 3: Market platforms as a gateway to ancillary services

In this option, the Aggregator (in the role of FSP) can access a single market platform to offer its flexibility to different buyers. There are still competing market platform operators so the Aggregator may either need to choose between the different platforms, or connect to several market platforms, although there are fewer connected platforms than in option 1, as shown in Figure 4. This option may therefore reduce the fragmentation of flexibility over the different markets and reduce costs for all parties involved.

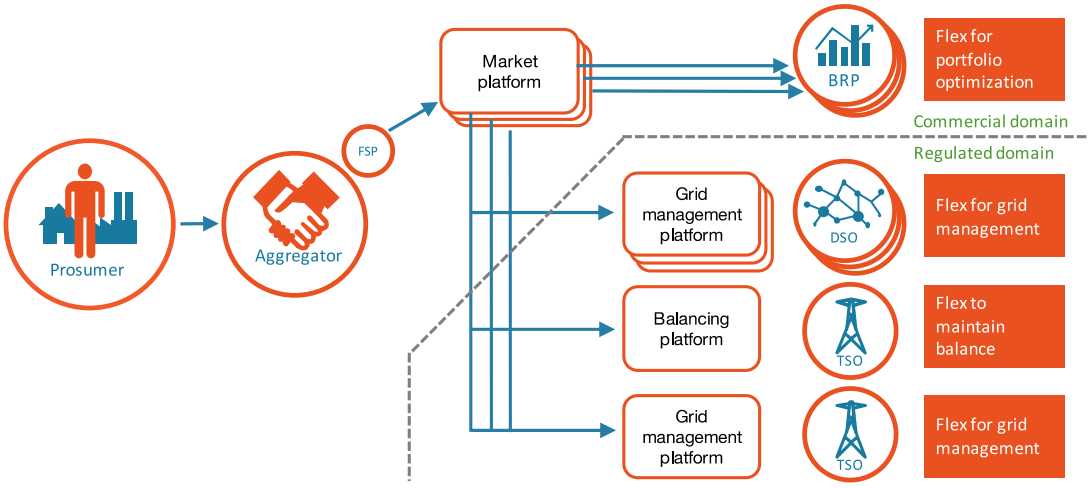


Figure 6 Option 3: Market platform as gateway to ancillary services

The market platform provides a gateway to balancing and grid management for TSO and DSO. Both maintain their own 'platforms' (which are effectively internal IT systems, inaccessible to other market parties).

2.3 The coordination of flexibility

While the DSO increasingly needs to use flexibility for grid management, the TSO realizes that an increasing part of its own flexibility requirement will be delivered by assets connected to distribution grids. The result is a compelling need and incentive to coordinate the use of flexibility between the TSO and DSO. Although the topic of TSO-DSO coordination can be considered separately from the development of flexibility market platforms, we do believe it is relevant to explain how the associated platforms relate. The focus will be on option 3, although TSO-DSO coordination can also be considered without the use of flexibility market platforms (i.e. in option 1).

2.3.1 Market platforms as a gateway to coordinated ancillary services

The figure below depicts the interaction between market platforms and ancillary services, when the requests from TSO and DSO to the market occur through a coordinated mechanism. For now, balancing is excluded from this coordination mechanism because integrating and coordinating a (real-time) balancing product is more complicated than integrating two (intraday) grid management products. Integrating balancing and congestion management is also complex because cost allocations for balancing and redispatch differ.

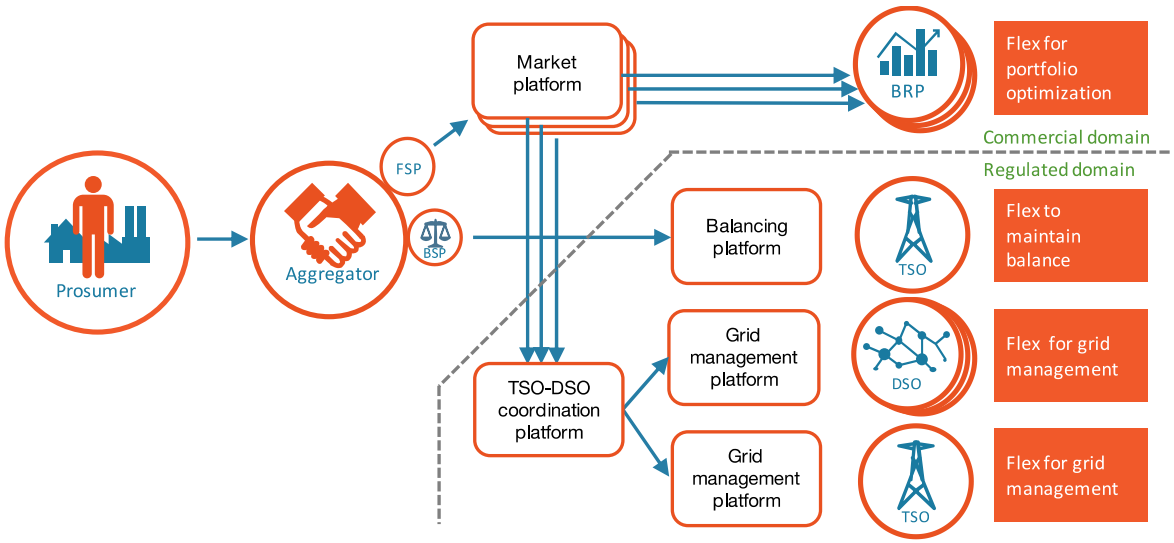


Figure 7: Option 3 including TSO-DSO coordination: Market platforms as a gateway to integrated ancillary services

Conceptually, this model seems more attractive than option 3, without TSO-DSO coordination, as there are fewer interface types between the market platform and ancillary services. The basic idea is that the platform allows the TSOs and DSOs to coordinate their need for, and activation of, flexibility, ensuring that the request of one flexibility requesting party (FRP) does not have a negative impact on another regulated party (e.g. activation on the request of the TSO leading to congestion in the MV grid).

Several hybrid forms of options 1 and 3 with full/partial/no TSO-DSO coordination are possible (at least in theory) e.g. Figure 7 with the market platform interacting with balancing products. This paper focuses on the variant where balancing products are kept outside the coordination mechanism and are not supported by market platforms as this seems the most viable option in the short to medium term.
The figure also suggests that market platforms can connect to intraday wholesale markets and ancillary services at the same time. To what extent this is viable will be examined in our analysis of three case studies.

While integrating grid management services (in terms of composing coordinated requests for flexibility to the market rather than product integration) in a single platform seems a promising solution, several caveats are required:

- It is important to maintain the overall market functioning and transparency. If, for example, an asset is not activated for a grid management service in one area as the activation may lead to grid congestion in another area, the CMSP

operating this asset may be prevented from obtaining revenues without even knowing it. This caveat applies to capacity management but less so to congestion management, as the congestion management mechanism may include dispatch restrictions that will obstruct this arbitrage option anyway.

- Combining TSO and DSO grid capacity management on one platform seems an easy way to coordinate the use of flexibility within these services. However, the exact rules on who takes precedence in activating a resource, and for what purpose, still need to be defined. The complexity increases when capacity management is also included, as the regulatory framework for grid capacity management (that has yet to be developed by member states as mandated by the Clean Energy package) may be fundamentally different compared to congestion management (copper plate vs. trade and / or dispatch restrictions). Therefore, USEF advises that there is agreement on roles, responsibilities and coordination principles before discussing the implementation of a joint IT platform for grid management.
- The coordination of flexibility use cannot be limited to the TSO and DSO only because (even in real-time) that same flexibility could also be used by other market parties e.g. a BRP for passive balancing or portfolio balancing, or a consumer for optimizing self-consumption. As a result, there is a need for a market coordination mechanism for flexibility, which is included in the USEF framework.
- Without involving market parties in flexibility coordination, the TSO-DSO coordination will (effectively) lead to the need for unit-based grid management services, strongly affecting the BSP's business case and excluding specific technologies from participating (e.g. EV charging). USEF recommends portfolio offers in all organised markets and products, even in location-specific services (meaning that these offers should relate to a congestion point, rather than the location of an asset).

The concept of TSO-DSO coordination platforms may even fuel the discussion about an Independent System Operator. This is specifically relevant for smaller DNO's as transforming into a system operator presents challenges due to their size.

Since this white paper focuses on the role/function of market platforms, as well as the interaction between market platforms and ancillary services, both options (with and without TSO-DSO coordination) will be addressed in this paper.

2.4 Our view on the possible benefits of market platforms

Market operators can support TSOs and DSOs in procuring ancillary services by allowing them to buy energy or services from FSPs, especially during the intraday (ID) timeframe. To facilitate this, offers on these market platforms need to include additional information when compared with flexibility offers in the ID wholesale market. The most obvious attribute is locational information (for congestion and capacity management) but also technical requirements (e.g. ramp rate) may need to be added.

To contract, operate and settle an ancillary service, the buyer of the service will still need to operate his products within his own IT system as the market platform is primarily focused on bringing buyers and sellers together. Some examples of functionality that we expect on the DSO/TSO side are: TSO-DSO coordination, prequalification, forecasting of the flexibility need and product settlement (physical settlement). Section 4.3 will describe how the functionality can be split between the market platform and the operational platforms.

The following benefits are expected to result from the setup with market places as presented in option 3 (Figure 6), compared to the situation where both TSO and DSO organize their own flexibility market places separately (option 1, cf. Figure 4):

- Both flexibility providers and buyers may face lower transaction costs as flexibility market platforms are more concentrated, well organised and competitive.
- The integration costs with flexibility platforms will decrease for both Aggregators and system operators by concentrating flexibility on a limited number of market places.
- The market liquidity will increase as flexibility is not fragmented over many smaller flexibility platforms.
- Higher transparency as prices for TSO and DSO products are transparent and may attract new flexibility service providers and stimulate more investments to unlock DSF. This will improve the overall market functioning, where the market price reflects actual availability or scarcity of flexibility.
- The market operator role is separated from the flexibility buyer role (i.e. DSO and TSO), ensuring neutrality between buyer and seller.

- Independent market operators are well positioned to monitor that no single market participant will dominate the market.
- As well as price transparency, volume and location transparency can feed into the TSO's and DSO's system operations, improving the efficiency of the planning, grid safety analysis and procurement of flexibility.

However, not all potential benefits are easy to reap:

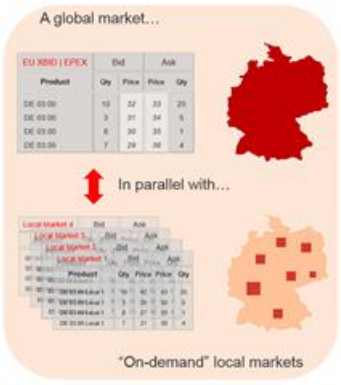
- Lowering the costs for ancillary services is not straightforward - see our analysis in section 4.2.3
- Unlike generation, both load and storage may come with a rebound effect - when devices offer flexibility to a congestion management product in one ISP, they may need to recuperate the energy in the next ISP which could lead to congestion in the next ISP. Therefore, the TSO/DSO may wish to select offers based on the rebound characteristics and these may be difficult to specify in an offer to the market place, especially when further integration with ID wholesale markets is foreseen.
- In Figure 2, the BRP/Supplier platform was mentioned, where flexibility is offered to the BRP, typically through implicit mechanisms. In general, these platforms (operated by Suppliers rather than neutral operators) are also able to provide flexibility to ancillary services but should the TSO/DSO ancillary services also interact with these platforms, or should the flexibility on these platforms be offered via any of the market platforms? The drawback of the first option is that it increases the fragmentation of flexibility (and complexity for DSO/TSO), the drawback of the second is that it may violate the level playing field for flexibility platforms and lead to monopolies for market operators.
- If TSOs and DSOs allow BRPs/Suppliers to access their platform(s) directly, then they should also allow individual FSPs direct access. This could further reduce the added value of the market platforms.
- In general, it is not clear which conditions the operator of such a market platform should meet. Since the operators may not need to be a NEMO (when trading is limited to one bidding zone) or even a BRP (when no energy is traded, only services), there is no existing regulatory framework for such a market party other than that related to the financial transactions. Since the safety and reliability of the grid will depend on these operators, additional regulations may be needed.

The next section introduces some of the main ancillary service support initiatives from market operators across Europe.

3 Current initiatives

Several market players in Europe are currently developing flexibility market platforms as introduced in the previous chapter. As power exchanges already have customers with flexibility within their client base, they are logical parties to develop these platforms. Three exemplary initiatives are introduced below. A further analysis and comparison is conducted in chapter 4.

3.1 EPEX SPOT local flexibility markets

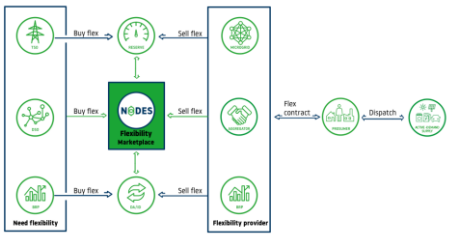
EPEX SPOT Local Flexibility Markets	Launching project: enera
The development of intermittent renewable energies creates new challenges for the power system, namely grid congestion. At the same time, information technologies evolve and become new tools to overcome these challenges, alongside emerging decentralized and flexible power resources. Making these flexibility resources available to system operators is key to tackling congestion. In this context, the EPEX SPOT Local Flexibility Market is an open and voluntary market-based congestion management platform, efficiently centralizing local flexibility offers with physical impact, that can be used by TSOs and DSOs to proactively alleviate congestion. EPEX SPOT will provide the platform and act as a neutral intermediary between flexibility demand from system operators and flexibility supply from flexible assets. It will also supervise price formation and guarantee a high level of transparency. The ambition is to create new opportunities: ▪ for market participants to value their flexible assets; ▪ for system operators to avoid or defer costly grid expansion and allow for a higher reliability, security of supply and coordination. The derived price signal emerging from these markets will create a new economic space that will allow new opportunities and foster the development of flexible resources in the grid going forward. The platform will rely on a high degree of digitalization and automation that will create a powerful coordination between system operators at all grid levels, therefore ensuring efficient usage of flexibility resources.	enera demonstrates how energy infrastructure can be innovated to provide greater resilience when integrating 100% renewable energy despite the new requirements, and the wide range of technologies that can be used simultaneously. Furthermore, enera demonstrates how markets and digitalization can reduce grid expansion costs considerably and provide opportunities for innovative business models. Enera consists of the three core topics: grid, market and data. The goal is to develop and implement a smart local flexibility market platform, which operates during the intraday timeframe, so that the DSOs and the TSOs can procure flexibility for the distribution or transmission grids to proactively alleviate congestion. For this purpose, locational flexibility offers are made by the flexibility providers in dedicated locational order books and efficient coordination between all parties is ensured. 

3.2 ETPA platform for congestion management

Electricity Trading Platform Amsterdam (ETPA)	Launching project: IDCONS
ETPA is an intraday marketplace that allows local players as well as traditional players to trade in energy products directly with other parties. The wholesale intraday platform focuses on lowering financial entry barriers and providing direct access for aggregators/ prosumers. ETPA will be the first party to act as a gateway to the currently developed IDCONS platform, to also provide ETPA members with	IDCONS is a combined Dutch DSO and TSO initiative to create a coordination platform between grid operators for buying congestion products in a coordinated way. The platform will allow all power exchanges to function as a gateway to the TSO/DSO congestion platform, lowering access costs for aggregators / traders who do not need to connect to more than one platform, while still allowing

Electricity Trading Platform Amsterdam (ETPA)	Launching project: IDCONS
direct access to TSO and DSO congestion markets. Traders and local players will be able to place their wholesale product on the ETPA platform for intraday wholesale trading. When certain product attributes such as location are added to the order, it will also be forwarded to the grid operator book on the IDCONS platform. This provides traders and local players on ETPA an extra opportunity to have their offers accepted.	competition between different Power Exchange (PEX) platforms and separate product requirements. This gateway function adds value to the PEX platform. The configuration allows for coordination between DSOs and the TSO, to ensure that congestion offers from one do not trigger new congestion in another grid operator's area. A smart algorithm is being developed to enable DSOs and the TSO to create and activate spreads that take into account other DSO/TSO grid conditions. It also increases the value for market parties active on this platform as congestion offers could be used by more than one party e.g. a TSO could use the same offers as a DSO without triggering new congestion. Finally, it will provide a clear interface for interaction with the market facilitating hub

3.3 NODES

NODES	Launching project: Engene
NODES' vision is to create a marketplace for the future supporting the drive to an emission free society. NODES' mission is to facilitate optimal use of flexibility in the grid by offering an open, integrated marketplace to all flexibility providers, BRPs and grid operators. NODES is an Independent Market Operator providing: ▪ Transparent pricing ▪ Secure trading ▪ Risk-free settlement NODES' key role, providing a marketplace for local flexibility, is to ensure that identified flexibility can be used where it has the best value, whether this be in the DSO or TSO grid or for a BRP that needs to rebalance its portfolio. By integrating the local flexibility market to existing intraday market and, in the future, reserve markets, NODES makes sure that the flexibility can be traded even if the local grid does not have an imminent need for the flexibility. In this way, the flexibility owner (Prosumer) and the Aggregator/BRP have better chance of a decent return-on-investment, thus incentivizing flexibility providers to enable more flexibility in the system. 	The Engene pilot has been run by Agder Energi, Norway's third largest energy group in terms of hydroelectric production. The group's 47 wholly and partly-owned power stations produce around 8.1 TWh of renewable energy on an annual basis. The grid company serves 200,000 customers. Generally, the objective of the Engene pilot project is to reduce peak load in certain hours. It is difficult to quantify the benefits in kWh and kW, but the pilot demonstrates huge potential in how to use flexibility assets in the power system. Over the next seven years, the expected investment cost in the Norwegian power grid is about $20 billion. This technology will reduce the need for investments significantly. The project shows how power-peaks can be reduced to avoid overload on a 25 MW sub-station transformer. Demand response and batteries are used to move load outside the peak-period so investments in the grid can be avoided or postponed. As well as reducing investment requirements, there are also environmental benefits e.g. avoiding building of new transformer stations and overhead powerlines. This will also make an important contribution to fulfilling the goal to electrify the transport sector. The same technology can be used in areas with overproduction, as a market can optimize the non-dispatchable power-production (small scale hydro, solar PV and wind). This will improve the use of distributed energy resources. An example of this is that NODES is now used in a pilot project with the German DSO, Mitnetz. The aggregator Entelios is currently offering Mitnetz flexibility over the NODES platform as an alternative to closing down wind and PV when there is overproduction in the distribution grid.

4 Analysis of flexibility market platforms

In this section, the three initiatives introduced in the previous section are further analysed. There are many similarities, explained in section 4.1. The main differences are discussed in section 4.2.
When market platforms provide a gateway to ancillary services, it is important to understand which functionality could/should be placed within the market platform, and which functionality could/should be placed at the TSO/DSO side. Section 4.3 explores a first concept addressing how to make this split.

4.1 Main similarities between initiatives

Below is a short overview and comparison of the three initiatives

- Both DSO and TSO congestion management products are supported. As trade and dispatch restrictions (typically associated with congestion management) are not enforced through/by the platforms, the grid capacity management product can be equally supported. Having said this, we observed that EPEXspot and NODES seem to primarily focus on grid capacity management, whereas ETPA focuses on congestion management.
- All platforms use a continuous auction mechanism (i.e. type 'eBay') for capacity/congestion management services.
- Main focus is on the intraday timeframe (i.e. after the day-ahead market results are known). Some platforms consider the support of real-time congestion management and balancing services but these are only foreseen as future developments.
- Other ancillary services (e.g. reactive power, voltage control, black-start support), adequacy mechanisms (national capacity markets, strategic reserves) and peer-to-peer trading are not supported by the current versions (but may be added when there is a market request/need).
- Both unit-based and portfolio-based offers are supported in 'localized' products (congestion and grid capacity management). Different ways to specify the location are supported (EAN, zip code, reference to congestion point ID).
- Main focus is on ISP[5]-based energy products. Some concepts support power products (i.e. without impacting imbalance settlement), alternative time intervals can potentially also be supported.
- Potential flexibility providers are Aggregators, Suppliers, Traders, End-users and Communities, provided they have a BRP license or can trade on behalf of (i.e. with agreement from) their BRP.

All concepts are (with respect to the support of ancillary services) in a development/market pilot phase. Implementation in operational environments is largely dependent on necessary modifications in regulatory frameworks of the member states, modification of ancillary services and organisational changes within the system operators.

4.2 Main difference between initiatives

Although the three presented initiatives are conceptually very similar and aim to reach similar benefits for both buyers and sellers of flexibility, the relation to ID wholesale trading seems to be the main differentiator. This strongly relates to the notions of *single-* and *multiple buyer* and ultimately to the expected price levels within these markets.

4.2.1 Link with intraday wholesale trading

The three initiatives have the following view on integration with ID wholesale trading:

- EPEX SPOT does not want to combine the intraday energy bids and congestion-management bids. Although EPEX SPOT has a strong position in the wholesale intraday market across Europe, its design phase has shown that mixing

[5] *Imbalance Settlement Period, time interval used within wholesale settlement processes. Normally 15, 30 or 60 minutes' time intervals.*

intraday wholesale and congestion management bids is not a good idea. This corresponds with a separate order book for ancillary services.

- ETPA combines ID wholesale trading and ancillary services; a flexibility provider can place a single offer that can be bought by either a BRP (or trader), TSO or DSO. If a flexibility provider wants to offer his flexibility against different prices, he should place two offers (e.g. one portfolio offer for ID wholesale, a second offer with locational information) and safeguard the consistency to avoid double activation. This corresponds with a single order book, both for ID and ancillary services (the grid order book is a subset of the ID order book where the locational information is visible for the grid operators and not for market parties).
- NODES allows offers for ancillary services to be routed to the ID market. NODES offers a single order book to flexibility providers, and will manage connections to ID and ancillary services with multiple buyers.

4.2.2 DSO/TSO: Single buyer of grid management product, or one of many in a wholesale product?

It seems attractive for TSOs and DSOs to buy flexibility on the wholesale ID market to resolve congestion as these markets already exist, have high liquidity and have potentially lower market prices than a separate congestion management product. However, just allowing flexibility providers to add specific attributes (e.g. grid location) to their offer does not mean that the TSO/DSO can simply run their product (i.e. fulfil their flexibility needs) by buying energy on the wholesale ID market. Although the asset providing the flexibility to different FRPs may be one and the same, there are several elements that make grid management services fundamentally different than a regular energy trade (wholesale transaction):

- **Anonymity**. In every energy transaction on the Power Exchange (PEX), the energy trader does not know his counterpart as the official trade is with the exchange itself. In any TSO/DSO product, the flexibility seller does need to know the counterpart as selling to a TSO or DSO comes with additional obligations.
- **Arbitrage options**. The main obligation in a grid management product relates to the flexibility to be delivered from the location specified in the offer. In a regular energy transaction (with another BRP), the flexibility provider is free to deliver the same amount of flexibility from another location. Moreover, there is no verification of the physical delivery at all on transaction level since wholesale allocation is performed on the BRP's perimeter level, and any imbalance cannot be traced back to single transactions. Locality reduces the Aggregator's (or his BRP's) arbitrage opportunities within its own portfolio or even against balancing prices.
- **Price risks**. In grid capacity management products, the TSO/DSO needs to create the right price incentives to stimulate the Aggregator to deliver as agreed and to avoid strategic behaviour. The USEF framework assumes that the penalty for under-delivery needs to exceed balancing prices, to discourage arbitrage on balancing prices. Another option could be that an Aggregator is excluded from future participation in TSO/DSO products. In both cases, the consequence for under-delivery (either intentionally or not) is higher than when selling to a BRP. Typically, the opportunity costs (of removing arbitrage options on other markets) will be included in the offer, meaning that the flexibility provider will ask a higher price to the TSO/DSO compared to the BRP.
- **Volume risk**. In grid management products, the Aggregator needs to assure (at least) the agreed volume is delivered. When the realised volume typically shows a (small) deviation from the activated volume, the Aggregator will likely offer a lower volume in a TSO/DSO product, compared to a BRP offer.
- **Flexibility quantification**. In ID markets, the AGR/BRP will typically offer any deviation from the day-ahead forecast. The flexibility quantification for TSO/DSO products will be based on the baseline methodology defined within the product. If the baseline methodology is not based on the DA forecast, or if there is no DA forecast (in case of smaller assets), the same activation may lead to different calculated volumes depending on the buyer.
- **Energy or flexibility?** If a (non-curtailable) wind farm expects intraday to produce more energy relative to the day-ahead nomination, it will offer the surplus on the ID market. It does not make sense for the TSO or DSO to buy it, since it is not a flexible asset (the energy will be produced anyway). This relates to the previous baseline remark.

If a flexible resource is capable of participating in different products, and when these different products are combined in a single order book, the flexibility provider still needs to place separate offers for the same resource. Therefore, using separate order books seems more appropriate to acknowledge the differences between the products, and create transparency on price levels.

Using multiple order books does not resolve the fragmentation of flexibility over different markets and products. It is up to the market operators to find innovative ways to further enhance the transparency and liquidity of flexibility markets in general.

4.2.3 Which price levels for grid management services can be expected?

As explained in the previous section, even if grid management and wholesale offers are combined in a single order book, the TSO and DSO cannot expect prices to be at wholesale level for grid management since the products differ.
Although the TSO/DSO may face higher prices for grid management services than ID wholesale prices, using market platforms is still likely to attract more flexibility providers to these platforms, compared to distributed platforms (cf. Figure 4). If there are substantial price differences between ID and congestion management services in specific (congested) areas, the market transparency may trigger flexibility providers to develop and offer flexibility in these areas, ultimately lowering the price for the DSO/TSO closer to (but presumably not reaching) ID level.

4.3 Analysis of required functionality

When system operators deploy market platforms to find economically optimal flexibility offers for grid management purposes, we must address which functional elements (supporting the grid management products) reside in the market platform versus the TSO/DSO systems (or elsewhere). In the table below we list the main functional building blocks and indicate which of these are supported by the examined platforms. Please note that the main focus of this analysis are grid management services, for balancing services additional functionality may be required.
We do not expect all listed items to be included in the market platform. In section 5.1, we draft a 'reference architecture,' based on consideration of platform purpose and neutrality, to describe which functionality should logically be placed within the market platform and which is outside of it. A description of the functional building blocks is included in appendix A.1.

Functional building block	EPEXspot	ETPA	NODES
Product requirements: publication	Core	Core	Core
Product requirements: include in offer	Core	Core	Core
Congestion points: publication	Core	Core	Core
Financial settlement of transaction	Core	Core	Core
Imbalance settlement: Integration for energy transactions	ND[6]	Core	Core
Imbalance settlement: exclusion for power transactions	ND	-	Core
Linked offers in different markets / products	ND	-	Core
Market place – (smart) matching of offers	ND	Core	Core
Availability contracts: Publication of requests	-	-	Optional
Availability contracts: Matching	-	-	Optional
Availability contracts: Validation	-	-	Optional
Availability contracts: Settlement	-	-	-
Availability contracts: Secondary market	-	-	Optional
Redispatch	ND	-	Optional
TSO-DSO coordination	Core	-	Optional
Grid safety analysis	-	-	-
Prequalification	-	-	-
Validation of product delivery	ND	-	Optional
Settlement of product delivery (physical settlement)	ND	-	-
Forecasting	-	-	-
Congestion management coordination with market parties	-	-	-
Value optimization / flexibility trading and risk management	-	-	-
Transfer of Energy (independent aggregation)	-	-	-

Table 2: Main functional building blocks for grid management services, including coverage by examined market platforms

[6] *Not Disclosed*

Building blocks indicated as 'core' are considered necessary elements (by the initiative) to support grid management services. Market platforms may also provide additional functionality (listed as 'optional'). It is important to understand that functionality required on the TSO/DSO product side is often not yet implemented (especially for DSO congestion management, which has limited application at present in Europe). As the market platforms are still trialling the support of grid management services, they may develop or offer functionality that is not necessarily core to the platform but needed simply to accommodate the trial. For example, the NODES platform works closely with the Agder Energi Flexibility Program with the aim of developing functional building blocks for Grid Operators and a Flexibility platform for Aggregators and BRPs. Several of the listed functional building blocks are developed in this project but will not be included in the market platform as those functions should be either at the buy-side or the sell-side of the marketplace.

In general, we observe many commonalities between the platforms in terms of the functionality covered. The few differences relate mainly to the integration with ID wholesale markets, as discussed in section 4.2.
Another element to consider is that these platforms are still being developed. The exact implementation will be highly dependent on TSO/DSO needs which are often not yet clear. We expect the functionality covered to converge further (similar to the convergence we have witnessed over the past decades for DA/ID wholesale platforms) when there is a clear view on:

- product requirements, especially DSO products which are (mostly) yet to be developed.
- TSO-DSO coordination: both at EU and member state level, the exact coordination mechanisms are under construction.
- redispatch responsibilities: are DSOs and TSOs allowed and willing to initiate energy transactions (which puts the redispatch responsibility with the TSO/DSO) or do they require a service (which corresponds to assigning the redispatch responsibility to the CMSP)?
- regional differences in all items listed above.

5 USEF's view on flexibility platforms

In addition to the current USEF specifications focused on roles, processes and information exchange, section 5.1 describes the interaction for flexibility on the basis of flexibility platforms. Special attention is given in section 5.2 to the interaction between market platforms and grid management services and the potential role of USEF in standardizing this interface.

5.1 Reference architecture for explicit demand-side flexibility

The relevant value chain platforms for explicit demand-side flexibility from the prosumer to the flexibility requesting party are depicted below. This is a concept version; more fine-tuning and elaboration with partner market players will lead to further enhancement. Also note that this architecture only shows option 3 (cf. section 2.2.3) which includes TSO-DSO coordination, although other models are possible.

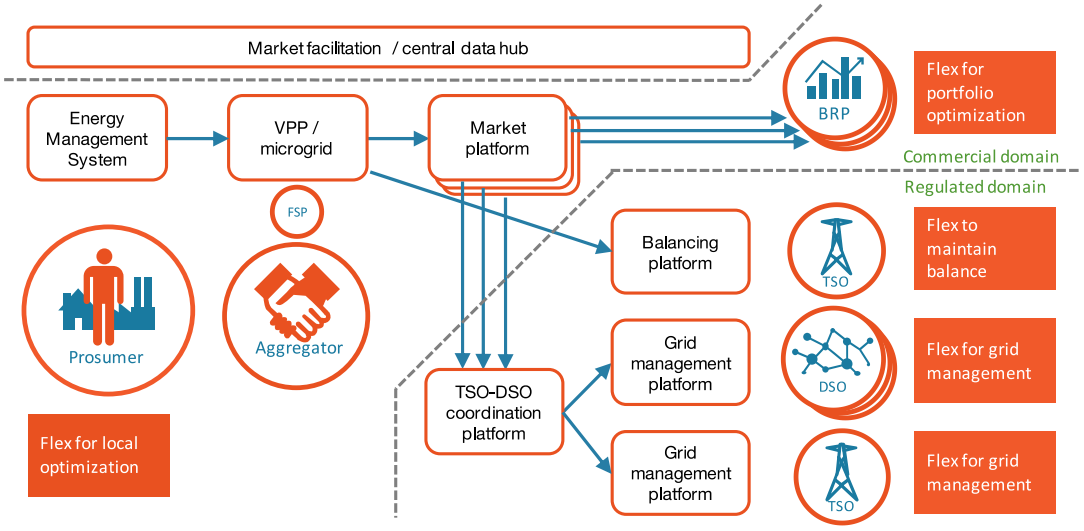


Figure 8: Flexibility reference architecture

In Appendix A.2, the main functional building blocks for grid management services (cf. section 4.3) are mapped on the different platforms identified in the reference architecture. A summary is provided in the table below, including a comparison with the scope of the USEF framework.

Category	Main functionality	Described within USEF 2018
Market platform	Matching of offers; publication of product characteristics and congestion points; financial settlement; Integration with imbalance settlement, publication and matching of availability contracts, incl. secondary market.	Limited to interaction between FSP and TSO/DSO
TSO / DSO coordination platform	TSO – DSO coordination on the dispatch of demand-side flexibility, redispatch	Redispatch
Market facilitation (central data hub or flex register)	Measurement, validation and settlement; transfer of energy (independent aggregation).	Fully covered
Technology platform / VPP / MicroGrid Controller	Forecasting, value optimization / flexibility trade & risk management, congestion management coordination, dispatch	Limited to interaction with ancillary services and coordination.

Category	Main functionality	Described within USEF 2018
TSO/DSO operational platforms (balancing, grid management	Forecasting and grid safety analysis; identifying flexibility need, tendering of availability, settlement of availability contract, validation and physical settlement of product delivery, prequalification.	Fully covered, except for forecasting and grid safety analysis.

Table 3: Main functionality of flexibility platforms

The following platforms have not been addressed in the table above:

- Community services. This has little relation to explicit flexibility services. If these services are provided through/by the platform, the community will need to seize the Aggregator role.
- BRP / Supplier Trading platform. See section 2.4.
- Energy management platform: this is outside the scope of this paper, only included for completeness of the figure.

The topic of measurement, validation and settlement (MV&S) needs special attention as a proper design is required to obtain viable business cases for the Aggregator, on one side, and effective products for the TSO/DSO on the other. Whereas it seems logical to place the validation and settlement of product delivery on the TSO/DSO operational platforms, consistency is also needed for situations where the Aggregator is active in different products and markets at the same time. Therefore, USEF proposes that the organisation of the validation of explicit DSF is in a central place. This could be the TSO-DSO platform although the platform may not be able to include explicit DSF trading on wholesale markets. Within the reference architecture, MV&S has been placed both at the operational platforms and at the market facilitation platform.

In Table 3, it becomes apparent that the core functionality developed within the market platforms complements the USEF framework specifications. USEF does cover TSO/DSO products, especially the product descriptions, validation and settlement, and market coordination. The USEF specifications therefore provide a solid basis to describe the interaction required between the market platforms and the grid management services platforms.

5.2 Standardized interaction market platforms and grid management services

USEF proposes standardization of the interaction between the market platforms and grid management services, as both market operators and system operators will benefit from this activity:

- TSOs and DSOs should not limit their interaction to only one market operator (unless there is no competition). The TSO and DSO need to approach market operators in a non-discriminatory manner and cannot allow themselves to be locked-in to a (commercial) market operator. Also, liquidity can only improve if TSOs and DSOs can access several market platforms. An open, standardized interface will lower entry barriers for operators to participate in grid management services.
- To market operators, every TSO and DSO is a potential customer of their platform. Since most market operators have a strong international focus, potentially thousands of system operators may interact with the market platform. A standardized interface would therefore strongly reduce the costs, while the competitive edge should be created using other elements such as the portfolio of flexibility providers active on the platform, or intelligent matching algorithms.

With lower transaction costs, Aggregators will also benefit as the costs of procuring flexibility will decrease and this, in turn, will also benefit end-users.

For these standardisation efforts, the following ingredients are necessary as a minimum:

- Clear understanding of ancillary services processes, ancillary services characteristics and of electricity / flexibility markets including market coordination.
- Clear framework for settlement and information exchange.
- Understanding of local specificities, ensuring the interface is sufficiently flexible to support local differences.

The standard interaction should cover both the situation with and without a TSO-DSO coordination platform. The current USEF framework already provides a solid basis for the corresponding process descriptions which can easily be mapped to a system architecture, as shown in Figure 8. We therefore believe all necessary information is available to draft the specifications for this interface.

6 Conclusion

Although it is possible for system operators to host grid management services on their own operational platforms, market operators can provide a significant contribution to future flexibility trading, by allowing TSOs and DSOs access to their platforms and thus access to a large and diverse pool of flexibility providers (BRPs, Aggregators, End-users).

Some of the potential benefits are

- Lower transaction costs, as flexibility markets are concentrated and well organised
- Higher liquidity, as flexibility is not fragmented over many smaller flexibility platforms
- Higher transparency, as prices for TSO and DSO products are transparent and may attract new flexibility service providers and stimulate more investment to unlock demand-side flexibility.

When TSOs and DSOs acquire flexibility through market platforms for grid management, they still need to implement functionality that cannot be provided by a commercial platform, the main being:

- TSO-DSO coordination;
- Verification and settlement of product delivery (physical settlement);
- Ex ante information exchange on forecasts, nominations and baselines;
- Tendering of availability contracts;
- Prequalification.

To allow a level playing field for market platforms facilitating grid management services, and to allow all TSOs and DSOs to make use of these developments, the interaction between the flexibility market platforms and grid management services needs to be standardized. The role model, process descriptions and message definitions developed within the USEF framework provide a solid basis for this standardization effort.
However, to reach standardisation on a European level requires further collaboration to achieve full support from all the major stakeholders within the European Union.

USEF therefore invites all major stakeholders (Electricity market operators, NRAs, Suppliers, Aggregators, TSOs and DSOs) to collaborate with us to help create this standard so together, we can propel the development of flexibility markets within Europe.

Appendix A: Functional building blocks

A.1 Description of main functional building blocks

The table below provides a description of the functional elements introduced in section 0.

Functional building block	Description
Product requirements: publication	Publication of technical requirements of ancillary services, such as: location, measurement requirements, under-delivery consequences, over-delivery consequences, ramp speed.
Product requirements: include in offer	Possibility for flexibility service providers to specify technical characteristics of their offer, such as: location, measurement specifications, ramp speed (either explicitly or by complying to the published requirements of a specific product).
Congestion points: publication	Publication of the locational information related to a congestion point, which should make clear to CMSPs which assets can support in solving congestions.
Financial settlement of transaction	Energy transactions require financial exchanges between counterparties. The platform could facilitate the cash flow transactions that the system transforms into payment instructions for different financial institutions. For instance, by offering payment options, overviews, securities etc.
Imbalance settlement: Integration for energy transactions	Energy transactions require balancing program updates of both counterparties. The platform could facilitate these updates by nominating the trade on behalf of both counterparties towards the imbalance settlement responsible.
Imbalance settlement: exclusion for power transactions	Power products are transactions without balancing program updates. This deviates from the “normal” energy trading on power exchanges.
Linked offers in different markets / products	Providing the FSP the option to offer a flexible resource (or pool of resources) in different markets or products, safeguarding that the flexibility a single resource/pool is not sold twice.
Market place – (smart) matching of offers	Matching logic of the platform, to ensure the Aggressor (buyer/seller of flexibility) obtains the best combination of offers that meet his criteria.
Availability contracts: Publication of requests	Publication of requirements for availability contracts, such as congestion point, size (Power), availability window, frequency of activation.
Availability contracts: Matching	Matching of offers for availability windows against request, as part of tendering process.
Availability contracts: Validation	Validation of availability contracts, by assessing whether the FSP meets the obligations of his contract by offering the correct amount of flexibility to the market, during the availability window.
Availability contracts: Settlement	Payment of availability contract, taking into account the outcome of the validation process for this contract.
Availability contracts: Secondary market	Market where future or active availability contract obligations can be traded between market players (typically flexibility service providers / Aggregators).
Redispatch	Mechanism that ensures that the activation (dispatch) of a flexible resource/pool in the context of a congestion/capacity management, will not affect the system balance. This is achieved by dispatching another resource/pool in opposite direction outside the congested area. This can be facilitated, provided the resources outside the congested area also have locational information.
TSO-DSO coordination	Coordination of flexibility deployment between the transmission and distribution system operators, to ensure their mutual activation will not cause conflicts. This

Functional building block	Description
	typically relates to the intraday planning and real-time dispatch phases, but may also cover long term planning, availability contracts and product design.
Grid safety analysis	TSO and DSO activity to safeguard that the required transportation / distribution capacity is available at the time needed. This is an iterative process starting years ahead, into day ahead, intraday and real time. The process typically takes heuristic and meteorological information into account; in the future, the dispatch plans for flexible (distributed) assets need to be taken into account.
Prequalification	Process where the ability to participate in an ancillary service is verified. This can be performed on three levels: ▪ Flexibility service provider level: e.g. on organisation level (ISO), process level (USEF-compliant) or IT-level (able to communicate with FRP) ▪ Pool level: to assess whether a pool can meet the technical requirements of the availability contract (including contracted power), in different circumstances (meteorological, market prices, maintenance). ▪ Resource level: to assess whether a resource is dispatchable and can meet the technical requirements of the product.
Validation of product delivery	Process to verify that the flexibility service provider has delivered according to his offer and the technical requirements of the product. In case of demand-side flexibility, this typically includes the use/calculation of a baseline (based on a predefined baseline methodology), where the activated energy equals the difference between the measured energy and the baseline, during the activation window. Also, the compliance with technical requirements of the product is checked; this means for congestion / capacity management products that the location of the activation is verified, to ensure it has actually contributed to solving the local congestion. Also, other types of validation are possible (cf. USEF's white paper Flexibility Value Chain update 2018).
Settlement of product delivery (physical settlement)	The financial settlement of a flexibility activation is normally settled through the market platform against agreed prices. This settlement assumes that the exact volume is delivered. Deviations from this agreement can be settled through the imbalance mechanism (a functionality provided by the platform). However, higher penalties may be needed for capacity/congestion management products, therefore a separate settlement process is needed to include such penalties. Since this focuses on the exact location of the activation, it is referred to as physical settlement.
Forecasting	Flexibility requesting parties need to determine how much flexibility they need to acquire, for this purpose forecasting services (e.g. for the load on a local congestion point) are needed. Also, flexibility service providers need to be able to
Congestion management coordination with market parties	Congestion management is a regulated mechanism as a temporary solution to grid congestion. It describes how trade and dispatch restrictions are to be enforced, and typically includes a redispatch mechanism. Coordination with market parties (incl. end users) are needed to inform them about the congestion and market restrictions. E.g. larger connections may need to submit a T/D prognosis, to which they are bound.
Value optimization / flexibility trade and risk management	Flexibility can be sold in different markets and products, sometimes several times (value stacking). For pools of flexibility even more options emerge. The Aggregator needs to balance between optimizing its revenue, and ensuring his ability to meet his contractual obligations. This is the value optimization process

Functional building block	Description
	of the Aggregator, typically performed with a trade and risk management platform.
Transfer of Energy (independent aggregation)	To enable independent aggregation, the transfer of energy needs to be organised. On one hand, the Aggregator needs to source the energy it sells in wholesale markets or ancillary services. On the other hand, the Supplier/BRP needs to be remunerated for the sourced energy that is transferred to the Aggregator (rather than to the end-user). Cf. USEF's work stream on aggregator implementation models report.

Table 4: Description of functional building blocks

A.2 Reference architecture for flexibility markets

Section 5 proposes a reference architecture for flexibility. The table below shows how, within the proposed architecture, the main functional building blocks can be distributed amongst the different platforms.
The final column indicates which building blocks are described within the USEF framework.

Functional building block	VPP / Microgrid controller	Market platform	TSO-DSO coordina-tion	TSO / DSO operational platform	Market facilitation / data hub	Included in USEF framework
Product requirements: publication		X		X		Y
Product requirements: include in offer		X				-
Congestion points: publication		X		X		Y
Financial settlement of transaction		X				-
Imbalance settlement: Integration for energy transactions		X				-
Imbalance settlement: exclusion for power transactions		X				-
Linked offers in different markets / products		X				-
Market place – (smart) matching of offers		X				-
Availability contracts: Publication of requests		X		X		Y
Availability contracts: Matching		X		X		-
Availability contracts: Validation		X		X		Y
Availability contracts: Settlement				X		Y
Availability contracts: Secondary market		X				-
Redispatch		X	X			Y
TSO-DSO coordination			X			-
Grid safety analysis				X		-
Prequalification	X			X		Y
Validation of product delivery				X	X	Y
Settlement of product delivery (physical settlement)				X	X	Y
Forecasting	X			X		-
Congestion management coordination with market parties	X			X		Y
Value optimization / flexibility trade & risk management	X					-
Transfer of Energy (independent aggregation)					X	Y

Table 5: Functional decomposition of flexibility reference architecture

Appendix B: Glossary

Term	Definition	Source
Active System Management (ASM)	Supervise and control power flows and voltage by TSO and DSO, this includes a variety of network planning and access options, adequately designed connection requirements for DG, ancillary services from DER to solve grid constraints.	Based on: Active Distribution System Management (Eurelectric, Feb. 2013)
Aggregator	A service provider that contracts, monitors, aggregates, dispatches and remunerates flexible assets at the customer side.	USEF
Ancillary Service	A service necessary for the operation of a transmission or distribution system. Ancillary services include both balancing services and grid management services	Directive 2009/72/EC
Balancing	All actions and processes on all timelines through which TSOs ensure, in a continuous way maintaining the system frequency within a predefined stability band and comply with the amount of reserves needed per Frequency Containment Process, Frequency Restoration Process and Reserve Replacement Process.	EG3 report on flexibility
Balance Responsible Party (BRP)	A market-related entity or its chosen representative responsible for its imbalances.	EG3 report on flexibility
Balancing Service Provider (BSP)	A market participant providing Balancing Services to a Transmission System Operator.	EG3 report on flexibility
Commercial domain	Part of the electricity system that is deregulated (as a result of market liberalisation), i.e. activities that are performed by commercial parties in a competitive environment (albeit many activities are still subject to specific regulation, e.g. energy supply).	USEF
Congestion management	Regulated mechanism imposing trade and/or dispatch restrictions, possibly non-voluntarily	USEF
Congestion / Grid capacity management service provider (CMSP)	A market participant providing Congestion management or Grid capacity management Services to a Transmission System Operator or Distribution System Operator.	USEF
Demand-side Flexibility (DSF)	Flexibility at the customer side, this includes both flexible load, generation and storage. DSF is “behind-the meter” or “behind- the connection”, meaning that the measurements on connection level typically also include other (flexible or non-flexible) load or generation.	USEF
Distribution System Operator (DSO)	A natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	Directive 2009/72/EC
Explicit Demand-side Flexibility	Committed, dispatchable flexibility that can be traded (similar to generation flexibility) on the different energy markets (wholesale, balancing, system support and reserves markets). This is usually facilitated and managed by an Aggregator that can be an independent service provider or a Supplier. This form of Demand-Side Flexibility is often referred to as “incentive driven” Demand-Side Flexibility.	Explicit and Implicit Demand-Side Flexibility, SEDC (smartEn), Sep. 2016

Term	Definition	Source
Flexibility	Ability to purposely deviate from a planned / normal generation or consumption pattern.	USEF
Flexibility platform	IT system that either facilitates or coordinates the trade, dispatch and/or settlement of demand-side flexibility.	USEF
Flexibility Requesting Party (FRP)	Market actor buying flexibility from FSP, i.e. either energy or (ancillary) service, either directly or through exchange / market platform.	USEF
Flexibility Service Provider (FSP)	Market participant offering services using flexible resources. This is either a BSP, BRP, CMSP or any combination of these three roles.	USEF
Frequency Containment Reserves (FCR)	Active power reserves available to contain system frequency after the occurrence of an imbalance	Guideline on electricity transmission system operation
(Electricity) Futures	In finance, a futures contract (more colloquially, futures) is a standardized forward contract, a legal agreement to buy or sell something at a predetermined price at a specified time in the future, between parties not known to each other. The asset transacted is usually a commodity or financial instrument.	Wikipedia
Grid capacity management	Using flexibility as an alternative to grid reinforcement without trade or dispatch restrictions, offered by the end-user and/or aggregator on a voluntary basis	USEF
Grid management	Operating and maintaining the grid, this includes both congestion management and grid capacity management.	USEF
Imbalance Settlement Period (ISP)	the time unit for which balance responsible parties' imbalance is calculated. Normally 15, 30 or 60 minutes' time intervals.	Electricity balancing guideline
Implicit Demand-side Flexibility	The consumer's reaction to price signals. Where consumers have the possibility to choose hourly or shorter-term market pricing, reflecting variability on the market and the network, they can adapt their behaviour (through automation or personal choices) to save on energy expenses. This type of Demand-Side Flexibility is often referred to as "price-based" Demand-Side Flexibility.	Explicit and Implicit Demand-Side Flexibility, SEDC (smartEn), Sep. 2016
Independent Aggregation	Situation where a customer has an agreement with an aggregator to dispatch and market (parts of) its flexibility, whereas this aggregator operates without the consent from or a contract with the electricity supplier of the customer.	USEF
Intraday (ID) period	Timeframe of the electricity market after intraday gate opening time and before intraday gate closure time, where for each market time unit, products are traded prior to the delivery of the traded products	Based on CACM Article 2 (37)
Nominated Electricity Market Operator (NEMO)	Entity designated by the competent authority to perform tasks related to single day-ahead or single intraday coupling	Guideline on capacity allocation and congestion management (CACM)
Ramping rate	Rate of change of active power by a power generating module, demand facility or HVDC system	Guideline on electricity transmission system operation
Regulated domain	Part of the electricity system that is regulated, i.e. activities that are performed by a body with a natural monopoly, typically a TSO or DSO.	USEF
Renewable Energy Sources (RES)	Natural energy resource which replenishes to overcome resource depletion caused by usage and consumption, either through biological reproduction or other naturally recurring processes in a finite amount of	Wikipedia

Term	Definition	Source
	time in a human time scale, such as sunlight, wind, rain, tides, waves, and geothermal heat.	
Transfer of Energy (ToE)	Wholesale electricity transaction between the Supplier and the Aggregator, triggered by a Demand Response activation by the Aggregator on the retail side, restoring the energy balance of both the Aggregator and the Supplier (and their BRPs).	USEF
Transmission System Operator (TSO)	A natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity.	Directive 2009/72/EC

About the USEF Foundation

To accelerate the transition to a commercially viable smart energy system, USEF Foundation has developed basics for a unified smart energy market, connecting projects and technologies at the lowest cost. With a value-to-all approach, USEF enables the commoditisation and trading of flexible energy use. The framework defines the market structure, stakeholder roles, how they interact and how they benefit by doing so.

Founded by key players active across the smart energy chain, USEF partners ABB, Alliander, DNV GL, IBM, ICT Group and Stedin work together to effectively address the challenges of one integrated system which benefits new and traditional energy companies as well as consumers. USEF's work has been incorporated in national and international policy proposals and the framework has been implemented in different smart energy projects across Europe.

More information can be obtained at www.usef.energy

About the USEF framework

USEF provides:

- Common terminology
- Framework for explicit demand side flexibility, with a main focus on
  - Roles & responsibilities
  - Market coordination of flexibility
  - Standardized market processes and information exchange
  - Measurement, validation and settlement
  - Facilitation of different Aggregator Implementation Models, incl. Independent aggregation
  - Product design, with a focus on DSO grid capacity management
- Exchanging Exchange of experiences and best practices through USEF's user community
  - Exchange on product design, business cases, implementation aspects, etc.
  - Capture of best practices in future releases of the framework.

The rise of renewables and general shift towards electrification are dictating a strong need for demand-side flexibility, where prosumers could be rewarded for deciding that part of their energy use is either not critical or not time dependent. With the growing need for flexibility, the concept of the flexibility platform emerges. But what is its exact purpose and function? More specifically, what is the potential value of platforms where flexibility can be traded? By examining three case studies, the concept is further analysed, identifying potential benefits and challenges.

"NODES highly appreciate the work USEF is doing on promoting distributed flexibility. This report highlights many of the requirements for a market based solution to solve this challenge. In this report, regulators, system operator market players and other stakeholders will find an excellent overview and comparison of the initiatives currently taking place across Europe."

Edvard Lauen – Director Corporate Development at Agder Energi AS

"My sincere compliments to the authors of this USEF white paper. It is spot on and represents a valuable contribution to the European discussion on platforms, as it addresses relevant topics which are on our agenda in our journey towards a sustainable, reliable and affordable energy system. "

Peter Hermans – Chief Technology Officer at Stedin

"In an era of increasing renewable penetration, decentralization and digitalization, flexibility platforms appear to be a key solution for the future of the power system. They create the economic space where supply and demand of a new ecosystem meet. USEF's pioneering work on the flexibility value chain and the design/architecture of these new markets is essential to enable its efficient use and to set the right conditions to unveil its full potential. In this regard, USEF's white paper on Flexibility Platforms sets a major milestone in the design and implementation of these markets and provides a unique point of view on current developments, placing it at the forefront of the flexibility dialogue in Europe."

Philippe Vassilopoulos, Director of Product development at EPEX SPOT

"This USEF white paper sheds light on the international discussion regarding flexibility platforms. Its valuable contribution is twofold: firstly, the paper provides a state-of-the-art review of ongoing flex platform developments with many interesting insights. Secondly, it depicts well-structured flexibility architectures that will help to develop a common language in the ongoing policy-making process."

Samuel Glismann - Policy Advisor at TenneT