USEF
POSITION PAPER

THE INDEPENDENT AGGREGATOR

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A solid foundation for smart energy futures

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This USEF position paper is shared with the USEF review board and is intended to streamline discussions about further development of the USEF framework.

1 Introduction

The rise of renewables and general shift towards electrification are dictating a need for demand-side flexibility. Prosumers could be rewarded for deciding that part of their energy use is either not critical or time dependent. If this flexibility was pooled, it could be used to solve problems experienced by system operators, such as avoiding congestion and grid upgrades and better balancing of supply and demand. This approach would create a more efficient and cost-effective system. In turn, this would pave the way for more renewables, creating a cleaner, more secure energy future.

The Universal Smart Energy Framework (USEF) addresses these challenges, delivering one common standard to accelerate an integrated smart energy future. Its aim: to unlock the value of flexibility for all stakeholders in the energy system, which is achieved by delivering a market structure for trading of flexible energy use, and the tools and rules to make it work effectively. USEF describes the market roles and their interaction, specifically focusing on the aggregator role, focused on bringing together enough prosumer flexibility to offer as solutions.

The Aggregator role is positioned centrally, between its end customers, who are all motivated to buy or sell flexible energy use because they receive benefits for doing so. Although the utility supplying the energy to a Prosumer has a logical position to take the role of Aggregator, also other market parties should be able to take this aggregator role. This concept is described by the term Independent Aggregator or Third Party Aggregator. The inter-related nature of energy and flexibility means that an Independent Aggregator's decisions related to a customer may impact the energy and balance position of the supplier. USEF describes the market roles and their interaction, as well as the required settlement rules or contracts, transparency of information, and clear rules and processes for communication so that all stakeholders are aware of when they will be impacted, and can receive compensation when they are impacted.

There are different models for opening the market up to Independent Aggregators with consideration for these things. This position paper describes the need for - and the position of the independent Aggregator in the energy system, and analyses the impact on USEF.

1.1 Position of the independent Aggregator

The USEF Framework allows an Aggregator[1] to create flexibility services based on the aggregation of demand-side flexibility, and to bring these products to markets where this flexibility can be monetized.

The principles that underpin USEF include the following:

- Flexibility should be activated where it creates the highest value, which requires a market mechanism that propagates the value of flexibility throughout the value chain.
- Demand-side flexibility should be able to compete with generation flexibility on an equal footing.
- All market players should be able to benefit from the activation of demand-side flexibility.
- There should be no barriers preventing new players from taking on the role of Aggregator (i.e., the playing field should be level). This also implies an even sharing of risks, e.g. free-riding needs to be avoided.
- The framework should align with existing market structures to the greatest possible extent, and allow for both quick and gradual implementation.

There are currently several obstacles in the EU markets to unleash the full potential of demand-side flexibility. One reason for this is that every demand response (DR) activation initiated by an independent Aggregator[2] will affect the positions of the associated Balance Responsible Party (BRP) and Supplier, with accompanying financial risks for both stakeholders. As a result, Prosumers are often restricted in offering their flexibility to independent Aggregators by the conditions of their supply contracts. The only option for the independent Aggregator seeking to offer a flexibility proposition to a Prosumer is to make contractual arrangements with the BRP responsible for that Prosumer—but this violates the level playing field principle, as it favors BRPs that are inclined to take on the role of Aggregator themselves.

1. In this paper, capitalized terms indicate USEF-defined roles, phases, and regimes, and lowercased versions indicate broader, general energy- market concepts.
2. Also called a third-party Aggregator, meaning one not linked to the Supplier or Balance Responsible Party serving the associated Prosumer.

The topic of the independent Aggregator is currently under heavy discussion in Europe, including within the European Commission's Smart Grids Task Force (SGTF). In studying the available documents, we note a common conviction that the regulatory framework should support the independent Aggregator model.

This position paper addresses the following topics:

a. Section 2 describes two examples of potential services provided by independent Aggregators, and explains how USEF will integrate with wholesale markets in general.
b. Section 3 presents a short summary of viewpoints on this topic and introduces the **virtual transfer point** as a supplementary approach.
c. Section 4 examines ways to facilitate the independent Aggregator role in greater detail, focusing on the main obstacles; describes its impact on USEF; and defines appropriate next steps for the USEF design team.

The Appendix provides a further elaboration of the EG3 model, explaining the need for compensation of the BRP/Supplier and addressing the balance responsibility for the activated flexibility.

2 How USEF envisions the independent Aggregator

2.1 Examples of services by an independent aggregator

In this section we present two typical examples of services that independent Aggregators might develop.

2.1.1 B2B example: Emergency power

An Aggregator may offer (through a BRP) tertiary control or strategic reserves services using a portfolio of uninterruptible power supply units (UPS) installed at commercial and industrial (C&I) customers. Since UPSs are, in general, only active during an outage, these devices are an apt source of flexibility for such services. A UPS vendor offering maintenance contracts is perfectly situated to take on the Aggregator role: it understands the technical features, it may have remote access to these devices, and it has a relevant customer portfolio. In this sense, the UPS vendor may be better situated to offer a flexibility proposition than the Supplier or BRP serving this Prosumer. In the current market structure, this Aggregator will either affect the BRP's balance or will need to take over the role of Supplier or BRP for all the Prosumer's load. Both solutions have major drawbacks.

2.1.2 B2C example: Smart charging at home

An Aggregator may offer (through a BRP) primary or secondary control services using a portfolio of charging units for electric vehicles (EVs). In order to provide these services around the clock, the Aggregator may also need to control the nightly charging process at the Prosumer's home. Since electric vehicles have a relatively high energy demand and may be charged at relatively high capacity levels, these devices are an apt source of flexibility for these services. An E-mobility Service Provider (EmSP) is perfectly situated to take on the Aggregator role: it understands the technical features, it may have remote access to these devices, it has a relevant customer portfolio, and it may already provide roaming contracts for public charging. In this sense, the EmSP may be better situated to offer a flexibility proposition than the Supplier or BRP serving this Prosumer. In the current market structure, this Aggregator will either affect the BRP's balance (assuming smart meter allocation is in place) or will need to take over the role of Supplier or BRP for all the Prosumer's load. Both solutions have major drawbacks.

These two examples demonstrate that the flexibility market may benefit from independent Aggregators. It shows that customers may be inclined to select different suppliers/buyers for energy and flexibility, as these are quite different products. However, commodity and flexibility are closely linked and separating these may turn out to be far from trivial. Separating commodity from flexibility in a fair, transparent and simple manner will be pivotal to accelerate the development of flexibility services.
We will refer to these examples when we analyze possible ways to facilitate the independent Aggregator. Before starting that analysis, we first describe how USEF integrates with wholesale and balancing markets in general.

2.2 USEF's position relative to the market

The facilitation of the independent Aggregator primarily concerns the organization of wholesale and balancing markets. The USEF framework does not describe these markets, yet needs to integrate with them. In this section we describe the basic elements of this integration.

USEF centers the Aggregator between its potential customers, as shown in figure 1.

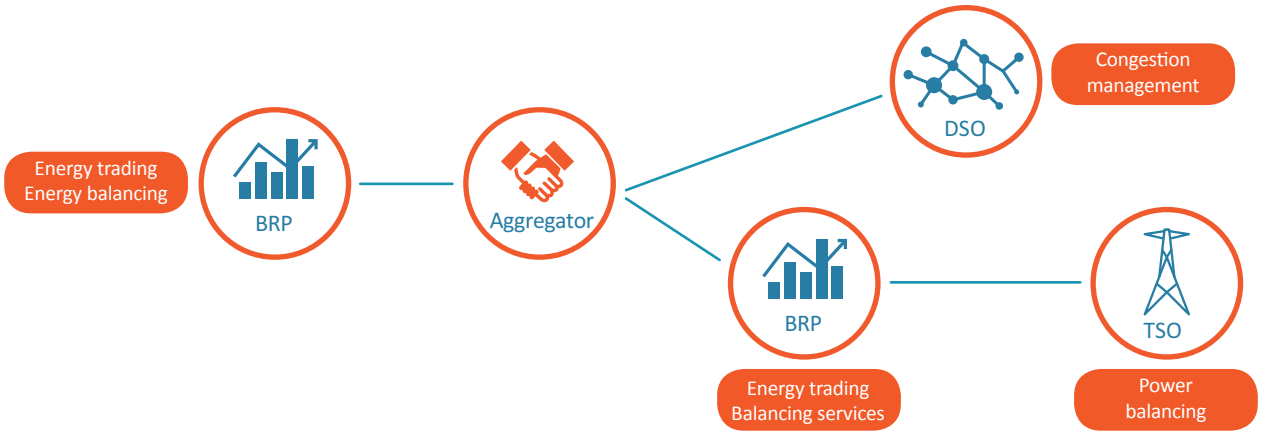

Figure 1: USEF's flexibility value model. See the associated position paper, "Flexibility Value Chain", for more detail.

Figure 1. reveals that flexibility services for the Transmission System Operator (TSO) are always provided by the BRP, not directly by the Aggregator. Depending on market conditions, this BRP might be an independent Aggregator, in which case the two BRP icons in this figure represent different BRPs.

USEF's primary objective is to provide a coherent framework in which the Aggregator is able to provide flexibility services to any of its potential customers, ensuring that the other stakeholders are sufficiently informed and, where necessary, compensated for the impact of the Aggregator's actions.

The secondary objective is to introduce and define market mechanisms where necessary. Ideally USEF will integrate with existing market structures, however USEF designs new markets when these have not yet been defined. This has the following consequences for the three potential customers listed above:

a. The Aggregator can already interact with the BRP, typically on a bilateral or vertically integrated basis. USEF provides a market mechanism through which the BRP can acquire flexibility from different Aggregators, although other types of interaction are also possible.
b. No local capacity markets currently exist; USEF therefore provides a complete framework for local congestion management, based on demand side flexibility.
c. Several TSO markets, most noticeably balancing markets, are already in place, though they are typically served by large generators. USEF will not prescribe mechanisms for these markets, but will describe how aggregated flexibility can be brought to them within a coherent energy framework.

Thus, by standardizing market processes and information exchange, USEF offers all market players easy access to flexibility markets. This will remove the need for bilateral contracts between the independent Aggregators with the BRP of the Prosumer

2.3 The four basic elements of flexibility activation in USEF

Figure 2: The timing of the four basic elements with respect to USEF's phases

An Aggregator activating demand-side flexibility as a service to one of its three potential flexibility customers is likely to affect the remaining stakeholders. The framework should therefore define the following four basic elements:

1. When and how the other two stakeholders are informed about the **capability** to activate
2. When and how the other two stakeholders are informed about the **intention** to activate
3. When and how the relevant stakeholders are informed about the **realization** of the activation (based on measurements)
4. When and how the other stakeholders are **compensated** for a possible financial impact of the energy transfer (through settlement)

In addition to delivering process descriptions, use cases, and data models, USEF also provides a reference implementation, enabling market parties to implement USEF's processes in an efficient and interoperable way.

3 Facilitating the independent Aggregator

3.1 Current viewpoints and the EG3 model

The independent Aggregator has been discussed in several recent papers.3 All of these recognize the value of opening the market to independent Aggregators, provided the associated BRP and Supplier are sufficiently compensated. A schematic view of the market structure according to the EG3 model developed by the SGTF is shown in figure 3.

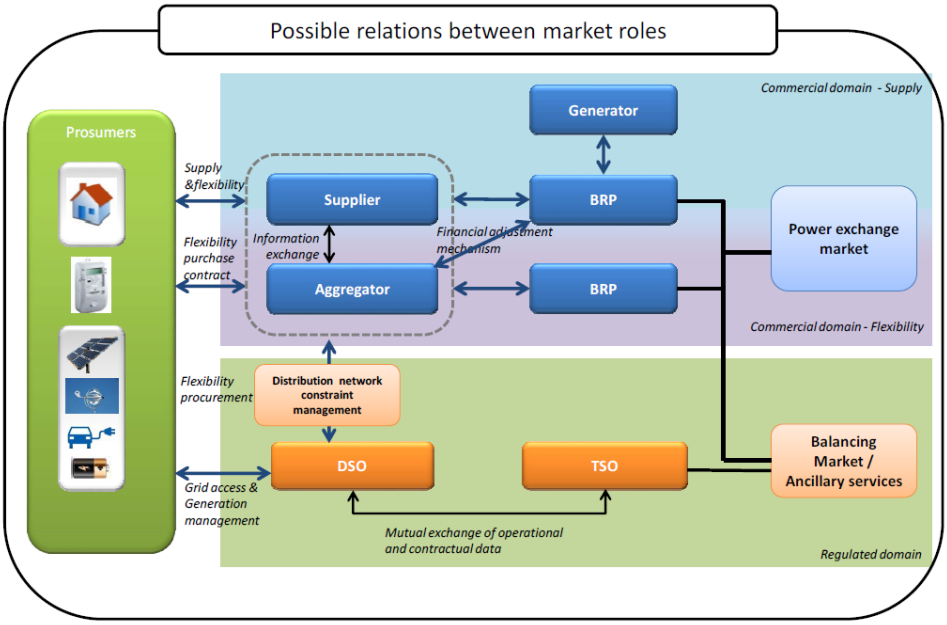

Figure 3: The EG3 model. Source: SGTF

Though the underlying assumptions are not always explicitly stated, all current concepts seem to be based on the following premises:

- The Aggregator acquires flexibility from the Prosumer, bundles it into a flexibility service, and offers this service to a market party.
- Only one Supplier will be active per connection (there is no Supplier associated with the flexibility traded by the independent Aggregator).
- The independent Aggregator needs to assign a BRP to the flexibility in its portfolio, where the flexibility is defined as the difference between actual use (measurements) and an agreed baseline reference. This BRP is required for two reasons:
  - In most EU countries, only a BRP can offer flexibility services to the TSO (which is currently the most obvious customer for an independent Aggregator).
  - The Aggregator may cause an imbalance if the realization of the DR activation differs from the expected (and agreed) result. Since the TSO must have a party to hold responsible for the imbalance, the Aggregator's flexibility portfolio needs to be part of a BRP's portfolio.
- The responsibility for flexibility-caused imbalance is limited to times when the flexibility is activated.
- Sub metering may be required in most cases, to identify the results of the Aggregator's DR activation.
- A baseline methodology is required, to identify the results of the Aggregator's DR activation.

3. See the references at the end of this paper for a partial list. 3

Most documents identify three possible ways to compensate the BRP and the Supplier, shown in table 1:

Model	Supplier Payment	BRP Correction
Regulated Model The DR operator (Aggregator) and the Supplier act independently.	The DR operator pays the Supplier an amount determined by regulation.	The curtailed energy block is corrected.
Corrected Model The customer's metering data are corrected from the curtailed energy.	Payment is realized through the metering data correction.	The BRP correction is realized through the metering data correction.
Contractual Model The DR operator and the Supplier agree on payment forms.	In B2B, the DR operator and Supplier agree on payments.	The curtailed energy block is corrected.

Table 1. Possible compensation methods. Source: French DSO company ERDF.

3.2 A supplementary method: Virtual transfer points

A second model, which may coexist with the EG3 model, is based on **virtual transfer points**: sub-metered locations behind the connection point.

The virtual transfer point (VTP) model replaces the current model, in which metering, billing, balance responsibility, and wholesale settlement are organized around connection points. A virtual transfer point may be equivalent to a connection, but a connection can also be split into several virtual transfer points. There are two main drivers behind this method:

- Directive 2014/94/EU on the deployment of alternative fuels infrastructure
  This directive states that "Member States shall ensure that the legal framework permits the electricity supply for a recharging point to be the subject of a contract with a supplier other than the entity supplying electricity to the household or premises where such a recharging point is located." It is closely related to the second example in section 2.1.
- Distributed generation
  In certain cases, the return supply on a connection needs to be allocated separately from the consumption on the connection. This would also enable multiple contracts for energy supply and return at one connection. In Germany, this concept is already often used to facilitate feed-in tariffs.

These drivers may lead to other solutions than virtual transfer points, such as separate connections per household / premises or a physical separation at the connection point into separate meters. However, both of these solutions are cost-inefficient and may jeopardize the business case for demand response. Note that the preferred solution is highly dependent on how member states implement the EU directive.

The main elements of the VTP method are as follows:

1. A transfer point is created by placing a sub-meter behind the connection, such as a sub-meter for an EV charger.
2. All remaining load is accounted for by deducting the sub-meters from the main meter at the connection, resulting in another transfer point.
3. A metering company is assigned to ensure that accountable information is acquired from the metering point.
4. Balance responsibility and wholesale settlement will stay largely intact; however, these processes will focus on virtual transfer points rather than connection points. At small connections, the use of VTPs will further increase the need for smart meter allocation, rather than allocation based on standard load profiles.

This method enables us to separate the load for a specific device from the total load. An Aggregator controlling a specific device can thus concentrate on this device only. However, in many cases sub-metering is also required for the EG3 model. The two main distinctions between these models are:

- In the EG3 model, there is only one Supplier per connection point. In the VTP model the Prosumer or Aggregator must assign a (possibly different) Supplier to the virtual transfer point.
- In the VTP model, the BRP associated with the Aggregator is responsible for all load on the VTP. In the EG3 model, this BRP is only responsible for the flexible part of the load.

4 Analysis and impact on USEF

4.1 Analysis

In this section we will examine the EG3 and VTP models in greater detail and highlight the main obstacles to their use.

4.1.1 Analysis of the EG3 model

When translating the EG3 model to a process and information model, one of the main complexities seems to be the settlement process, or more precisely, the evaluation of the Aggregator's performance. We will further examine this complexity using our examples from section 2.1.

Smart-charging example

Under normal conditions (without DR activation), the incumbent BRP (associated with the supply contract) will forecast the connection's energy consumption including the EV charger, and will source the required energy.

If an Aggregator controls the charging process and offers its flexibility to the balancing markets, then an agreement is needed on a baseline load reference, i.e., the load pattern the EV charger would have shown without the Aggregator's activities. This reference forms the basis for the performance assessment of the service delivered by the BRP (associated with the Aggregator) to the TSO, and may therefore differ from the A-plan which is the reference used in the current version of USEF. Expectations are that the customer for this flexibility service - i.e., the TSO - will define this baseline. When DR activation is expected (or announced), the incumbent BRP will need to forecast the connection's consumption based on this baseline reference, which will also govern settlement afterward to ensure the Aggregator's activities do not cause imbalance.
There are several complications related to the baseline reference:

- If the Supplier applies time-of-use tariffs, then two parties are performing demand-side management on the same load, and it is hard to separate the effects of both stakeholders. The baseline reference must account for this, but a sufficiently accurate baseline may not be viable.
- If the BRP bases a connection's forecast on historical measurements, then the Aggregator's activities may affect the forecast, which will complicate the nomination process.
- The BRP's sourcing needs to be based on the actual expected load if no DR activation occurs, but on the baseline reference whenever DR activation does occur. These may differ, yet the BRP may be notified of DR activation too late.
- Since the Aggregator is performing load shifting, the rebound effect (in terms of energy volume) is equal to the DR activation itself. The rebound will therefore also impact the supply and balance position of the BRP. The rebound effect may be autonomous (not steered by the Aggregator). This could be solved by considering the interval where the rebound occurs to be part of the activation time; however, it may be difficult to distinguish when the rebound takes place, and consequently to determine the periods in time for which the BRP associated with the Aggregator holds balance responsibility.
- If the total load for one day (or, in our example, one night) differs from the total baseline load, the Aggregator may be forced to leave its flexibility unused, as the volume difference may end at its BRP's balance responsibility.

Emergency power example

If an Aggregator controls the UPSs and offers their flexibility to the balancing markets, the application of the EG3 model is far more straightforward.

- The baseline reference can be set to zero, as the UPS is (in general) inactive.
- If the incumbent BRP is well informed, almost none of the complexities in the smart-charging example apply.
- The BRP does need to take activation into account in its nomination process.

In general, it is fair to say that the applicability and complexity of the EG3 model are highly dependent on three things:

- the flexibility service and customer
- the flexibility resource(s)
- the number of activation times (few times a year vs. continuously managed loads)

From this, we draw two conclusions:

1. Without a proper baseline methodology, either the business case for the Aggregator will collapse, or the incumbent BRP or Supplier will be negatively affected.
2. At first glance, the emergency power example seems straightforward, whereas the smart-charging example seems highly complex. We expect that every service-resource combination will need a well-developed baseline methodology; the viability of each combination depends on the ability to find a suitable one. Also C&I flexibility products seem to have a higher short–term viability then retail products.

4.1.2 Analysis of the virtual transfer point model

The main complexity in the VTP method seems to be on the Prosumer supply and billing side, since balance responsibility is strictly separated per virtual transfer point. We will further examine this complexity using our examples from section 2.1.

Smart-charging example

The Aggregator can use the electricity meter in the EV charging unit (wall box) as a sub-meter, provided it meets minimum requirements (accountable, remotely readable). A Meter Data Company (MDC) must collect the data, and the MDC reading the meter at the connection must deduct the charging energy volume from the total volume. The Aggregator must assign a Supplier and a BRP to the EV charging unit; it may choose the same ones for all its customers. This creates a situation very similar to the current market organization; however, several complications emerge on the Prosumer level:

1. The Prosumer now has two (or more) supply contracts and will receive multiple bills, which may present complications; for example, if energy taxes are based on graduated scales.
2. If the Prosumer wants to use photovoltaic power to charge the EV, the energy must be transferred across internal virtual transfer points, which means that both Suppliers must transfer ownership of energy that has never left the house.
3. In practice, an Aggregator associated with a BRP and Supplier that is serving the Prosumer with a flexibility contact may be inclined to serve the Prosumer's full load, which would lead us back to the current market situation.

Emergency power example

This example is very similar to the previous example.

1. If the energy produced by the UPS is consumed by the Prosumer (which will often be the case), the energy must be transferred from one Supplier to the other.
2. Tax complications are also likely to occur in this scenario.

From this, we draw two conclusions:

1. The VTP method is an alternative way to facilitate the independent Aggregator. It may coexist with the EG3 model; its implementation depends on regulatory choices within the EU member states.
2. It differs significantly from the EG3 model in that it incorporates a separate Supplier for each transfer point, making it a transparent solution for the flexibility market with a high impact on Prosumer supply and billing.

4.1.3 Conclusions

The main conclusions are summarized in the table below.

	Pros	Cons
Current situation	· Clear responsibilities · Relatively simple model · No additional settlement	· Aggregator role is tightly coupled with the incumbent BRP/Supplier
EG3 model	· Level playing field for Aggregator · One Supplier per connection	· Possible high costs in metering process (sub-metering often required) · Complexity in settlement process
VTP model	· Clear responsibilities · Independent Aggregator allowed, with some additional obligations	· Additional supply contract(s) for Prosumer · High costs in metering process (sub-metering required) · Complexity in Prosumer billing and self-balancing

Table 2. Comparison of independent Aggregator models

4.2 Impact on USEF

4.2.1 Impact of the EG3 model

The EG3 model is in line with the current USEF model, in which the Aggregator interacts with the Prosumer, DSO, and BRP. The identified information flows are also acknowledged and implemented in USEF's processes, albeit at a high level.

There is, however, one possible effect the EG3 model may have on the current USEF framework. EG3 discerns two BRPs: the BRP associated with the Aggregator and the BRP associated with the Prosumer. If these market players are different, which in the case of the independent Aggregator they by definition are, then we need to project the four basic elements of USEF flexibility activation onto these separate roles. We elaborate on this projection in the appendix for the ***regulated*** compensation method (described in Table 1). If a different compensation method is used, there may be additional impact, primarily on the ***Settle*** process.

Next steps

Since USEF describes and (through its reference implementation) implements processes, we cannot ignore the baseline methodology's complexity. It seems that no method is available that can cover all flexibility services. Therefore the USEF specifications will further be elaborated using a set of combinations of services and resources, representative short-term viable propositions, as follows:

- Decide on the relevant flexibility services, customer(s), and resources. Then, for each combination of these:
  - Define the flexibility service or product in detail.
  - Describe the long-term flexibility contract.
  - Describe the baseline methodology.
  - Verify the Plan, Validate, and Operate phases.
  - Elaborate the Settle phase.

4.2.2 Impact of the VTP model

The impact of the virtual transfer point model on USEF is very limited. In this case, the Aggregator has a contractual relationship with a BRP, and will only operate within that BRP's portfolio. The current version of USEF is therefore fit for purpose, with the single modification that the definition of a Connection Point may be expanded to encompass a virtual transfer point.

Appendix Elaboration on the EG3 model

In the following analysis, we focus on the DSO's responsibility for congestion management and the TSO's responsibility for power balancing, since these activities seem most relevant to demand-side flexibility in the short to medium term. We examine the effects the Aggregator has on the BRP and the DSO when providing balancing services to the TSO, and address the four basic elements of flexibility activation introduced in section 2.4. The interaction between the Aggregator and the Prosumer is excluded from this analysis.

A.1 Flexibility services aimed at the TSO

In this section, we examine the case where the Aggregator provides balancing services through the BPR to the TSO

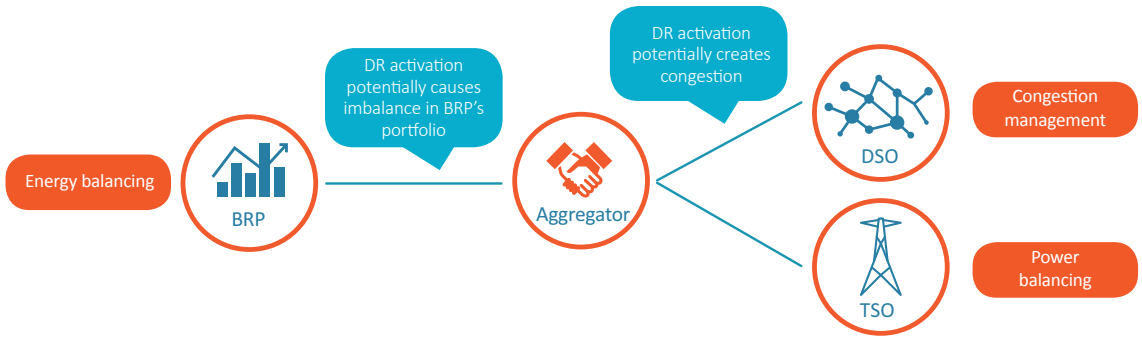

Figure 4: An Aggregator providing balancing services to a TSO.

A.1.1 Reference scenario

We assume that for a specific Prosumer, the nomination shown in figure 5 has occurred for a specific PTU.

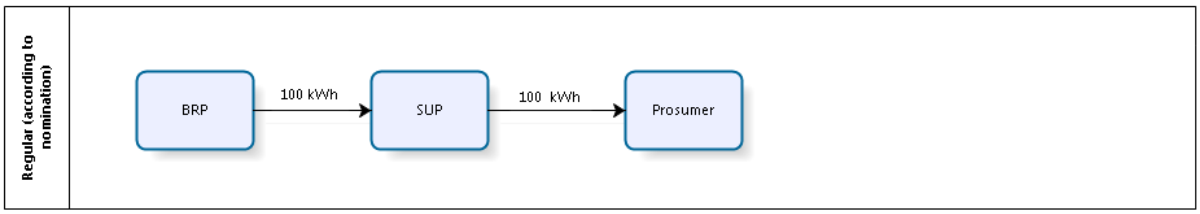

Figure 5: Reference scenario

This means that, under normal conditions, this Prosumer will cause no imbalance for the BRP and the supplier will deliver 100kWh of commodity. This "normal behavior" can be considered the baseline reference by which to evaluate DR activations.

A.1.2 The Aggregator's position

The Aggregator offers a capacity product to the TSO for balancing purposes.

"Figure 6. Capacity view" on page 15 depicts the situation where the Aggregator controls a Prosumer's load in order to meet its obligation to the TSO to offer capacity to the balancing market. The figure depicts the situation for ramping down (demand enhancement); a similar figure can be drawn for ramping up (demand curtailment). The red lines represent effects caused by the Aggregator, and the black lines represent effects that are external to the Aggregator's actions.

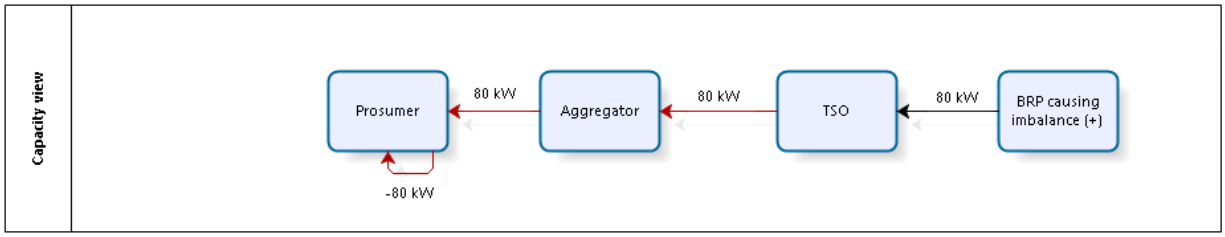

Figure 6: Capacity view

The energy effects from the Aggregator's actions are further detailed below.

Energy effects

An Aggregator offering balancing services to the TSO and needing to ramp down (i.e., absorb energy) may influence the Prosumer's load as indicated in Figure 7. This diagram depicts the current situation in many EU countries, where the Aggregator may influence loads but does not take a commodity position. In this case, the BRP responsible for the Prosumer will face an imbalance due to the Aggregator's demand enhancement.

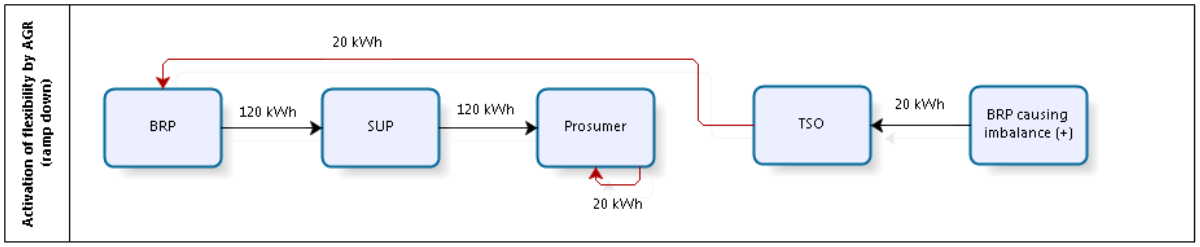

Figure 7: An Aggregator ramping down (demand enhancement).

Figure 7 shows the energy effects for one specific PTU of 15 minutes.
The load can be influenced in four ways (or any combination):

1. 20 kWh of additional load is initiated.
2. 20 kWh of load is shifted from another PTU to this PTU.
3. 20 kWh of the Prosumer's own generation is reduced (denoted by circular reference).
4. 20 kWh is stored locally (also denoted by circular reference).

Since the Aggregator has initiated the additional load, the Aggregator can be added to the energy equation as shown in Figure 8.

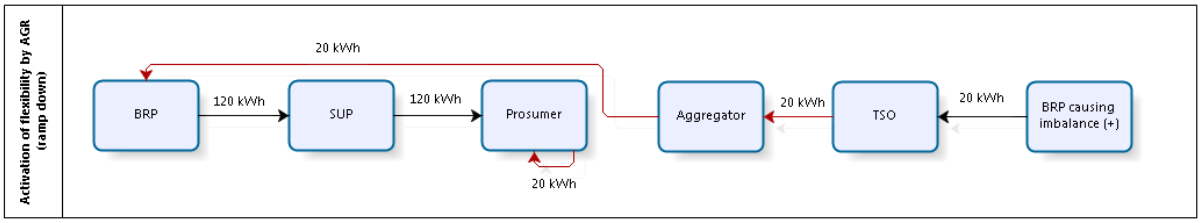

Figure 8: Adding the Aggregator to the energy equation.

Alternatively, the Aggregator could deliver the energy directly to the customer. This would result in two energy suppliers serving one connection, whereas the action depicted in the figure above could limit the transaction to the wholesale market. Especially when the Aggregator is ramping up (demand curtailment), the Supplier would deliver energy that does not pass the Prosumer's connection point, which would significantly complicate billing, taxes, and other matters.

Adding the Aggregator to the energy equation is not a necessity, but in our opinion it is a logical choice. There are two main justifications for it:

1. If the acquired or sold energy is not delivered by the Aggregator, the TSO is forced to buy or sell the remaining balancing power on the market, often at higher prices. The associated volume effects cannot be borne by the BRP whose portfolio was affected by the Aggregator, and must thus be borne by the Aggregator. This implies that the Aggregator must also take a volume position.
2. In this example we only consider the Aggregator offering balancing services to the TSO. The Aggregator can also offer other services (such as services targeting the national capacity market) or target other customers (such as the DSO). The solution proposed here works for every other product-market combination we studied, making it clear and transparent and supporting the principle that parties should be accountable for their own activities. In our example, the TSO both acquires the flexibility and settles the balance responsibility; other product-market combinations are often more complex.

To keep roles separate, the conclusion that the Aggregator needs to take a volume position for the traded flexibility means the Aggregator needs to assign a BRP to its flexibility portfolio. To do that, the Aggregator must form a contractual arrangement with a BRP. The main difference from the current situation is that the Aggregator is not limited to the BRP associated with the Prosumer through its supply contract but can choose its own BRP, which means it could select a single BRP for its entire portfolio.

The conclusive energy flow is shown in Figure 9. The Aggregator has a contractual relationship with both the Prosumer and BRP-2, yet takes no explicit role in the energy equation. Energy trading and settlement take place between BRPs, in line with existing wholesale markets.

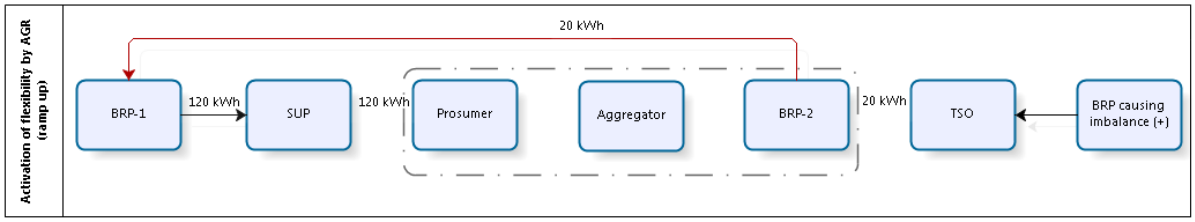

Figure 9: Energy flow and BRP's position

We conclude our analysis by repeating the first figure from section 2.2 of the main paper. A second BRP has been positioned between the Aggregator and the TSO, with three positive results:

1. This setup easily aligns with current market organizations where energy trading and balancing are organized through the BRP role.
2. This setup ensures that the balance responsibility for the flexibility is placed where the flexibility is controlled.
3. This setup clearly shows that either the Aggregator is serving the needs of a BRP directly (often based on portfolio optimization), or the needs of a TSO through a BRP.

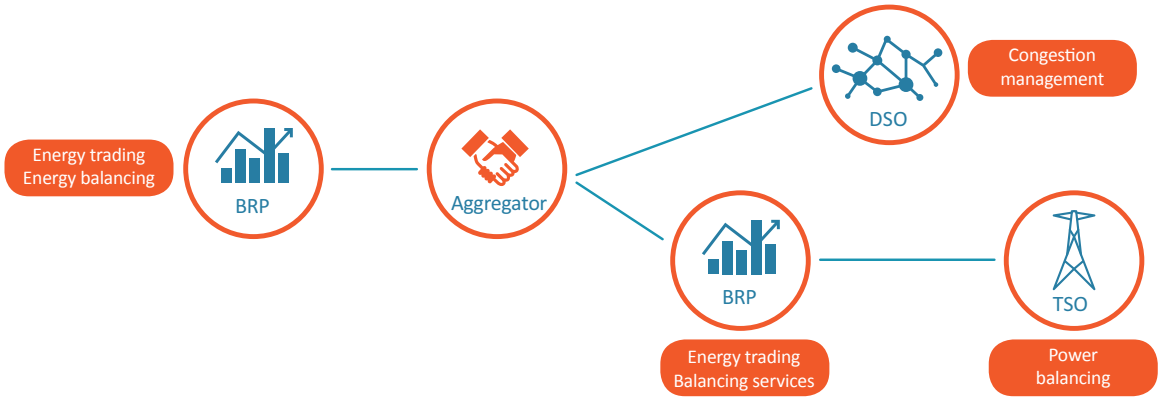

Figure 10: The BRP's position in flexibility markets

A.1.3 Mapping to the four basic elements of flexibility activation in USEF

Since the Aggregator is providing services to the TSO through its own BRP, we need to examine the required interaction with the other stakeholders: DSOs and (affected) BRPs. In Table 3 we include a first assessment of the required interaction for the four basic elements; this may need further elaboration given the commercial sensibility of certain information.

	BRP-1	DSO
Capability	In the Contract phase, the Aggregator needs to specify on the Prosumer level[4] which flexibility is under its control, including its main characteristics.	In the Contract phase, the Aggregator needs to specify on the Congestion Point level which flexibility is under its control, including its main characteristics.[5]
Intention	The Aggregator needs to specify on the Prosumer level which flexibility will be activated, including its main characteristics (similar to USEF 2014:I.II A-plan).	The Aggregator needs to specify on the Congestion Point level which flexibility will be activated, including its main characteristics (already included in USEF 2014:I.II D-prognosis).
Realization	The BRP needs to be informed on the Prosumer level of the flexibility that has been activated, including its main characteristics.	The DSO needs to be informed on the Aggregator–Congestion Point level of the flexibility that has been activated, including its main characteristics. (This is similar to the smart-meter allocation on the Congestion Point level as included in USEF 2014:I.II wholesale settlement.)
Settlement	The BRP needs to be compensated for the flexibility that has been activated by an Aggregator. The settlement price will be determined by the regulator, yet a gross retail price (possibly decreased by a balancing risk margin for the flexibility) seems reasonable, as this reflects the directly incurred costs and benefits for the BRP and associated Supplier.	If (and only if) flexibility from this Aggregator has been activated for the DSO's purposes, a penalty will be charged if the Aggregator does not meet its final D-prognosis. This only applies when the activation for the TSO is misaligned with the DSO's request, thus increasing potential congestion (already included in USEF 2014:I.II settlement).

Table 3. Mapping to the four basic elements of flexibility.

In the short term, measurement will occur on the connection level, either through smart metering or interval metering. For optimal market functioning, flexibility metering should be possible on the device or appliance level. This requires additional changes to the wholesale processes, to enable virtual allocation based on sub metering (virtual transfer points). This would allow an E-mobility Service Provider to take on the role of Aggregator for a fleet of electric vehicles, for example, without the need to include all non-controllable load in its portfolio, when charging takes place behind a retail or commercial connection.

4. The Prosumer level is necessary to ensure the BRP will not counteract the balancing mechanism if it observes that its Prosumer is deviating from its program or forecast. The Supplier may also need to adjust the customer invoice to reflect the wholesale settlement.
5. The DSO needs these characteristics to determine the technical parameters (available capacity, ramp up or down times, and daily or seasonal patterns).

A.2 Flexibility services aimed at the DSO

In this example we assume that the Aggregator is providing congestion management services to the DSO.

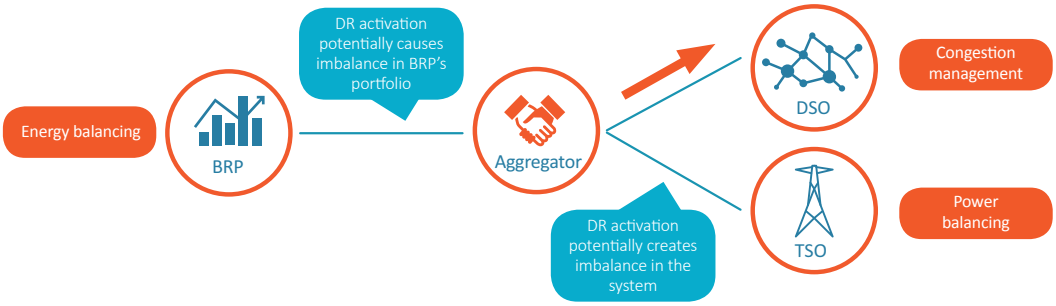

Figure 11: An Aggregator providing congestion management services to a DSO.

A.2.1 Mapping to the four basic elements of flexibility activation in USEF

Since the Aggregator is providing services to the DSO, we need to examine the required interaction with the other stakeholders, the TSO and BRP. In this case we assume the Aggregator has no contractual relationship with the Prosumer's BRP, only with its own BRP. In Table 4 we include a first assessment of the required interaction for the four basic elements; this may need further elaboration given the commercial sensibility of certain information.

	BRP	TSO
Capability	In the Contract phase, the Aggregator needs to specify on the Prosumer level which flexibility is under its control, including its main characteristics.	In the Contract phase, the Aggregator needs to specify on the portfolio level which flexibility is under its control, including its main characteristics.
Intention	The Aggregator needs to specify on the Prosumer level which flexibility will be activated, including its main characteristics (similar to USEF 2014:I.II A-plan).	The Aggregator needs to specify on the portfolio level which flexibility will be activated, unless the activation is evened out in its own portfolio. This responsibility can be performed by the Aggregator's BRP, by sending a nomination for the Aggregator's flexibility portfolio.
Realization	The BRP needs to be informed on the Prosumer level of the flexibility that has been activated, including its main characteristics.	The TSO needs to be informed on the Aggregator-BRP level of the flexibility that has been activated, including its main characteristics. (This is included in USEF 2014:I.II wholesale settlement.)
Settlement	The BRP needs to be compensated for the flexibility that has been activated by an Aggregator. The settlement price will be determined by the regulator, yet a gross retail price (possibly decreased by a balancing risk margin for the flexibility) seems reasonable.	If the Aggregator does not meet its nomination, the deviation will be settled through the balancing mechanism.

Table 4. Mapping to the four basic elements of flexibility.

A.3 Other services and markets

We believe that other services and other markets can be integrated into this framework in a similar fashion. However, one must assess for each service whether all roles receive the information required to execute their own tasks related to their responsibilities, and whether they are sufficiently compensated for any incurred damage.

References

[1] Regulatory Recommendations for the Deployment of Flexibility, Smart Grid Task Force EG3, January 2015, https://ec.europa.eu/energy/sites/ener/files/documents/EG3%20Final%20-%20January%202015.pdf

[2] Missing Links to Integrate Demand Response Aggregators into the European Wholesale Electricity Markets, Eurelectric, Draft, December 2014

[3] Demand-Side Response Policy Paper, ENTSO-E, 15 September 2014

[4] Demand Response in France: Focus on NEBEF Mechanism, ERDF, 06-02-2015

[5] Flexibility, FEBEG position paper, FEBEG, 12-05-2014

[6] Enabling independent aggregation in the European electricity markets, Smart Energy Demand Coalition, February 2015