

Flexibility and Aggregation Requirements for their interaction in the market

A EURELECTRIC paper

January 2014

EURELECTRIC is the voice of the electricity industry in Europe.

We speak for more than 3,500 companies in power generation, distribution, and supply.

We Stand For:

Carbon-neutral electricity by 2050

We have committed to making Europe's electricity cleaner. To deliver, we need to make use of **all low-carbon technologies**: more renewables, but also clean coal and gas, and nuclear. Efficient electric technologies in **transport and buildings**, combined with the development of smart grids and a major push in **energy efficiency** play a key role in reducing fossil fuel consumption and making our electricity more sustainable.

Competitive electricity for our customers

We support well-functioning, distortion-free **energy and carbon markets** as the best way to produce electricity and reduce emissions cost-efficiently. Integrated EU-wide electricity and gas markets are also crucial to offer our customers the **full benefits of liberalisation**: they ensure the best use of generation resources, improve **security of supply**, allow full EU-wide competition, and increase **customer choice**.

Continent-wide electricity through a coherent European approach

Europe's energy and climate challenges can only be solved by **European – or even global – policies**, not incoherent national measures. Such policies should complement, not contradict each other: coherent and integrated approaches reduce costs. This will encourage **effective investment** to ensure a sustainable and reliable electricity supply for Europe's businesses and consumers.

Flexibility and Aggregation

Requirements for their interaction in the market

A EURELECTRIC paper

January 2014

KEY MESSAGES

- The growing share of variable generation in Europe is increasing **the need for flexibility** in the electricity system. Flexibility on the demand side could be used by market players to optimise their portfolio as well as by system operators for balancing and constraints management purposes.
- In this context, **aggregation** offers the opportunity to exploit the flexibility **potential of smaller customers**. Aggregation will allow better access of these customers to the market. By selling their flexibility to market actors, customers could benefit from lower energy bills. The design of such a flexibility market will be largely determined by the operational and market rules set out in EU network codes.
- In order to **allow aggregated flexibility to participate in spot and intra-day markets, system balancing and constraints management**, the following issues need to be addressed:
 - **Market rules** should be brought in line with the characteristics of aggregated demand response and generation. The European network code on electricity balancing should provide a level playing field for all flexibility providers.
 - **Balancing responsibility on a connection should be clearly defined and consistently metered**. There should be no gaps or overlaps in the balancing responsibility of different actors on a connection.
 - **Smart meters with a reading interval corresponding to the settlement time period** are a technical prerequisite for participation of such users in balancing markets.
 - Constraint management and balancing are separate system operational issues. However, **the aggregated flexibility services required for constraint management and balancing could be delivered by the same resources**. Close coordination between constraint management and balancing will allow for higher liquidity and exchange of data between all relevant parties. This is necessary for safe operation and security of supply and for non-discriminatory access of flexibility to markets. A common place to pool this flexibility should be explored as one option for this coordination.

TF Balancing / Technical Aspects of Aggregation
Chair: David TREBOLLE (ES)
Vice-Chair: Ruud OTTER (NL)

Contact:
Pavla MANDATOVA, Advisor, EURELECTRIC Secretariat
Olga MIKHAILOVA, Advisor, EURELECTRIC Secretariat
pmandatova@eurelectric.org, omikhailova@eurelectric.org

Table of Contents

1. Flexibility and Aggregation - Introduction to Concepts and Challenges	5
2. Handling Balance Responsibility of Aggregators	7
3. Imbalance Settlement & Metering Capabilities	8
4. Pooling of flexibility for a secure system.....	8
Conclusions & Recommendations.....	12

1. Flexibility and Aggregation - Introduction to Concepts and Challenges

A rising share of variable generation in the system increases the need for the remainder of the capacity – both on the supply and the demand side – to complement flexibly this variable output. In systems with a high share of variable renewables (RES), lower predictability in the market as well as for network operators implies a **high need for flexibility** to cope with this volatility.

Use of flexibility

On an individual level **flexibility** is the modification of generation injection and/or consumption patterns in reaction to an external signal (price signal or activation) in order to provide a service within the energy system. The parameters used to characterise flexibility include the amount of power modulation, the duration, the rate of change, the response time, the location etc.

The possible market uses for flexibility are threefold:

- **Portfolio optimisation**
Portfolio optimisation is used by market players to meet their energy obligations resulting from energy markets at minimum costs by arbitrating between generation and demand response on all different time horizons.
- **Balancing**
This refers to the procurement of balancing services (capacity) and activation of balancing energy by the TSO to balance demand and supply through the balancing energy market. This is related to all actions and processes, from balancing gate closure time until real-time through which TSOs ensure, in a continuous way, the maintenance of the system frequency within a predefined stability range.
- **Constraints management in transmission and distribution networks**
Flexibility services will allow network operators to tackle network constraints in all timescales, maintaining reliability and quality of service and maximising integration of distributed energy resources.

Value of aggregation

A number of technologies can provide flexibility, including centralised or de-centralised generation, demand side participation and energy storage. However, only very large customers, e.g. industrial customers, find it easy to sell their flexibility on an individual basis and participate in the flexibility market today. Smaller residential and commercial customers may face high barriers in accessing these markets. Transaction costs of such participation are too high if managed at individual level.

Aggregation offers the opportunity for smaller residential and commercial customers to exploit their flexibility potential. Aggregation is a commercial function of pooling de-centralised generation and/or consumption to provide energy and services to actors within the system. Aggregators can be retailers or third parties. They may act as an intermediary between customers who provide flexibility (both demand and generation) and procurers of this flexibility. They would identify and gather customer flexibilities and intermediate their joint market participation. This could be done via flexibility products or simply by selling and buying aggregated energy (kilowatt-hours) at optimal points in time.

Main challenges

The Energy Efficiency Directive (2012/27/EU) requires enabling demand response to participate alongside supply in wholesale and retail markets, including balancing and ancillary services provision. Technical specifications for participation in these markets must include the participation of aggregation.

The possibility of services from the demand side turns the value chain of the system upside down: from the system providing services to customers, to the situation where customers provide services back to the different actors in the system. New demand response services will open the door for customers to manage and adjust their consumption as well as to reduce their energy bills.

It is difficult to forecast at this stage how significant a role the flexibility on the demand side will play. But in order to guarantee a level playing field for all market participants and unlock market access for consumers and aggregation, market rules will need to be adapted to enable them to participate in energy markets.

This paper focuses on the development and basic requirements for aggregated products to be integrated in the intraday and balancing markets. It also starts developing the views on how this could be coordinated with constraint services at distribution level.

The EU network code on electricity balancing is supposed to enable provision of balancing reserves from system users connected to distribution networks, including the aggregation of small both demand and/or generation units. Aggregation should be enabled to access balancing markets, on a level playing field with other participants.¹

This will require adjusting today's balancing market rules that were designed with focus on 'traditional' flexibility of large scale generation. In some markets it may not yet be allowed to pool generation and consumption or it is simply not possible to pool the flexibility of small (household) connection because the energy consumed is based on a statistical load profile. There may be capacity thresholds for bidding in these markets or regulated prices.

In addition, metering infrastructure requirements for imbalance settlement will need to be addressed to allow for efficient pooling of available flexibility of small customers.

¹ Framework Guidelines on Electricity Balancing, ACER 2012.

2. Handling Balance Responsibility of Aggregators

Everyone connected to the grid is balance responsible (responsible for his individual balance). A household and a small and medium size enterprise (SME) customer typically outsource their balancing responsibility to the retailer who can either take it up himself or arrange a Balance Responsible Party (BRP) for them, i.e. a market participant or its representative is responsible for its imbalances.² One BRP is responsible for balancing demand and supply for a certain metering point. This BRP holds an open delivery contract to this metering point. The BRP/retailer charges the customer for the balancing service, which is part of the contractual arrangements between BRP/retailer/customer.

The imbalance settlement process, a financial settlement mechanism aiming at charging or paying BRPs for their imbalances, takes place after real-time. The TSO charges or pays market participants depending on if they are short (have a shortage of supply vis-à-vis their nomination) or long (have a surplus), respectively. These payments and charges also depend on whether the entire system as a whole is long or short. They are based on underlying balancing market prices. This provides balancing responsible market participants with the incentive to have their demand and supply in balance so that overall deviations of the system are minimised. For the TSO this process should be a 'zero-sum' game where it has no financial interest and bears no financial risk.

Balance responsibility

The customer could sell the flexibility of his production or load capacity to his retailer.

Other solutions could be possible, e.g. besides his retailer, the customer could have contractual arrangements with other service provider(s), e.g. a third party aggregator. The key requirement here is that every supplier/service provider who has entered into a contract with a customer is metered separately for the part he is responsible for to allow a correct allocation of imbalances.

Metering of flexibility services

Measuring the energy exchanged with the grid (transported electricity) is necessary for determination of the amounts to be allocated to the BRP and then settled in the imbalance settlement process. This measurement and allocation of the consumption and production to the correct BRP in a distribution grid are important market facilitation functions that should be managed by an independent party.

The technical requirements on metering and verification for delivered flexibility services should be adequate to support service and contract requirements between the retailer, TSO, DSO and BRP etc. In other words, metering needs to allow verification of the delivery of flexibility services. This must then be incorporated into the imbalance settlement process.

Indeed, any reduction of demand or increase of local production behind the meter of a customer initiated by an aggregator (be it on request of a TSO, a DSO or for a market exchange on spot/intra-day markets), results in a situation when energy is produced by the BRP/retailer but does not anymore go through the meter of the customer because it is delivered directly to the market. This energy has to be paid for by the aggregator to the BRP/retailer and this has to be a part of a contract between the BRP/retailer and the third party aggregator. Other possible solutions to compensate the energy delivered by the BRP/retailer should be treated with caution, since they could lead to free

² There could also be supplier obligations to take over balance responsibility of small consumers.

riding by the third party aggregator on the (production) costs assumed by the BRP/retailer. For example, the BRP/retailer might be unduly penalised for his long position in the imbalance market caused by the actions of the third party aggregator.

The responsibility for ensuring adequate metering for flexibility service verification must be clearly defined as part of the commercial service requirements or contract.

3. Imbalance Settlement & Metering Capabilities

Measurement with an interval which is used as the settlement time period (15, 30 or 60 minutes) is a prerequisite for customers load and/or generation within a portfolio of aggregated units. These measurements are used to allocate the right volumes to the right parties in the allocation process. **Installation of smart meters with these capabilities** would thus be necessary.

Frequency of the settlement process implies the interval at which the measured values need to be collected. If the settlement process is a daily process then these values need to be collected on a daily basis. If the settlement process is a monthly process these values only need to be collected and validated on a monthly basis.

Even where smart metering allows for meter reading in short intervals, for low voltage connected meters in particular, communication periods are not close to real time and doing so would probably be very costly. So even though BRPs should have the possibility to have an accurate estimation of their imbalance in real time and first figures of their real time imbalance closely afterwards, so that they can adjust their behaviour in an efficient manner, a balance needs to be found between the need for accuracy and speed of the information and related metering costs.

Another important principle is that settlement of constraints management and balancing should be clearly separated as they are fundamentally different. While balancing is paid by the ones being out of balance (time/market aspect), constraints management is included in the grid tariff (location/network aspect).

4. Pooling of flexibility for a secure system

Another issue that should be addressed is how to **enable aggregation to access balancing markets as well as constraints management.** This chapter identifies the key aspects to be dealt with and lists issues that require further investigation.

Constraints management in transmission and distribution networks

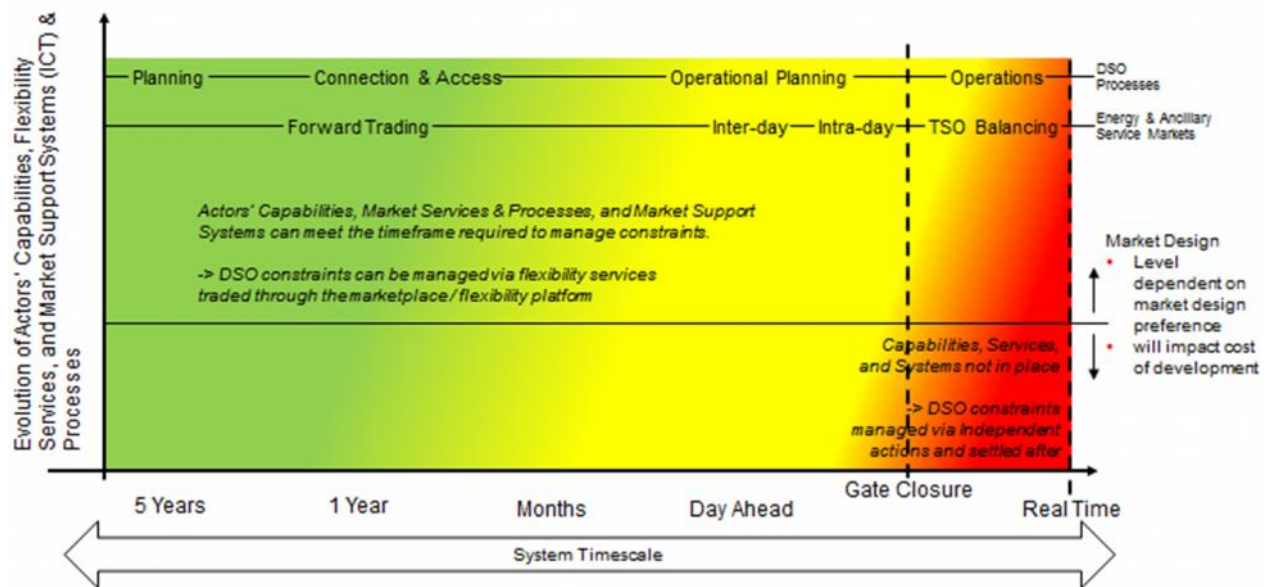
Besides portfolio optimisation and balancing, flexibility will also help to relieve constraints in transmission and distribution networks.

The physical flow of energy between the various zones and nodes of the power system must be maintained within the system security standards. Their non-fulfilment could in a worst case result in a cascade shutdown of the power system through circuit overload-tripping or through voltage or phase-angle instabilities. A power network is **constrained** when it is **not possible to transfer power from/to a group of electric assets without causing damage or power system instability.** Typical constraints refer to thermal ratings, voltage violations, fault levels and transient stability issues.

A system operator can procure the option to activate flexibility (directly from a generator or a customer who is a BRP himself or acts via an intermediary). The TSO and the DSO, respectively, are responsible for the remedial action in their own grid.

Today, TSOs procure flexibility in the form of ancillary services, mostly from large power producers. In the **future, DSOs** could additionally procure ancillary services from distributed generation and other distributed energy resources (including demand response and decentralized storage) as one of the tools for maintaining the quality of service and the security of supply in their networks. Such services could be in some cases more economically efficient than grid expansion, or they could be used as a temporary solution until grid investments and reinforcements are finalised.³ Procurement of these services may take place in long or short timescales.

The figure below indicates possible timeframes for procurement of flexibility services by the DSO and how this aligns with the timescale of established energy and ancillary service markets, depending on the market design. It includes a so-called ‘traffic lights approach’. Flexibility services could be used to proactively resolve congestions in the ‘yellow’ zone without entering into the ‘red’ zone where independent action will need to take place (the way contingencies are dealt with today). Their possible use for longer term congestions (‘green’ zone) needs to be further investigated. As the technical capabilities of different system actors (such as availability of analytical tools for forecasting, state estimation, fast load flows etc.) will rise, markets for flexibility services will be able to operate closer to real-time.



³ The DSO can procure ancillary services from local providers if there is a market. If there is no market DSO must have other tools to maintain the stability of the grid. DSOs should be able to look at the business case for both the investment solutions (CAPEX) and the service-based solution (OPEX) and decide for the most cost-efficient one (or a combination of the two). See EURELECTRIC paper Active Distribution System Management – Recommendations & Discussion paper (2013).

'Pooling of flexibility'

However, further system coordination will be necessary because the aggregated flexibility services required for constraint management and balancing might be delivered by the same resources:

- **Activation of flexibility located in distribution network for the purpose of system balancing or transmission constraints management may lead to constraints in distribution networks** and affect security of supply and quality of service. For example, a flexibility provider may have a contract to provide reserves to the TSO. He needs to use the distribution system to which its resources are connected to deliver this service. However, a bottleneck on the distribution system may prevent this delivery. If a DSO bottleneck impedes the usage of a flexibility bid (in the 'red' zone), then the DSO should make the bid(s) unavailable on the flexibility platform.
- Similarly, **DSO constraint management** (e.g. DSO may lose some MW of demand) **will also affect the TSO grid and balancing of the system**. TSO needs the information and the flexibility platform may provide it.

DSOs should have visibility of the planned aggregation or individual actions connected to their networks especially in the 'yellow phase'. This would ensure that market schedules are not in conflict with network operation and to seek mitigating actions either through internal network control actions or via commercial flexibility services. In the 'yellow zone' this should be dealt with by a commercial re-nomination or re-dispatch mechanism. If this occurs in the red zone it should be considered as an operational emergency. The DSO may also inform about restricted feeders ahead (outside of the red zone) due to operational limitations, e.g. unplanned or foreseen limitations.

The coordination between TSO and DSO should function as it does currently within transmission network: transmission network operator actions do not conflict with the balancing of the system because the system operator is perfectly aware of its actions. They are perfectly coordinated, as they are mostly a single actor – the TSO.⁴ DSOs should have information about TSO actions in its network because they are responsible for avoiding constraints in their respective networks as described above.

An effective mechanism should be found that coordinates between these two purposes to maintain liquidity and keep the complexity and cost of market participation low. A common market place for flexibility (a 'flexibility platform') should be further explored as an option that would allow to coordinate the actions of all involved agents, by enabling well-structured and organised exchange of data between all relevant parties, especially TSO(s) and DSO(s).

Facilitating the exchange of information on which units are to be re-dispatched via such a platform would allow network operators to act in coordinated manner. System operators should be able to access this information even if they do not procure ancillary services as constraints in their network may arise due to other actors' actions. For example, the DSO may keep operating its networks in a business-as-usual way if it is the most cost-effective solution. With this information DSOs will be able to take into account system costs due to network congestion, when planning for network expansion, so that an optimum for the system is reached.

⁴ Except for countries where ISO or ITO models are implemented.

In addition, all the flexibility products delivered from customers connected to distribution networks should be as far as possible differentiated by time and by disaggregated location information. Network operators would make available location information via the flexibility platform that would enable commercial players - not aware of the network topology - to provide flexibility services where needed (e.g. activating the right customers in case of demand aggregators). Different ways to achieve this are currently being investigated (e.g. within the ADDRESS project).

Next step: creating a common marketplace for flexibility?

In order to make this possible, a number of issues will need to be further investigated by relevant stakeholders, including network operators, market participants and regulators. They include:

- Handling of the information streams amongst market parties, TSOs and DSOs so that everyone can fulfill their responsibility;
- Set-up of the market information model for the flexibility platform;
- Set-up of the technical information model required by DSOs to procure system services;
- Possible use of flexibility to solve DSO congestions in the 'green' zone;
- Arrangement of the settlement for balancing and the settlement of constraint management;
- Interactions with the integrated European CMO for balancing;
- Types of products that can be shared for both constraint management and balancing; products that could be traded at the flexibility platform;
- Types of services and products required for optimal management of distribution network in the long and short term;
- Access to the flexibility platform; who are the buyers and the sellers.

Conclusions & Recommendations

Use of flexibility & aggregation

- **Aggregation offers smaller customers the opportunity to exploit their flexibility potential.** The customer could benefit twice: by selling flexibility products and by lowering total system costs.
- Flexibility can potentially be used for several purposes: (1) portfolio optimisation, (2) procurement of balancing services (capacity) and activation of balancing energy by the TSO, and (3) constraint management in transmission and distribution networks. **The design of the balancing market should take into account the possible use of flexibility for network constraint management.**

Balance responsibility

- All players connected to the grid are directly or indirectly 'balance responsible'. **Overlaps or gaps of balancing responsibility must be avoided.** If a customer has a contract with more than one retailer, these retailers need to have separate measurements. The same goes for the aggregation actions: they should always be related to a separate measurement and settlement.
- The retailer active at a connection require adequate and consistent metering. Gaps and overlaps in measurements would jeopardise the system and the commercial position of retailers.

Imbalance settlement period and metering requirements

- Smart meters are necessary to allow the amounts to be allocated to the BRP and then settled in the settlement process if aggregated flexibilities want to participate in balancing markets. As regards the interval for collection of metered values, a balance needs to be found between the need for accuracy and speed of the information on the one hand and the related metering costs on the other.

Pooling of flexibility

- In order to **enable aggregation to access balancing markets as well as constraints management**, an effective mechanism needs to be found that coordinates between these services for TSO and DSO to maintain liquidity and keep the complexity and cost of market participation low.
- **Even if further investigation is needed regarding pooling flexibility for other purposes than balancing, transparency in such a pool** would give system operators the ability to deal with system constraints in an open marketplace, rather than as operational emergencies. Any party using measurements should only be entitled to the information they need to perform their tasks, taking into account that measurements and any other customer information are the customer's property. Settlement of constraint management and balancing should be clearly separated.



Union of the Electricity Industry - EURELECTRIC aisbl
Boulevard de l'Impératrice, 66 - bte 2
B - 1000 Brussels • Belgium
Tel: + 32 2 515 10 00 • Fax: + 32 2 515 10 10
VAT: BE 0462 679 112 • www.eurelectric.org