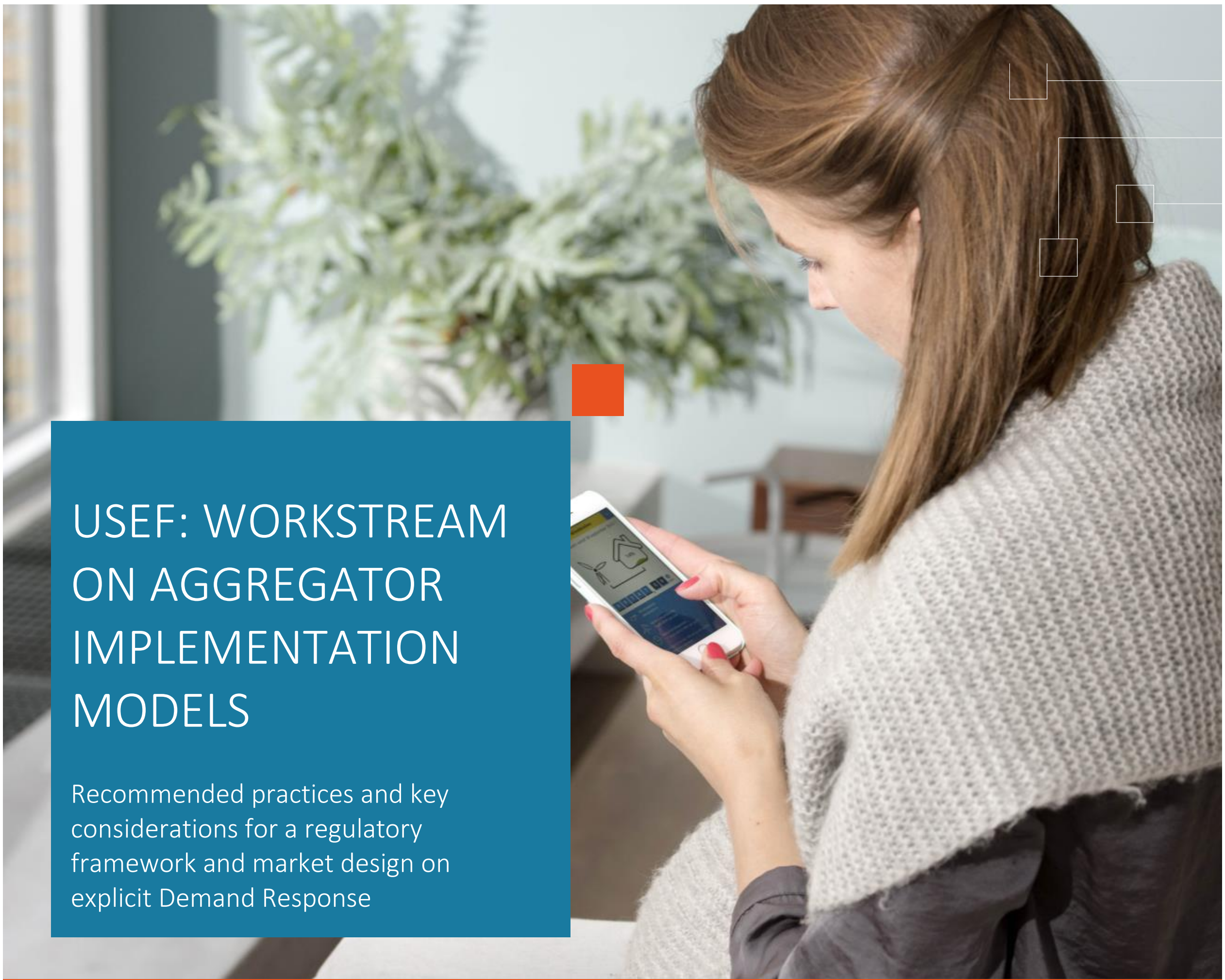

USEF: WORKSTREAM ON AGGREGATOR IMPLEMENTATION MODELS

Recommended practices and key considerations for a regulatory framework and market design on explicit Demand Response

Update September 2017: Includes residential customer segment

A solid foundation for smart energy futures

Version 2.0: September 2017

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Disclaimer: Although the recommendations and considerations in this report are the result of common understanding and consensus of all participants, it does not necessarily align with the corporate opinion(s) of the participant's organizations.

Management Summary

The European Union is moving towards a more sustainable energy sector. The proportion of renewables is growing fast: The European Commission predicts it will rise from 25% today to 50% by 2030. At the same time, with increased electrification, the way we use energy is changing too. We are increasingly using electricity to power vehicles, heating / cooling systems, and many other aspects of our daily lives. Patterns of demand and generation are going to shift, and become increasingly out of step. So power systems will need more flexibility to balance supply and demand.

Energy flexibility and demand-side response (DR) are essential for the European Union to meet its sustainable energy goals. And with traditional, fossil fuel-burning flexibility resources going offline for environmental reasons, that flexibility will need to take new forms. At the same time, companies and individuals can install their own renewable resources shifting them from energy *consumers* to energy *Prosumers* – drawing power from or feeding it to the grid depending on conditions. Prosumers have the potential to deliver that new form of flexibility the power system needs. The flexibility they offer individually may be small, but the overall power volume could be enough to keep the power system balanced.

For the prosumer to gain access to this flexibility market, and thus support the long-term sustainability of the energy system, a new role is needed in the energy value chain: the *Aggregator*. Operating between flexibility Suppliers (in this case Prosumers) and flexibility users – transmission system operators (TSOs), distribution system operators (DSOs) and balance responsible parties (BRPs) – the Aggregator bundles many small flexibility resources into a useful flexibility volume.
It is a role that can be fulfilled by existing market parties (e.g. suppliers) and new entrants.

Both regulators and industry bodies agree demand-side response will be a vital part of future sustainable energy systems and that aggregators are necessary to make this possible. Also it is generally accepted that regulation is required to secure Aggregators' sustainable market access. But there is much debate over exactly how aggregation will work best in practice, and precisely which regulation is needed with respect to aggregator implementation models and the wider flexibility market. Moreover, different Aggregator implementation models are currently emerging in different countries. Yet for a truly transparent and integrated flexibility market, we need more harmonisation of roles and processes.

In the Aggregator implementation models for explicit DR, flexibility is separated from the underlying energy supply, where the aggregator takes responsibility for the activation of flexibility and the Supplier for energy supply. However, separating flexibility from energy is not straightforward, since activation of flexibility leads to a deviation of the 'normal' energy consumption or generation pattern of that Prosumer, and thus affects the amount of consumed/delivered energy. Consequently, the Balance Responsible Party, (BRP) who takes balance responsibility for the supply, and the Supplier supplying the energy are both affected.

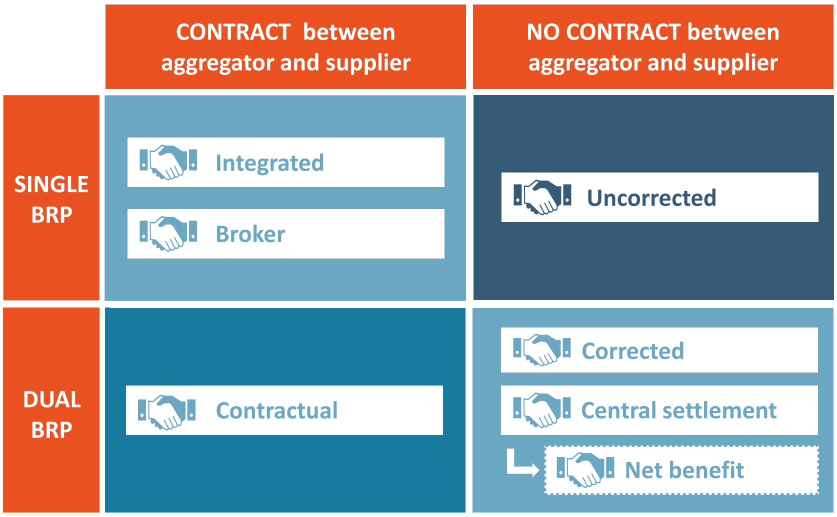
USEF Foundation's Aggregator workstream was set up in the beginning of 2016 to further shape the Aggregator role and integrate demand-side flexibility in to all relevant markets and products. The workstream analysed the different topics related to the aggregator role with particular focus on the relationship between aggregator and the BRP/Supplier. This resulted in a list of 'complexities' that have to be solved:

- **Measurement and validation -** Ensuring correct and trustworthy data
- **Baseline methodology –** How to define appropriate baseline methodologies, roles and responsibilities?
- **Information exchange and confidentiality -** Finding a balance between transparency and confidentiality
- **Transfer of energy price methodology -** How to compensate the position of the Prosumer's supplier and its BRP?.
- **Relationship between implicit and explicit Demand Response -** How to separate both impacts unambiguously
- **Rebound effect -** Can the BRP or Supplier be negatively impacted and if so, how can this be compensated?
- **Portfolio conditions -** How to participate in TSO/DSO/BRP products through a portfolio?

The workstream also defined a method for classifying aggregation implementation models, based on the following questions:

1. Are the roles of the Supplier and Aggregator combined in a single market party?
2. Does the Aggregator need to assign its own BRP?
3. Does the Aggregator need a contract with the Supplier's BRP?
4. For dual-BRP models: how is energy transferred between the Aggregator's BRP and the Supplier's BRP?

The classification leads to seven different aggregation implementation models shown below (and discussed in Section 5.2):



Each of these models has certain advantages and limitations which are discussed in the implementation model assessment in Chapter 7. The group's intention is not to advocate a certain model but to state objective facts associated with each model. Different Aggregator implementation models are currently emerging in different countries. We believe that understanding the different models will also support harmonization efforts.

The workstreams thorough analysis of the complexities has led to a list of recommendations and considerations, presented in Chapter 6 of this report. *Recommendations* were formulated in those cases where, from an engineering perspective, workstream participants reached an agreement on a solution for a given complexity which satisfied the needs of all stakeholders. The recommendation could be used to advise the EC and NRAs and/or could be a component in a standardized contract between the Aggregator and the Supplier (or its BRP). In cases where an agreement could not be reached, we have chosen to formulate a *consideration* clearly stating the implications of different options that could be envisaged. This provides a background for an NRA's decision and can used to settle bilateral negotiations on a case-by-case basis. For each of the recommendations and considerations, the applicability is specified for:

- The specific (flexibility) products
- The specific customer segments
- The specific Aggregator Implementation Models

The Aggregator workstream has studied the Commercial and Industrial C&I customer segment (C&I) as well as the residential segment. The first version of this report (Nov 2016) was focused on C&I customers. This update gives the final results for both customer segments.

Especially for the residential customer segment additional models were introduced for situations where the activation of Demand Response takes place on a day-to-day basis where activation is difficult to distinguish from normal operations. This gave rise to the so-called Reference Profile Models.

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1 About this report

1.1 Background

The Universal Smart Energy Framework (USEF) describes a standard which unlocks the value of flexible energy use by making it a tradeable commodity and delivering the market structure and associated processes and rules required to make it work effectively. USEF is designed to offer fair market access and benefits to all stakeholders and enables so-called *explicit demand response*, yet can co-exist with *implicit demand response* schemes resulting from time-varying electricity prices or time-varying network grid tariffs.

Within USEF there is a clear distinction between the energy supply chain and the flexibility supply chain. USEF's Aggregator role unlocks and maximizes the value of demand-side flexibility. To that end, the Aggregator establishes a contract with the End-user (Prosumer) describing the terms and conditions under which it can exploit the flexibility. However, separating flexibility from energy is not straightforward since activation of flexibility leads to a deviation of the 'normal' energy consumption or generation pattern of that Prosumer, affecting the amount of consumed/delivered energy. Consequently, the Balance Responsible Party (BRP), with balance responsibility for the supply, and the Supplier supplying the energy are both affected. To keep things simple, USEF – in its current framework - appointed a single BRP role, who bears balance responsibility for both energy and flexibility. In this framework the Aggregator establishes a flexibility service contract with this BRP, specifying the terms and conditions for trading flexibility, including the settlement of imbalance resulting from flexibility transactions. The BRP can use the flexibility to optimize its own portfolio, trade it on the market, or transfer it from the Aggregator to the TSO. A second source of value for the Aggregator are DSO services like grid congestion management. To that end, the Aggregator (implicitly) establishes a flexibility service contract with the DSO.

USEF describes a role model which, in general, does not limit or prescribe which market parties should / can take or combine certain roles. However, the current USEF specifications do require a contractual relationship between the Aggregator and the BRP associated with the Prosumer, whose flexibility is deployed by the Aggregator. This may lead to a situation where the Aggregator role is reserved for market parties fulfilling the Supplier role. This could be resolved by establishing an independent Aggregator

> An *independent Aggregator model* refers to a situation where an Aggregator serves a Prosumer, exploiting its flexibility without having a contractual relationship with, or consent from, the Supplier or BRP serving that same Prosumer.

The publication 'USEF: the framework explained' [1] already introduced the concept of an independent Aggregator, including a second BRP associated with the Aggregator to bear balance responsibility during flexibility activation. This is referred to as a flex-only balance responsibility model or simply Flex-BR model. The exact relationship between the Aggregator and the BRP_{sup} was not detailed further.

USEF Foundation's Aggregator workstream was set up in the beginning of 2016 to further shape the Aggregator role to integrate demand-side flexibility in all relevant markets and products. The workstream focused on the possible relationships between an Aggregator and the BRP/Supplier, including both contractual relations and non-contractual. The result of this work is published in this report.

1.2 Purpose

The Aggregator is a new, crucial role in the energy value chain. The regulatory framework for this Aggregator role is still under discussion in the multiple EU markets with different Aggregator implementation models currently emerging in different countries. However, transparent and efficient integration of flexibility across markets requires harmonization of roles and processes. With an engineered approach, this report provides viable solutions for the multiple challenges related to the Aggregator role.

The purpose of this work is to develop an independent overview to:

- Support EU discussions by providing analysis on the different topics related to the Aggregator role (e.g. sub-metering, baselining). We achieve this by providing a set of recommendations and considerations leading to viable solutions (simple, transparent, fair) that can be implemented in a cost-efficient way.
- Advise the further development of USEF.

1.3 Scope

This document discusses possible Aggregator implementation models, which can be applied to implement the Aggregator role In existing energy markets. Allowing one or more implementation models is part of the market regulation and should be decided upon by the European Commission or national regulatory authorities. To support harmonization, this document presents a comprehensive set of recommendations and considerations that specify how to integrate explicit demand response with all relevant markets and products.

1.4 Contributors

The Aggregator workstream consists of independent energy professionals from multiple countries with different roles in the energy market.

Participants	Role
Andreas Flamm (Entelios)	Aggregator
Peter Schell (REstore)	Aggregator
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Claus Fest (Innogy)	Supplier
Poul Brath (Dong Energy)	DSO
Paul de Wit (Alliander)	DSO
Hans de Heer (USEF)	Subject matter expert
Marten van der Laan (USEF)	Moderator

1.5 Intended Audience

One of the goals of this report is to advise the USEF foundation on the further development of the framework and therefore the USEF Foundation is one of the target audiences. This document is also useful for:

- EU- policy makers and regulatory bodies
- National policy-makers and regulatory bodies
- Primary stakeholders of demand-side flexibility, i.e. TSOs, DSOs, BRPs, and Suppliers.
- Organizations taking up the Aggregator role
- (Industrial) bodies and associations like ACER, CECED, CEDEC, CEER, EDSO, EFET, ENTSO-E, ESMIG, EURELECTRIC, GEODE, SEDC, and others

1.6 Reading Guideline

Chapter 2 describes the role of demand response in the transition to sustainable energy systems and the complexities involved in integrating demand response. Chapter 3 provides the context of this work: the different roles involved and their interaction related to demand response. It also includes an example which is used to illustrate the different aggregator implementation models. Chapter 4 lists the different flexibility services (products) that we have considered in this study and the assumption being made. In Chapter 5 we present a classification method for possible aggregator implementation models resulting in six different *aggregator implementation models*. Chapter 6 provides a set of recommendations and considerations for each of the identified complexities, Chapter 7 gives a set of recommendations and considerations with respect to aggregator implementation model assessment, a decision tree for an aggregator active in the residential customer segment and a possible demand response roadmap.

2 Harmonizing EU aggregation models for effective demand-side response

Energy flexibility and demand-side response (DR) are essential for the European Union to meet its sustainable energy goals. Hence, a new role is emerging in the energy value chain: the flexibility Aggregator. But different energy markets have different drivers and challenges. The industry- and continent-wide study that has been undertaken by the USEF Foundation's Aggregator Workstream shows how aggregation can be implemented effectively in different markets to deliver optimal flexibility for all.

The European Union is moving towards a more sustainable energy sector. The proportion of renewables is growing fast: The European Commission predicts it will rise from 25% today to 50% by 2030. At the same time, with increased electrification, the way we use energy is changing too. We are increasingly using electricity to power vehicles, heating / cooling systems, and many other aspects of our daily lives.

These trends will have major impacts on the power system. Patterns of peak demand and peak generation are going to shift, and become increasingly out of step. So power systems will need more flexibility to balance supply and demand. And with traditional, fossil fuel-burning flexibility resources going offline for environmental reasons, that flexibility will need to take new forms. At the same time, companies and individuals can install their own renewable resources to shift from energy *consumers* to energy *Prosumers* – drawing power from or feeding it to the grid depending on conditions. Prosumers, both residential and Industrial, have the potential to deliver that new form of flexibility the power system needs. The flexibility they offer individually may be small but the overall power volume could be enough to keep the power system balanced.

2.1 Creating an accessible flexibility market

The key questions are: how does the power sector take advantage of this new flexibility resource and how can Prosumers benefit from the flexibility they can offer? It is widely accepted that the answer to these questions must be built on market-based factors such as incentives for Prosumers who are willing to make their flexibility available.

One option is to expose Prosumers to energy prices that reflect actual scarcity, allowing them to shift their energy demand to periods with low energy prices. Known as *price-based* or *implicit* demand response, this mechanism is already implemented in some countries for commercial and industrial segments. With a large-scale roll-out of smart metering, it can be applied to the residential sector as well[1].

However, both the energy balancing and system adequacy markets require a second form: *incentive-based* or explicit demand response. Here Prosumers can receive (financial) rewards for agreeing to respond to requests to adjust power generation / consumption. This is more suitable for energy balancing and system adequacy as the flexibility is *dispatchable* and can be tailored to the markets' exact needs (size and timing).

[1] This is already the case in France

Incentive-based demand response leads to the emergence of a new type of player in the energy value chain: the *Aggregator*. Operating between flexibility Suppliers (in this case Prosumers) and flexibility users – transmission system operators (TSOs), distribution system operators (DSOs) and balance responsible parties (BRPs) – the Aggregator bundles many small flexibility resources into a useful flexibility volume.

This allows these smaller packets of flexibility to be traded, lowering the existing market-entry barrier for individual Prosumers. As a result, incentive-based demand-side response becomes a possibility for all.

To see how Aggregators open up new flexibility resources and make demand-side response possible, we can look at the example of Belgium. In the summer of 2014, Belgium was facing the likelihood of having insufficient generation capacity to meet demand during the upcoming winter due to essential maintenance at two nuclear power plants. The Government prepared disconnection plans for end users as a last resort, but also asked the industry for help. This resulted in extra generation capacity by switching on emergency power facilities, and the possibility of reducing demand at industrial plants in return for financial incentives. Aggregators contracted the generation units and industrial plants and offered the flexibility to the national TSO Elia. Today. in Belgium, demand-response can also be part of primary, tertiary and interruptible contracts programmes.

2.2 An industry-wide view

Both regulators and industry bodies agree demand-side response will be a vital part of future sustainable energy systems and that Aggregators are necessary to make this possible. Also it is generally accepted that regulation is required to secure Aggregators' sustainable market access. But there is much debate over exactly how aggregation will work best in practice, and precisely which regulation is needed with respect to Aggregator implementation models and the wider flexibility market.

Ideally, Prosumers should be free to offer their flexibility to any party they choose. However, how to organise the market to realise this, while also meeting the needs of other stakeholders, is not yet clear. Thanks to solid work by regulators and industry, good progress has been made in understanding the challenges of integrating demand-side response. From these efforts, it is becoming increasingly evident that no one solution for implementing flexibility aggregation will be suitable for all the different market situations that are likely to exist across Europe. In energy flexibility, one size does not fit all.

2.3 Looking at the bigger picture of demand-side response

To see why this is the case, we only need to look at the various challenges involved in integrating explicit demand-side response.

Measurement and validation

How do you measure or calculate flexibility? Whose responsibility is it to do so? What is the role of sub-metering? How to ensure correct and trustworthy data?

Baseline methodology

A baseline methodology is needed to quantify the performance of flexibility service providers towards the customers of the flexibility (being the TSO, BRP or DSOs) and provide a basis for the transfer of energy. But who should be responsible for establishing this baseline methodology? And which parameters are used to ensure a sufficient level of accuracy and reproducibility?

Information exchange and confidentiality

For effective demand-side response, each player in the energy value chain will need information from others, for example to enable accurate forecasting or billing. However, some of this information may be commercially sensitive. Agreeing what information will be shared, when and at what aggregation level is thus critical. Finding a balance between transparency and confidentiality is crucial.

Transfer of energy price methodology

Is an energy settlement between the Aggregator's BRP and the Supplier (and/or its BRP) needed? If so, how should this be organised? Which costs or avoided revenues should be compensated? Does the system need different policies for different types of customer?

Relationship between implicit and explicit demand response?

In many cases, a flexibility resource may be subject to both price-based (implicit) and incentive-based (explicit) demand response. Can the impacts of the two forms be separated unambiguously? Or does the combination need to be avoided?

Rebound effect

After a period in which flexibility has been activated, a rebound effect may occur. For instance, a reduction in energy consumption could lead to demand being shifted to a later time. Does this effect need to be compensated towards the Supplier or its BRP? If so, how?

Portfolio conditions

Which complications occur if an Aggregator offers flexibility from within a portfolio, rather than a set of separate flexibility resources? How can these challenges be overcome? How to participate in TSO/DSO/BRP products through a portfolio?

2.4 An engineering view

Clearly, the challenges involved in integrating demand-side response into an energy system are many and varied. Furthermore, the relative importance of each of these challenges varies depending on the specific market, product, segment and resource type being considered. This explains why it is not feasible to expect that a single solution for aggregation will fit all likely market conditions acceptably. However, when balancing, adequacy and congestion products and wholesale markets are more harmonized throughout Europe, harmonized solutions for DR market design are attainable and desirable. The better these rules are harmonized, the more effective it will be to trade DR volumes across borders.

So how should the flexibility market be shaped? This question has already been addressed by bodies such as the European Commission [2] [3], CEER [4] [5] [6], EDSO [7], ENTSOE [8], EURELECTRIC [9], and the SEDC [10]. While these works have begun to outline possible market and implementation models for aggregation, they have tended to take a high-level view of the issue.

Building on this firm grounding, USEF is now addressing the same issue but from an engineering perspective, looking at the feasibility of implementation models. In its Aggregator workstream, USEF has brought together a pan-European team of experts representing the various players and roles within the energy value chain in an effort to more concretely understand how the full complexity of demand-side response and energy flexibility impacts the implementation of aggregation.

Evaluating aggregation implementation models

The workstream has identified criteria that an Aggregator implementation model should fulfil to be considered a good fit for a given market. As mentioned above, the model must allow Prosumers a free choice of who they offer their flexibility to while also being fair to all parties and minimising complexity. Moreover, within the specific conditions of the target market, the model should ensure transparency, an appropriate compensation of the impact of a DR activation on the BRP and Supplier, verifiability and accountability yet protect (commercially) sensitive data. Finally, it must be market based, enabling the correct incentives to reward desirable behaviour and prevent gaming.

Aggregator implementation model classification

In addition, the workstream has presented a method for classifying aggregation implementation models. This classification is based on the following questions:

1. Are the roles of the Supplier and Aggregator combined in a single market party?
2. Does the Aggregator also need to assign its own BRP?
3. Does the Aggregator need a contract with the Supplier's BRP?
4. For dual-BRP models: how is energy transferred between the Aggregator's BRP and the Supplier's BRP?

This classification leads to a set of possible aggregation implementation models beyond those identified in previous works. Together these models provide a common starting point that will streamline cross-border trading of flexibility products and may ultimately lead to a single European market for demand-side participation.

2.5 Helping Europe deliver effective demand-side response

Different Aggregator implementation models are currently emerging in different countries [11] [12] [13]. Yet for a truly transparent and integrated flexibility market, we need more harmonisation of roles and processes.

To support that harmonisation, the USEF Aggregator workstream delivers, through this report, a comprehensive set of recommendations and considerations that provide ways to integrate demand-side flexibility in all relevant markets and products.

3 Context of this report

In this chapter, we introduce the main elements of the USEF specifications, which served as the context for the workstream's discussion. Also an example use case is presented which is repeatedly used in the model descriptions.

3.1 Setup

For this work we assume a setup where an Aggregator is offering *explicit* (incentive-based) *demand response* services to flexibility customers, either TSOs, BRPs or DSOs. To this end, the Aggregator builds up relationships with *Prosumers* having *controllable assets* (processes). Prosumers will receive a remuneration based on the flexibility they offer through their assets. The Aggregator builds a *portfolio* of assets to meet the size and timing constraints of specific flexibility products. These assets belong to different Prosumers. The Aggregator may choose to specialize on a single flexibility product or offer multiple products within the same portfolio.

Flexibility is defined here as a change in the Prosumer's load profile, either by changing power levels and/or shifting in time. Flexibility cane be delivered by generation assets, consumption assets and storage. See [1] for details.

Since the activation of flexibility changes the energy profile of the Prosumer, the BRP and Supplier of the Prosumer will be affected. Hence, the relationship between Aggregator and BRP/Supplier is important and is investigated in this work. Note that there can be multiple Supplier/BRP combinations in the Aggregator's portfolio. The Prosumer's assets are assumed to be in the distribution network, so also the DSO will be affected as activation of flexibility will generally result in a changed network usage. This setup is depicted in Figure 3-1.

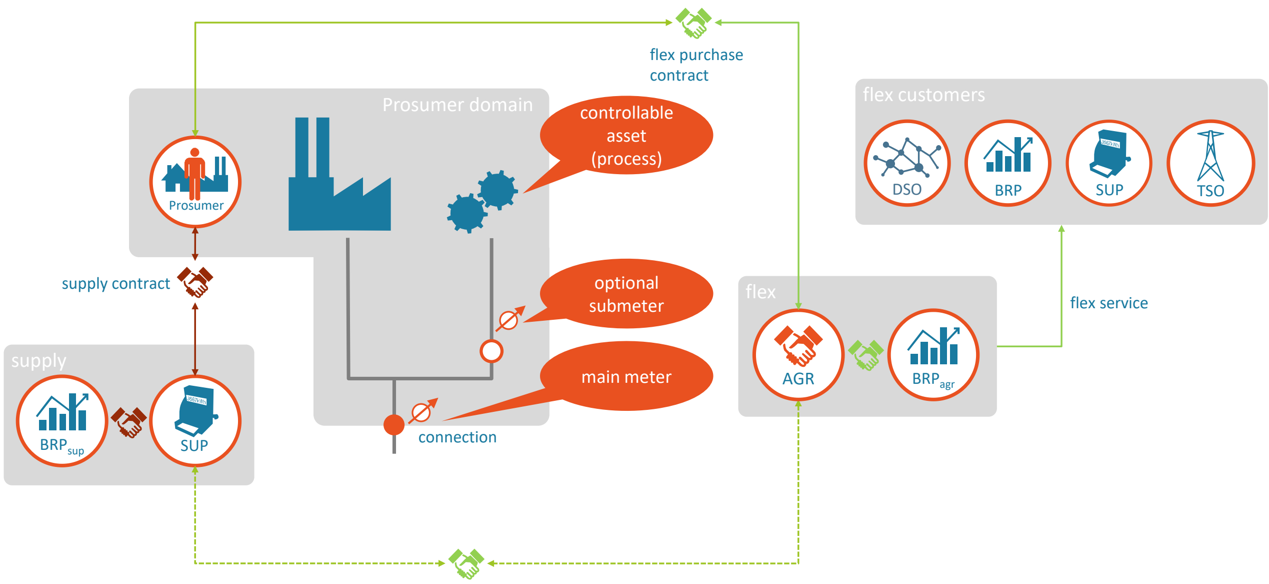

Figure 3-1: Assumed setup for this work

In the picture we distinguish between two BRP roles:

- BRP_{agr} is a BRP associated with the Aggregator who is balance responsible for the activated flexibility
- BRP_{sup} is a BRP associated with the Supplier who is balance responsible for the load and/or generation of the Prosumer

Some of the implementation models that we will discuss in Chapter 5 have only one BRP.

Note that in the picture the BRP and Supplier are grouped in a combined energy supply offer to the Prosumer. This is the most common case where the choice of Supplier implies a BRP. This coupling, however, is not fixed: in many member states, an (industrial) Prosumer is free to select its own BRP to outsource its balance responsibility irrespective of the Supplier choice. In general, our recommendations also cover the latter situation.

Also note that the relationship between the flex-part and supply-part is not clearly assigned to a specific role. In the case of a contractual relationship, two different contracts have to be established: one between Aggregator and Supplier about the Transfer of Energy and one between BRP_{agr} and BRP_{sup} about perimeter corrections.

3.2 Roles

For this work we assume the USEF roles model as described in *USEF: The Framework Explained* [1]. The roles relevant for this work are listed below. In addition, we introduce the role of the Balancing Service Provider.

Prosumer	A Prosumer can be regarded as an end user that no longer only consumes energy, but also produces energy. USEF does not distinguish between residential end users, small and medium-sized enterprises, or industrial users; they are all referred to as Prosumers. In this text we also use the term Prosumer for end users that have controllable assets (Active Demand & Supply) and are thereby capable of offering flexibility.
ADS	In USEF, Active Demand & Supply (ADS) represents all types of systems that either demand energy or supply energy which can be actively controlled. This enables the ADS device to respond to price and other signals from the Aggregator and to provide flexibility to the energy markets via the Aggregator. The Prosumer owns the device and defers responsibility for controlling its flexibility to the Aggregator. The Prosumer has final control over its assets, which means the Aggregator's control space is limited by the Prosumer's comfort settings. Hence the Prosumer is always in control of its comfort level; if the associated remuneration is high enough however, the Prosumer might be willing to compromise on its comfort levels. In this text we also use the terms units, assets or resources when referring to ADS.
Aggregator	The role of the Aggregator is to accumulate flexibility from Prosumers and their Active Demand & Supply and sell it to the BRP or Supplier, the DSO, or (through the BSP) to the TSO. The Aggregator's goal is to maximize the value of that flexibility by providing it to the service defined in the USEF flexibility value chain that has the most urgent need for it. The Aggregator must cancel out the uncertainties of non-delivery from a single Prosumer so that the flexibility provided to the market can be guaranteed. This prevents Prosumers from being exposed to the risks involved in participating in the flexibility markets. The Aggregator is also responsible for the invoicing process associated with the delivery of flexibility. The Aggregator and its Prosumers agree on commercial terms and conditions for the procurement and control of flexibility.
BRP	A Balance Responsible Party (BRP) is responsible for actively balancing supply and demand for its portfolio of Producers, Suppliers, traders, Aggregators, and Prosumers, with the means granted by those actors. In principle, everyone connected to the grid is responsible for his individual balance position and hence must ensure that at each imbalance settlement period (ISP) the exact amount of energy consumed is somehow sourced in the system, or vice versa in case of energy production. The Prosumer's balance responsibility is generally transferred to the BRP, which is usually contracted by the Supplier. Hence the BRP holds the imbalance risk on each connection in its portfolio of Prosumers.
DSO	The DSO is responsible for the active management of the distribution grid and introduces the system operation services defined in the USEF flexibility value chain [1]. The DSO is responsible for the cost-effective distribution of energy while maintaining grid stability in each region. To this end the DSO will 1) check whether DR activation within its network can be safely executed without grid congestion and 2) may purchase flexibility from the aggregators to execute its system operations tasks.
TSO	The role of the Transmission System Operator (TSO) is to transport energy in each region from centralized Producers to dispersed industrial Prosumers and Distribution System Operators over its high-voltage grid. The TSO safeguards the system's long-term ability to meet electricity transmission demands. The TSO is

	responsible for keeping the system in balance by deploying regulating capacity, reserve capacity, and incidental emergency capacity.
BSP	A Balancing Service Provider (BSP) is a market participant providing Balancing Services to the TSO. Each Balancing Energy bid from a Balancing Service Provider is assigned to one or more Balance Responsible Parties. In the current USEF framework [14] we have considered a BSP as a specific type of BRP, and therefore did not make this role explicit. Note that the BSP role is not distinguished in all EU member states. In most states the BRP offers balancing services and is the counterpart to the TSO.[2]
Meter data Company	The Meter Data Company (MDC) is responsible for acquiring and validating meter data. The MDC plays a role in USEF's flexibility settlement process and the wholesale settlement process. In many countries, this role is performed by the DSO.
ARP	The Allocation Responsible Party (ARP) is responsible, within a metering grid area, for establishing and communicating the realized consumption and production volumes per ISP, either on the consumer level or on the aggregated level. The realized volumes are primarily based on actual measurements, but can also be based on estimates. The allocation volumes are input for the flexibility settlement process and the wholesale settlement process.
Supplier	The role of the Supplier is to supply energy, to buy the energy, hedge its position on all timeframes, manage the energy and the associated risks, and invoice energy to its customers. The Supplier and its customers agree on commercial terms for the supply and procurement of energy. A Supplier is a specialization of the Trader role as it exchanges energy with Prosumers as well.
Trader	A Trader buys energy from market parties and re-sells to other market parties on the wholesale market, either directly on a bilateral basis (over the counter) or via the energy exchange (day-ahead, intraday) etc.
ESCo	The ESCo offers auxiliary energy-related services to Prosumers. These services include insight services, energy optimization services, and services such as the remote maintenance of ADS assets. If the Supplier or DSO is applying implicit demand response through (for example) time-of-use or kWmax tariffs, the ESCo can provide energy optimization services based on these tariffs. Unlike the (role of) Aggregator, the ESCo is not active (nor exposed) on wholesale or balancing markets

[2] In the Belgium market model, the BSP role is included

3.3 Flexibility Value Chain

In “USEF: The Framework Explained” [1] we introduced the USEF Flexibility Value Chain as a comprehensive overview of all existing and future flexibility Services an Aggregator can offer. For this work we have used a subset, applying the most relevant products. In some cases, the flexibility services are already defined as concrete products and are fully operational, for example, primary, secondary or tertiary control. Depending on the national regulations and product definitions, these products may already allow (aggregations of) demand side flexibility to participate [15]. In some other cases, for example DSO congestion management or voltage control, a clear product definition does not yet exist.

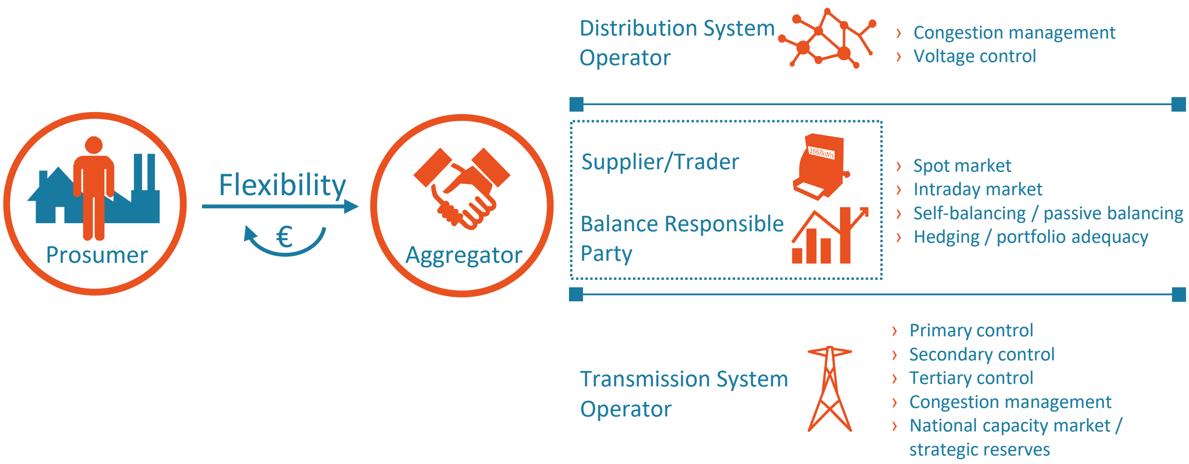

Figure 3-2 Flexibility Value Chain, relevant subset for this work

The Flexibility value chain is depicted in Figure 3-2. The services are further described in Chapter 4.

3.4 Explicit versus implicit demand response

In Section 2.1 we mentioned explicit and implicit Demand response. In [15] a useful definition is provided which we cite here:
“…

> In **Explicit Demand Response schemes** (sometimes called “incentive-based”) the **aggregated** demand side resources are traded in the wholesale, balancing, and capacity markets. Consumers receive **direct payments** to change their consumption (or generation) patterns upon request, triggered by, for example, activation of balancing energy, differences in electricity prices or a constraint on the network. Consumers can earn from their consumption flexibility individually or by contracting with an Aggregator: either a third-party Aggregator or the customer’s Supplier.
>
> **Implicit Demand Response** (also sometimes called “price-based”) refers to consumers choosing to be exposed to *time-varying electricity prices or time-varying network grid tariffs* that reflect the value and cost of electricity and/or transportation in different time periods. They respond to wholesale market price variations or in some cases dynamic grid fees. Introducing the right to flexible prices for consumers (provided by the electricity Supplier) does not require the role of the Aggregator.

…”

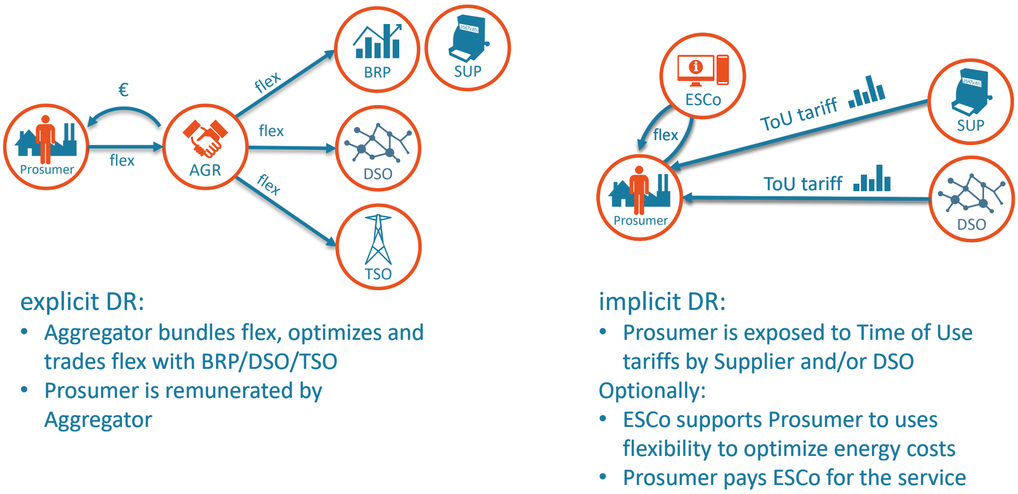

Figure 3-3 Difference between explicit demand response and implicit demand response

Prosumers exposed to time varying tariffs might have an automated system or a 3rd-party (ESCo) service that helps them to consume their energy against optimal prices. The market coordination mechanism as described in USEF is based on explicit demand response. The two types of demand response should co-exist [16], yet may interfere. The interference between implicit and explicit demand response is one of the seven complications that are investigated in this report.

3.5 USEF market coordination mechanism

For this work we build upon the USEF market coordination mechanism (MCM), as defined in [1], which builds on top of all existing markets. This MCM has five phases:

As far as relevant for this work the phases are described below:

Table 3-1 USEF MCM phases applied to Aggregator's operation

Contract	The Aggregator establishes all contractual relations needed to participate in explicit demand response. Aggregators will need a "flexibility purchase contract" with the Prosumer to allow them to activate the Prosumer's assets. Aggregators may establish a contract with the flex customers like the TSO. Finally, depending on the exact implementation model (see Chapter 5) there might be a need for contracts with one or more BRPs.
Plan	The Aggregator sets the activation plan for its portfolio of assets, based on the availability of the asset, and the boundary conditions resulting from Prosumer's asset operation plans. The Aggregator may choose to place bids (USEF: FlexOffers) for specific flex products.
Validate	The Validate phase is specific for USEF and is the phase where the DSO can perform a grid safety analysis to check whether the grid is capable of distributing the forecasted energy demand and supply. In case of grid constraints, the DSO may want to purchase flexibility, or delimit DR activation (under regulatory supervision) if the flexibility offers by the market turns out to be not sufficient.
Operate	In operate all plans are executed, resulting in the actual supply and demand. Aggregators may activate flexibility to meet the demands of their customers. E.g. the TSO may invoke balancing power when the system is off-balance, the BRP to avoid imbalance in its portfolio and the DSO to avoid congestion.

	Measurements are performed in order to quantify the delivered flexibility ex-post.
Settle	The flexibility that has been delivered is calculated and paid for, and there may be penalties for over and/or under-delivery by Aggregators. Also, as part of the settlement phase, the Prosumer may be remunerated for its delivered flexibility. In some Aggregator implementation models (see Chapter 5) there is a Transfer of Energy (ToE) involved in the wholesale settlement processes.

3.6 Example use case

For a thorough understanding of the different Aggregator implementation models, we feel that an example is helpful. We have chosen the example of a secondary control service (aFRR) because this includes most topics that will be discussed in the remainder of the document. Moreover, such a service is operational in all European member states and therefore well-understood. Instead of operating this service from a single asset, we now assume that the service is delivered from a portfolio based on a larger number assets aggregated by the Aggregator. Note that an FRR product is classified as a hybrid product with both a capacity and an energy remuneration component. The example is listed below.

Table 3-2 secondary control service example (aFRR) in the different MCM phases

Contract	TSO contracts market parties to deliver aFRR. aFRR is delivered by a Balancing Service Provider role. Aggregators may bundle aggregated flexibility and deliver via a BSP to the TSO. Part of the contract phase is normally a pre-qualification of the assets, either on individual asset level (as in today's operation) or on portfolio level. The Aggregators register their portfolio such that a DSO has knowledge of DR in its distribution grid
Plan/Validate	On day-1, the BSP places its bids. Contracted parties are obliged to place a bid. In most aFRR implementations non-contracted or free bids are allowed as well. Bids are placed on a merit order. Also on D-1, the DSO could expect grid overload situations which might be a reason to purchase flexibility or, if the market does not offer sufficient flexibility, issue a restriction for activation of various flex assets[3] (under regulatory supervision). We assume such a restriction is known before the bids are actually placed.
Operate	The TSO continuously monitors the balance and requires a baseline from assets that are part of a bid. This is in order to be able to check the effect of DR activation. This monitoring is with relatively high frequency (NL market: every 4 seconds) and thus requires M2M communication with the assets. If the system is off-balance, the TSO activates one or more bids to procure the required balancing power. This activation must be reflected in the asset status update.
Settle	Based on the asset status log, the TSO checks whether the requested flexibility has actually been delivered and also calculates the amount of energy involved in an activation. The flexibility that has been delivered is remunerated, and the balance position of the associated BRP is corrected with the calculated amount.

The 'actors' in this use case are depicted Figure 3-4.

[3] In the current USEF specification, the DSO checks the grid status and has options to purchase flexibility in case of congestion or other grid issues. As USEF advocates a market-based approach, the DSO has to pay more than other market parties to obtain the flexibility. USEF's Orange regime is introduced as a fallback in case insufficient flexibility is available for the DSO to avoid an outage—the DSO can temporary overrule the market to avoid an outage by limiting connections.

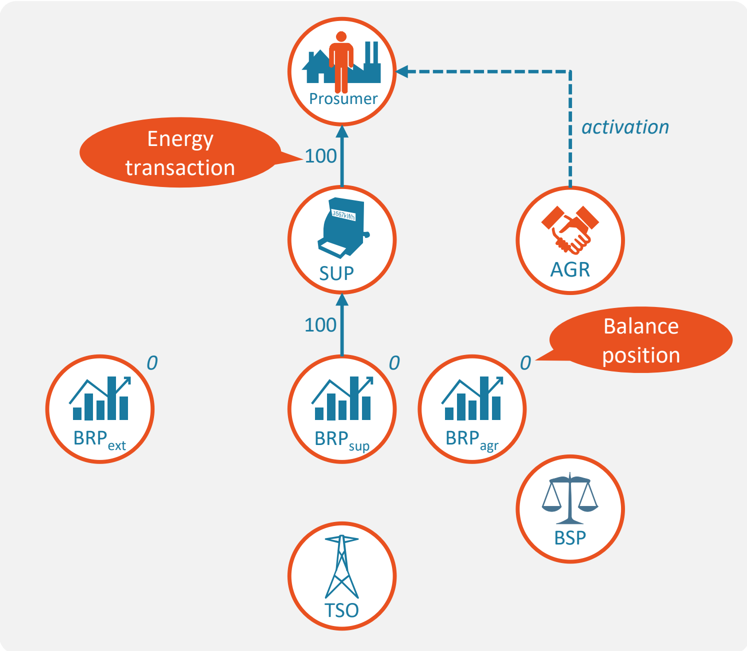

Figure 3-4 shows the different actors of the example use case. The Aggregator controls an asset belonging to the Prosumer and is therefore able to activate flexibility. This flexibility is sold to the TSO via a BSP. A BRP associated with the Aggregator (BRP_{agr}) bears balance responsibility during activation. In the default case, without DR activation, the BRP_{sup} has nominated 100 units of energy, that are scheduled to be supplied to the Prosumer. BRP_{ext} is a third BRP who will cause a system imbalance upon which the TSO will act by invoking an aFRR service. The Supplier (SUP) is responsible for the supply of energy and the balance responsibility is born by a BRP associated with the Supplier (BRP_{sup}). During the time DR is activated the BRP associated with the Aggregator (BRP_{agr}) is responsible for all associated imbalance. DSO, MDC and ARP role are not depicted, but play a role in the interaction diagrams below.

Figure 3-5 to Figure 3-8 show the interactions between the different actors in the different phases of the MCM.

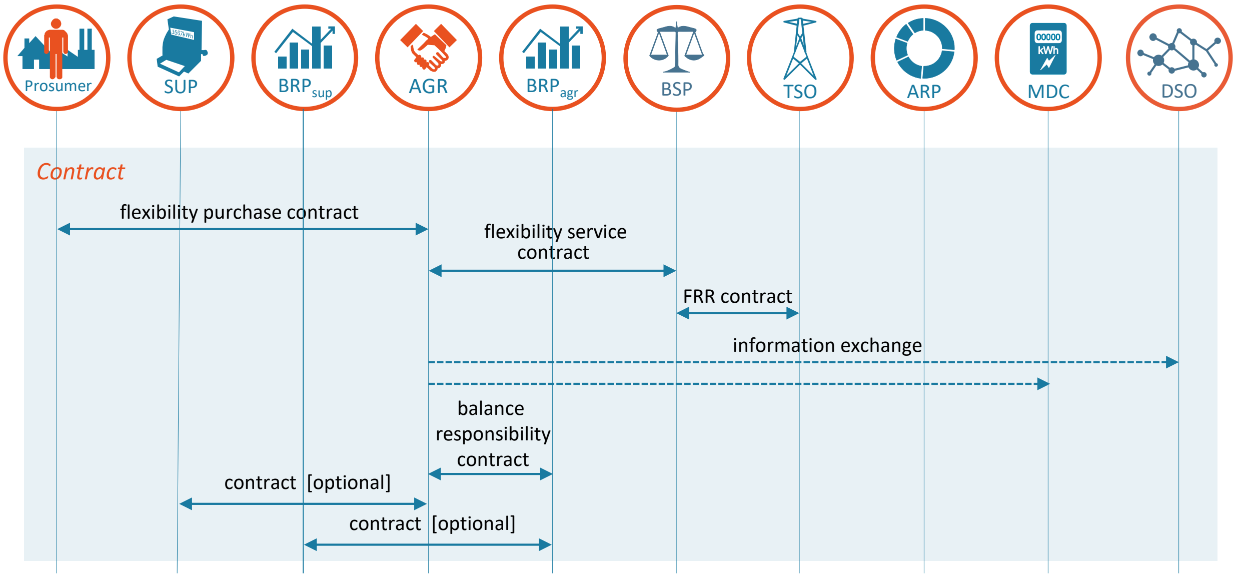

Figure 3-5 Interactions during Contract phase. The Aggregator needs a 'flexibility purchase contract' with the Prosumer to control the assets. Next, it needs to be able to deliver the aFRR service to the TSO via the BSP. To this end, a flexibility service contract is established between Aggregator and BSP. The BSP is the contracting party for the TSO, resulting in an aFRR contract. This contract generally includes pre-qualification. As part of the pre-qualification the DR response of the assets are checked, either on asset level or on portfolio level. The Aggregator registers its portfolio such that the DSO could act when the flex activation would lead to grid constraints. Similarly, the Aggregator registers itself at the MDC to receive meter data for flex settlement. The Aggregator needs a balance responsibility contract with the BRP associated with the Aggregator (BRP_{agr}) such that this BRP can take care of eventual imbalances due to DR activations. Finally, in some implementation models a contract is established between Aggregator and the Supplier to settle the transfer of energy and a second contract between BRP_{agr} and BRP_{sup} to settle perimeter corrections. Since SUP and BRP_{sup} already maintain a balance responsibility contract for the supply (not depicted), this second contract can also be established indirectly via the contract between AGR and SUP.

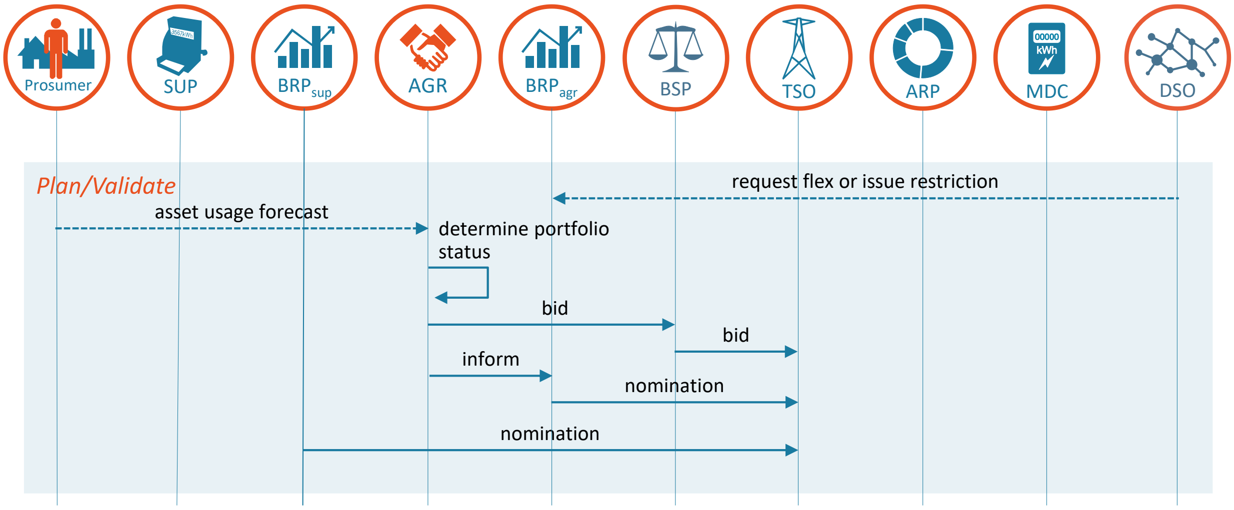

Figure 3-6 Interactions during Plan/Validate phase. Prior to the operation, in the aFRR typically at D-1, the Aggregator determines the portfolio status, based on the availability of the asset, and the boundary conditions resulting from Prosumer's asset operation plans. The latter is typically based on Prosumers' forecast information. In case of temporary grid constraints, the DSO could request for flex or issue restrictions on flex activation (under regulatory supervision). Knowing the portfolio status, the Aggregator places one or more bids for aFRR which are forwarded by the BSP to the TSO. The BRPs communicate their nominations (and schedules) to the TSO. Information about the bid is included in the nomination of BRP_{agr}.

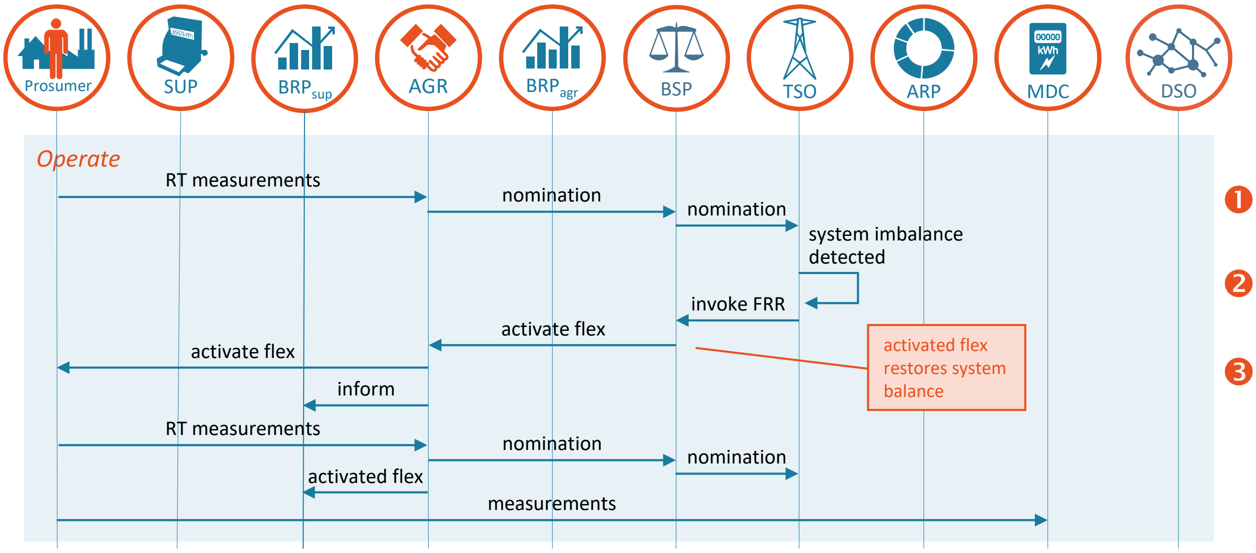

Figure 3-7 Interactions during Operate phase. During operation the assets are continuously monitored and communicated to the TSO in the form of a rolling nomination. This allows the TSO to determine a baseline. As soon as the TSO detects a system imbalance that requires active correction, it will respond by invoking aFRR. This is served by activating flex, which will either reduce or increase the load at the Prosumer and thereby resolve system imbalance. BRP_{sup} is informed to avoid counterbalancing (only needed if BRP_{sup} has on-line metering installed). The nomination by the Aggregator continues repeatedly during the entire ISP, and is used by the TSO to check whether the requested energy reduction/increase was actually delivered (performance qualification). Also after each ISP, the BRP_{sup} is informed about the activated flex. Finally, the MDC will collect measurements that will be used to carry out the necessary calculations (a.o. perimeter corrections) during the Settle phase. Since the activation of flex results in a changed energy profile during activation, BRP_{sup} has an imbalance in its portfolio. Also the Supplier's position changes: he supplies less than planned when the demand is reduced and more than planned when the demand is increased. (The numbers in this figure correspond to specific use case steps which will be described below.)

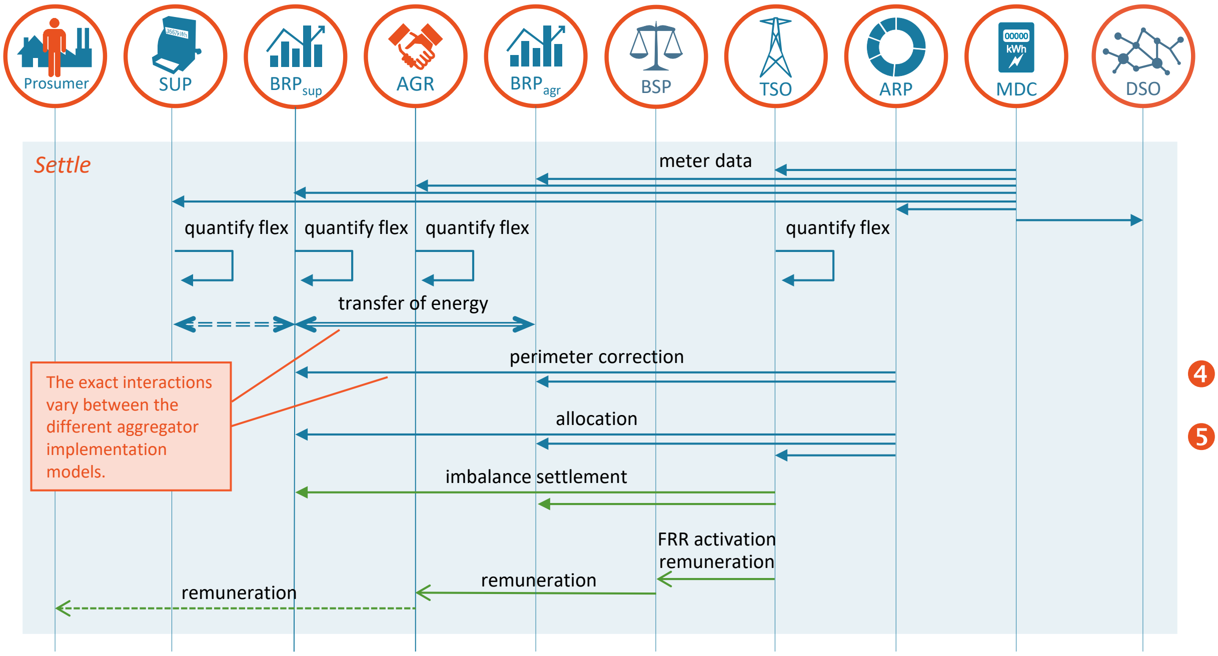

Figure 3-8 Interactions during Settle phase. The green arrows indicate financial transfers. The MDC collects and distributes the meter data to all roles that have granted access to this data to make their calculations or do verifications[4]. Based on these data, the actors will quantify the activated flexibility and a Transfer of Energy can take place, which is used to correct the perimeter of the BRP_{sup} for the imbalance caused and the Supplier for the modified supply position. Whether and how this Transfer of Energy takes place varies between the different Aggregator implementation models (see Appendix 1). The Transfer of Energy typically also includes financial remunerations. After the Transfer of Energy, the standard allocation process and imbalance settlement take place. Finally, The BSP is remunerated for its service delivered (assuming an energy remuneration component) and this is the basis for remuneration of the Aggregator and the Prosumers. (The numbers in this figure corresponds to specific use case steps which will be discussed during the model descriptions in Sections 5.2 and 5.3.)

In the figures below we show the interactions, energy transfers and balance positions for the different steps of the use case.

Use case

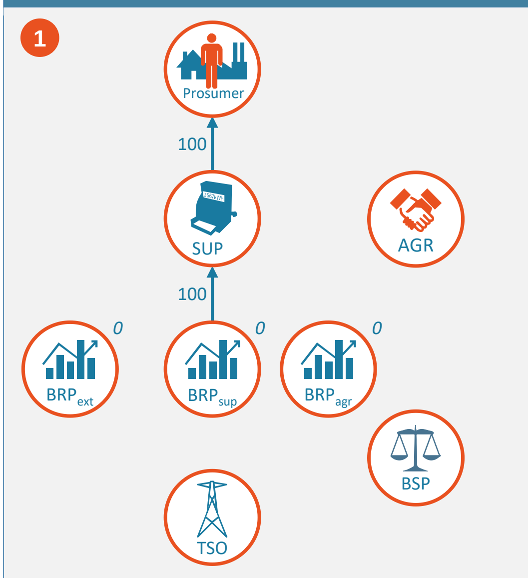

Figure 3-9 Use case step 1 (Operate phase)

Start of the Operate phase. All BRPs are in balance. The Prosumer consumes 100 units, supplied by SUP, nominated by BRP_{sup}.

[4] Could also be a central entity like the DataHub in DK

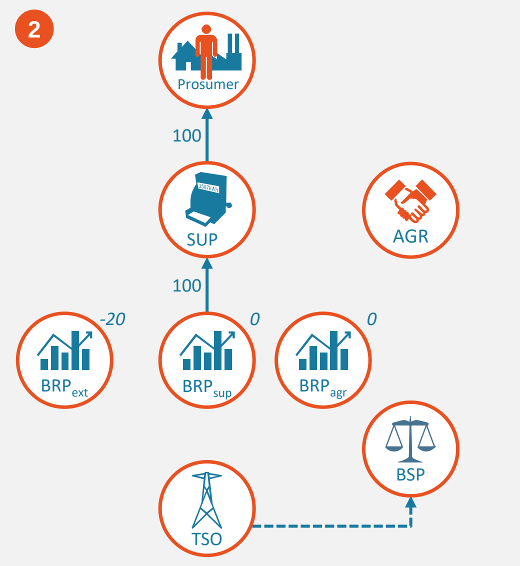

Figure 3-10 Use case step 2 (Operate phase)

In this step, an imbalance of -20 occurs in the portfolio of BRP_{ext} (who may not be aware in real-time), resulting in a system imbalance of -20. This is first reacted upon by the primary control mechanism. Next the TSO will need to acquire secondary control power to restore the balance and the frequency. BSP is called to deliver 20, activated through the balancing merit order.

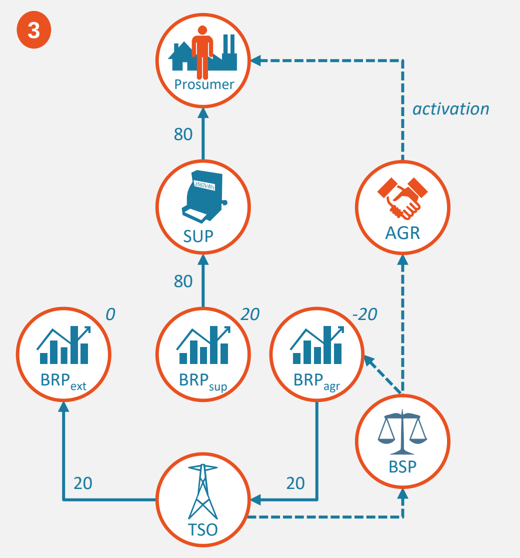

Figure 3-11 Use case step 3 (Operate phase)

BSP releases balancing energy by activation of flexibility through the Aggregator. The consumption reduces from 100 to 80 units.

The BSP associates with BRP_{agr} to be able to deliver 20 to the TSO. Through the balancing mechanism, 20 is delivered to BRP_{ext}, restoring the balance in its portfolio.

However, the supplier, having sourced 100 but only delivering 80 to Prosumer, is faced with an open supply position of +20 and the BRP_{SUP} has an imbalance position of +20. The aggregator on the other hand has delivered 20, yet did not source this energy, leaving an imbalance position of -20 in his associated BRP_{AGR}.

Steps 3 (model specific issues), 4 and 5 of this use case will be discussed for each of the different Aggregator Implementation Models in Sections 5.2 and 5.3.

Also important for the discussion is an alternative use case where the activation of flexibility only partly succeeds. This results in under-delivery. Steps 1-2 of this alternative are the same as in the original use case. Steps 3-5 differ. Note that a second alternative, where the Aggregator activates more than asked for, is also possible. This is not worked out in a separate use case. In the recommendations and considerations part (Chapter 6) we will highlight the differences.

Alternative use case

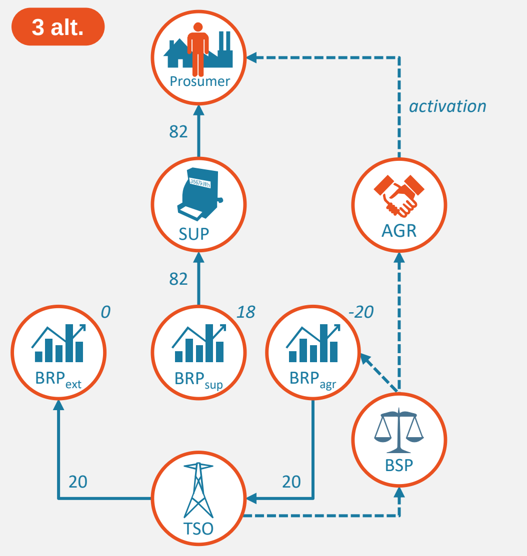

Figure 3-12 Alternative Use case step 3 (Operate phase)

This case is similar to step 3 of the standard use case, but now the activation of flexibility has only partly succeeded. AGR can only activate 18 units, hence the consumption reduces from 100 to 82 units.

BSP has offered 20 to the TSO and the associated BRP_{agr} *is supposed to deliver 20 to the TSO. As this is a cleared transaction, 20 units are transferred from* BRP_{agr} *to TSO.*

As a result, BRP_{sup}, *is faced with an imbalance of +18 and SUP has an open supply position of 18.* BRP_{agr} *has sold 20 and faces an imbalance of -20 because it has not sourced this energy.*

Through the balancing mechanism, 20 is delivered to BRP_{ext}, *restoring the balance in its portfolio.*

Also for this alternative use case, steps 3, 4 and 5 will be discussed for each of the different Aggregator Implementation Models in Sections 5.2 and 5.3.

4 Assumptions on product design

Similar products have different shapes in the current member states. The, design of future products is not fully crystalized yet. We have therefore made some assumptions about the characteristics of the products in the flex value chain as a basis of our assessment in the next sections. As far as possible, these assumptions are based on current market characteristics

Table 4-1 Flexibility Services

Cust-omer	Service	Type	Capacity remuner-ation	Volume (energy) Remuneration	Notification	Classification
TSO	Primary control (FCR)	Balancing	Yes	No	Real-time	Capacity
TSO	Secondary control (aFRR)	Balancing	Yes	Yes	Real-time	Hybrid
TSO	Tertiary control	Balancing	Yes	Yes[5]	Real-Time	Hybrid
TSO	National capacity market/ strategic reserves	Adequacy	Yes	Yes/No	DA / Intraday	Capacity/ Hybrid
TSO	Congestion management	Grid management	Yes/No	Yes	DA	Energy
BRP[6]	Spot market (day ahead trading)	Wholesale (portfolio optimization)	No	Yes	DA	Energy
BRP[6]	Intraday trading	Wholesale (portfolio optimization)	No	Yes	Intraday	Energy
BRP[6]	Self balancing, passive balancing	Wholesale (portfolio optimization)	No	Yes	Real-time	Energy
BRP[6]	Hedging/portfolio adequacy	Adequacy	Yes	Yes	DA	Hybrid
DSO	Congestion management	Grid management	Yes[7]	Yes[8]	DA/ID/RT	Hybrid
DSO	Voltage control	Grid management	Yes	Yes/No	ID/RT	TBD

The last row in this table is a classification of the different services in three categories:

- **Capacity products**. Products based on the capacity to reduce or increase load. The associated energy component has typically a low volume due to 1) infrequent activation, 2) low volume per activation and/or 3) symmetric activation such that energy component is equalled out. By definition, these kinds of products have a capacity remuneration and no energy remuneration.

[5] There are a few exceptions where energy is not remunerated (e.g. in Belgium, but will be phased out).
[6] Depending on market organization and BRP – Supplier relationship also the Supplier could be envisaged as customer of these services
[7] Assuming long-term contracts. No capacity remuneration for free bids
[8] Based on the current USEF specifications

- **Energy products**. Products based on an actual energy reduction or increase for a certain duration, usually an ISP or longer. These products are typically used for portfolio optimization and energy market trading. The remuneration is based on the amount of energy
- **Hybrid products**. Combination of the above. Typically, these products have both a capacity remuneration and an energy remuneration.

The products are further described below.

Primary control or frequency containment reserves (FCR) are the first line of defense against frequency deviations in the grid caused by, for instance, the unexpected tripping of a large generation unit. Primary reserves respond rapidly (within seconds). They aim to maintain the grid frequency at 50 Hz (in Europe). Equipment on the Prosumer's premises that is able to support the grid frequency can provide this service. For instance, in Germany, Belgium and the Netherlands primary control is auctioned by the TSO on a weekly basis. Traditionally, only rotating equipment has supplied primary control, but several types of Prosumer loads can supply this service as well.

Secondary control or frequency restoration reserves (FRR) are used to relieve the primary control from its duty and allow it to return to a normal operational state. Secondary control aims to reduce imbalance within one imbalance settlement period. Secondary control is generally supplied to the TSO based on public bidding (on the imbalance market) and dispatched based on a merit order. Depending on national regulations, aggregated loads can also bid in to provide secondary control.

Tertiary control resembles secondary control, but it responds more slowly and can be sustained for a longer time period (several ISPs). It relieves the secondary control from its duty. As with secondary control, aggregated loads can also supply this service, based on national regulations.

National capacity markets (including **strategic reserves**) aim to increase the security of supply by organizing sufficient long-term peak and non-peak capacity. Typically, an increase in solar and wind generation requires greater supporting capacity to compensate for daily and seasonal fluctuations and during prolonged periods of solar and wind absence. An alternative is load shifting or shedding. Depending on national regulations, load flexibility can be aggregated and supplied to capacity markets. Although some national capacity markets (and strategic reserves) are already active in the EU, it is not yet clear how many capacity markets will be created in the long term and whether the TSO will organize this market.

Congestion management in the transmission grid is basically the same as congestion management in the distribution grid (see below), though the size of the congestion and the applicable regulations will differ. Given the potential higher liquidity in this market, this is often organized as a day-ahead, energy-only market. Aggregated load flexibility is a feasible service for both.

Day-ahead trading aims to shift loads (or dispatchable generation) from a high-price time interval to a low-price time interval on a day-ahead basis or longer. It enables the BRP to reduce its overall electricity purchase costs. Clearly, this cost advantage will have to be shared with the Prosumer as an incentive to shift his load.

Intraday trading closely resembles day-ahead trading, but the time frame is constrained to the day of the electricity program. Depending on national regulations, the electricity program can be changed one to a few hours before the actual time period it refers to. This enables intraday trading and load flexibility can be used to create value on this market, equivalent to the day-ahead and long-term markets.

Self-balancing is the reduction of imbalance by the BRP within its portfolio and within one imbalance settlement period to avoid imbalance penalties; in this case the Aggregator will activate flexibility (possibly in the perimeter of other BRPs), the associated energy reduction or enhancement is sold to this BRP for self-balancing. In **passive balancing**, the Aggregator's BRP helps reduce the imbalance for the whole control area by deviating from its own electricity program. If this contributes to reducing the total imbalance, the BRP may receive remuneration for its passive contribution, depending on market design.[9] The BRP does not actively bid on the imbalance market using its load flexibility, but uses it within its own portfolio. There are risks involved in this strategy, related to the predictability of the total imbalance. Generally, an online signal for the total imbalance is required, provided by the TSO or other means.

Hedging/portfolio adequacy is a service to protect a BRP against high wholesale and/or balancing prices. Within this contract, the Aggregator will activate flexibility as soon as the spot, intraday or imbalance prices exceed a predefined level. The energy volume is then acquired from the Aggregator's BRP against this predefined price. This can be considered as a method for the BRP to ensure portfolio adequacy, i.e. he is able to balance his portfolio, whilst hedging against high energy prices. The Aggregator may activate this flexibility in the perimeter of other BRPs.

Congestion management in the distribution grid refers to avoiding the thermal overload of system components by reducing peak loads. In contrast with grid capacity management, this is a situation where failure due to overloading may occur. It is a short-term problem (with respect to the duration of a grid reinforcement project) for the DSO that requires a relatively swift response. The conventional solution is grid reinforcement (e.g., cables, transformers). The alternative (load flexibility) may defer or even avoid the necessity of grid investments.

Voltage control typically is needed when solar PV systems generate significant amounts of electricity. This will "push up" the voltage level in the grid. Using load flexibility by increasing the load or decreasing the generation is an option to avoid exceeding the voltage limits. This mechanism can reduce the need for grid investments (such as automatic tap changers) or mandatory generation curtailment.

[9] E.g., the Dutch imbalance market supports passive balancing, but the German market does not.

5 Aggregator Implementation Models

As became clear from the previous chapters, the Aggregator, as new market party, needs to be fitted in to the existing energy market organization. This can be done in many ways, with different relationships to the other stakeholders and with varying responsibilities. Seven concrete Aggregator implementation models are presented in this chapter.

In this text we have chosen the term 'implementation model', since it encompasses relationships, responsibilities, structures and (standardized) information exchange to 'implement' the aggregator in the market organization. More specific:
An *Aggregator Implementation Model (AIM)* is a market model for the Aggregator role, describing its relation to the Supplier and BRP of the Prosumer, and describing how balance responsibility, transfer of energy and information exchange are organized.

5.1 Considerations for the Aggregator role

5.1.1 Separating flexibility from supply

In the Aggregator Implementation Models, flexibility is separated from the underlying energy supply. The Aggregator takes responsibility for the activation of flexibility and the Supplier for the energy supply. In this attempt to separate flexibility from supply, we apply three main principles:

1. The responsibilities of the Aggregator (and his BRP) are restricted to:
   - (i) the activation periods[10]. For the activation period the so-called rebound effect needs to considered (see Section 6.6)
   - (ii) assets (flexibility resources) that are activated[11].
   - (iii) For each activated asset, the deviation from its baseline
2. The Aggregator does not need to take responsibility for the supply of energy to the Prosumer[12].
3. The effects of the DR activation for the Supplier and the BRP related to the Supplier should be properly compensated[13].

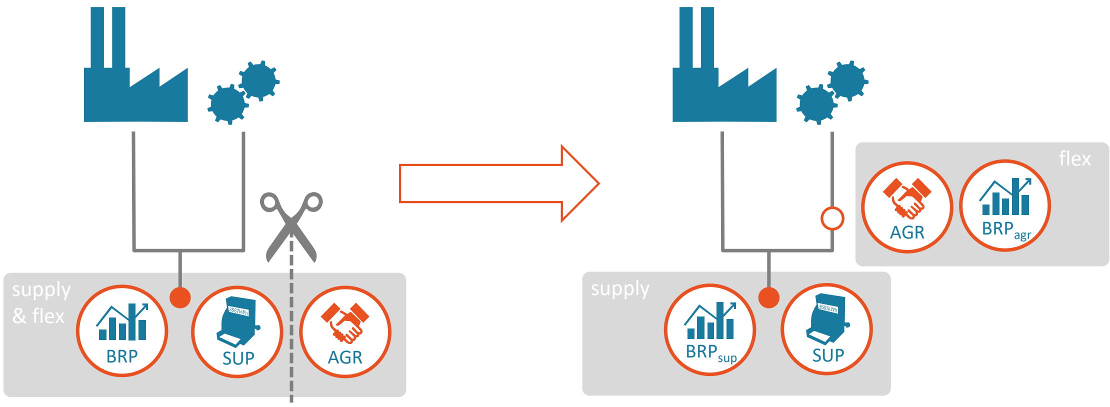

Figure 5-1 Separating flexibility from supply

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[10] This applies to our (seven) main models. In section 5.1.4 we briefly examine an alternative set of models where the Aggregator takes (full) balance responsibility, with or without activation.
[11] With the exception that an Aggregator may choose to take full responsibility for its pool (cf. recommendation 704 in section 6.7).
[12] With the notion that for the *corrected* model, as well as the *reference profile* models, the Aggregator may need to supply the deviation from the baseline.
[13] Primarily based on the results of [2].

The following elements may be needed for this compensation (depending on the Aggregator Implementation Model):

- The perimeter of the BRP of the Supplier needs to be corrected with the activated flexibility, restoring the BRP's balancing position.
- A transfer of energy is needed from the (BRP of the) Supplier to (BRP of the) Aggregator to ensure the Supplier is remunerated for the energy it has sourced through its BRP, but not sold, in case of load reduction (generation enhancement). The transfer of energy is reversed in case of load enhancement (generation reduction).

There are two reasons why the Aggregator should associate with a BRP:

- If the Aggregator fails to deliver the required amount of flexibility to his customer, his failure will often cause imbalance. In most AIMs the Aggregator needs to arrange for this imbalance (i.e. select his own BRP)
- If the Aggregator wants to trade energy (in energy or hybrid products)

5.1.2 Isolating the controllable asset

As part of the separation of flexibility from supply there is a need to isolate the controllable asset that is used for DR from the other assets at the Prosumer's site, thereby removing the responsibility from the AGR for the uncontrollable load. To this end, the Aggregator may apply sub-metering.

Sub-metering may also serve additional purposes:

- to better quantify the performance of the Prosumer towards the Aggregator
- to better quantify the performance of the Aggregator towards the customer of the flexibility (TSO, DSO, BRP), this might even be a requirement from the flex product definition
- to better quantify the activated flexibility as a basis for the transfer of energy
- to allow different Aggregators to operate different flexibility resources at the same Prosumer at the same time

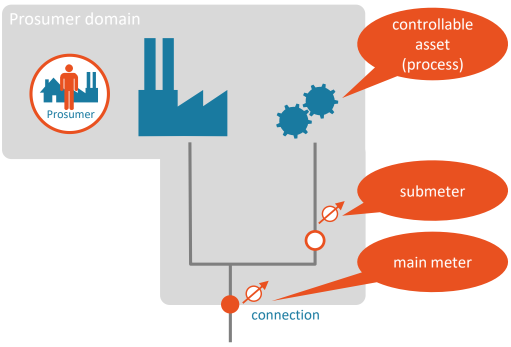


Figure 5-2 sub-metering to isolate the controllable asset

5.1.3 Relation with split supply models

There is a tendency in several member states to allow more than one supplier per connection, main drivers are:

- Directive on the deployment of alternative fuels infrastructure, Article 4.8 Electricity supply for transport, stating that "Member States shall ensure that consumers have the right to contract electricity simultaneously with several suppliers so that electricity supply for an electric vehicle can be contracted separately".
- Feed-in of renewable energy, allowing Prosumers to choose different suppliers for energy consumption and energy (net) production.

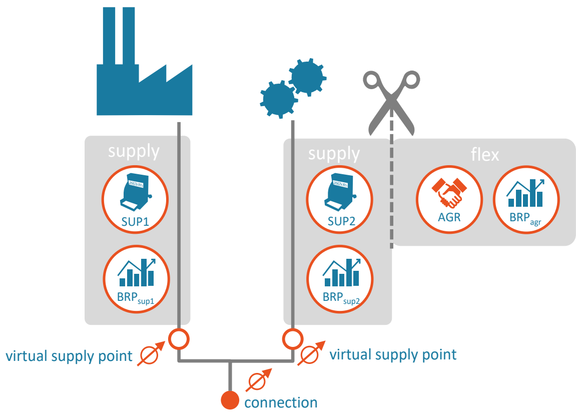


Figure 5-3 split supply model. Left part is supply to the uncontrollable load; right part is supply to controllable asset. Aggregator may want to operate DR on the flexible asset without being responsible for supply. Then the Aggregator Implementation Models can be applied to the right part separating flex from supply.

These so-called *split-supply models* are typically implemented by adding additional meters, either parallel at the connection or through sub-metering. However, synthetic profiles could also be used.

A split supply option may be an interesting alternative model for Aggregators to offer their services. E.g. an electric mobility service provider could use the electricity meter in the charging unit of the electric vehicle as a sub-meter, supply the energy and trade the flexibility of the charging process. in this case the roles of Aggregator, Supplier and (presumably) BRP are combined in a single market party (integrated model).

If an Aggregator (as market party) prefers not to combine the roles, then any of the alternative Aggregator Implementation Models presented in this document could be applied to each of the virtual supply points. This is depicted in Figure 5-3.

Where the split supply models focus on the split of supply, our Aggregator Implementation Models focus on the valorization of flexibility by defining a clear allocation of balance responsibility. Therefore, split-supply models and Aggregator Implementation Models are complementary, allowing for any combination of the two concepts.

5.1.4 Reference Profile Models

The Aggregator Implementation Models discussed in this document are based on the principle that the Aggregator only takes balance responsibility during times of activation (the activation window). This might be difficult or even impossible when activation takes place on a day-to-day basis, for example in the case of heat pumps in the residential setting. Then it becomes difficult to hand-over balance responsibility to the BRP of the Aggregator, since a proper baseline, indicating the “normal” (uncontrolled) behavior, cannot be established.

In the concept of the reference profile model, the Supplier needs to source and supply the energy for a customer, as in our standard Aggregator Implementation Models. However, instead of handing over balancing responsibility for the activation times only (as done in the AIMs), here the balance responsibility is transferred ex-ante, typically day ahead, from the BRP of the Supplier to the BRP of the Aggregator. The Aggregator can optimize the load profile of the customer compared to the reference profile, and sell the flexibility on every market or product. Reference profile models are discussed in Section 5.3. These models are useful for demand response in the residential setting where the activation takes place on a daily or hourly basis, see also Section 7.3.

5.2 Aggregator Implementation models

This section introduces a classification of Aggregator Implementation Models based on the following questions:

1. Are the roles of the Supplier and Aggregator combined in a single market party?

2. Does the Aggregator need to assign its own BRP?
   There is a clear distinction between single-BRP and dual-BRP models. In general, a dual-BRP model complicates the allocation process: synthetic profiles are needed to separate the balance responsibility. However, a single-BRP model restricts the Aggregator in the type of flex-products and markets he can develop/access.

3. Does the Aggregator need a contract with the Supplier’s BRP?
   Models that are based on a contractual relationship require less regulation, as most (if not all) aspects can be arranged bilaterally. However, if all allowed models require a contract with BRP_{sup}, this will affect the level playing field for Aggregators. Developing standardized contracts is (content wise) very similar to defining a regulatory framework.

4. For dual-BRP models: how is energy transferred between the Aggregator and the Supplier?
   Dual-BRP models are further classified based on the energy transfer method, defining if, and how, energy volumes are transferred between AGR and SUP. Possible methods are: Prosumer, Central, Bilateral, Central/socialized and None.

The only model where the roles are combined in a single party is the *integrated model*. In all other models the roles are performed by different market parties. The table below gives a two by two classification scheme on the 2nd and 3rd question and further differentiate by the 4th question. The integrated model is considered to be a contractual model because when the roles are combined operational agreements between the roles also need to be made.

Table 5-1 Aggregator model classification scheme

	CONTRACT between aggregator and supplier	NO CONTRACT between aggregator and supplier
SINGLE BRP	Integrated Broker	Uncorrected
DUAL BRP	Contractual	Corrected Central settlement ↳ Net benefit

Viability of certain models will depend on the flexibility product, - asset type, customer segment and/or member state. We expect that several models will co-exist (no *one size fits all*), however the number of allowed models should be kept low for simplicity and efficiency reasons. Chapter 7 discusses the model assessment.

The models are introduced in the sections below. For all models, we will use a generic table structure (see Table 5-2); a figure showing the relationships between the different roles and an elaboration of the two use cases.

Table 5-2 Relevant characteristics for the Aggregator implementation models

Synopsis	Summary of main elements describing this implementation model.
Main characteristics	Main characteristics according to the classification scheme (Table 5-1)
Contractual relationships	Every contractual relationship between two roles can be replaced by a market party combining these two roles.
Balance responsibility	Description which party takes balance responsibility for which load/generation of the Prosumer / connection, at which point in time.
Perimeter correction	Adjustment of BRP (of Prosumer) perimeter by the TSO based on activated volume by the Aggregator
Transfer of Energy	Transfer of energy between the BRP of the Supplier and the BRP of the Aggregator

All models currently deployed in Europe can be mapped on the chosen classification. It is not the purpose of this document to make a complete overview of deployments.

5.2.1 Integrated Model

Table 5-3 characteristics integrated model

Synopsis	In the integrated model the roles of Supplier and Aggregator are combined in one market party. Compensation for imbalances and the open supply position are not necessary.	
Main characteristics	Aggregator needs to assign its own BRP?	n.a.
	Aggregator needs contract with Supplier?	n.a.
	Energy transfer method?	n.a.
Contractual relationships	The Supplier/Aggregator combination has a contract with the Prosumer, selling energy and buying flexibility against a reward, the form of which is dependent on the proposition. Supplier can organize "aggregation" on its own or use a third-party as a service.	
Balance responsibility	Balance responsibility for the connection is with BRP_{sup}	
Perimeter correction	No perimeter correction by ARP needed	
Transfer of Energy	n.a.	

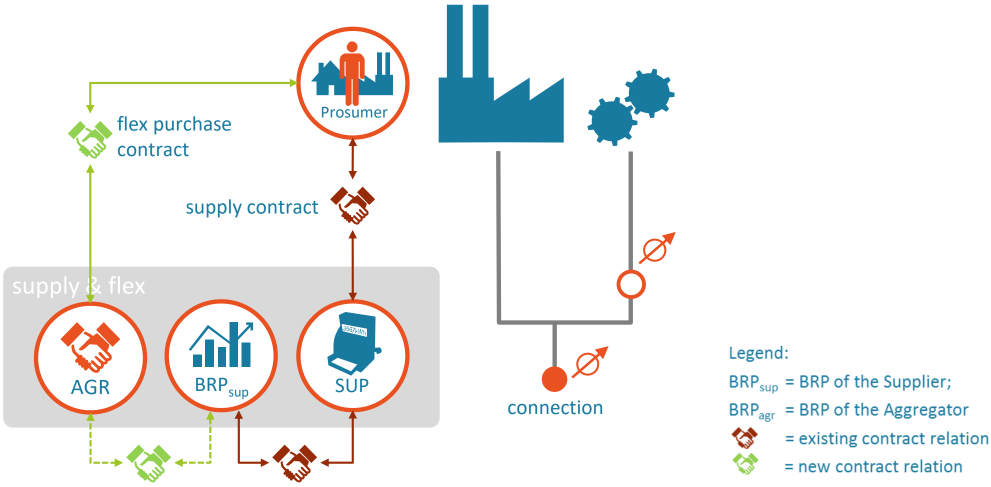


Figure 5-4 Integrated model

Use case

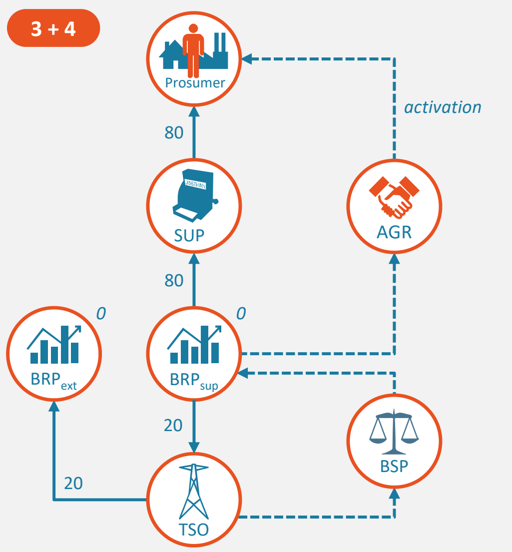


Figure 5-5 Use case steps 3-4
(Operate + Settle phase)

BSP releases balancing energy by activation of flexibility through the Aggregator. The consumption reduces from 100 to 80 units.

In the integrated model, BRP_{sup} sources the balancing energy it sells to the TSO. TSO corrects the (balancing) energy transferred ex-post for BRP_{sup}.

BSP is associated with BRP_{sup}, i.e. the AGR does not interact with the TSO through its own BSP.

The alternative use case (partial activation) is not depicted since any imbalance due to partial activations is handled as all other imbalance in the BRP's portfolio.

5.2.2 Broker model

Table 5-4 characteristics broker model

Synopsis	In the broker model, the Aggregator transfers the balance responsibility to the BRP_{sup}. Compensation for the open supply position and the caused imbalance is settled bilaterally based on contractual arrangements.	
Main characteristics	Aggregator needs to assign its own BRP?	No
	Aggregator needs contract with Supplier?	Yes
	Energy transfer method?	None
Contractual relationships	Aggregator has a bilateral contract with Supplier / BRP_{sup}, possibly based on a standardized contract. Aggregator has a flexibility service contract with a BSP, who is offering the flexibility to the TSO.	
Balance responsibility	The Aggregator transfers its balancing responsibility for the flexibility it operates to the BRP of the Supplier, therefore full balance responsibility of the connection lies with BRP_{sup}.	
Perimeter correction	No perimeter correction by ARP needed[14]	
Transfer of Energy	n.a. (but the model allows a settlement between BRP_{sup} and AGR, see use case step 4, Figure 5-8)	

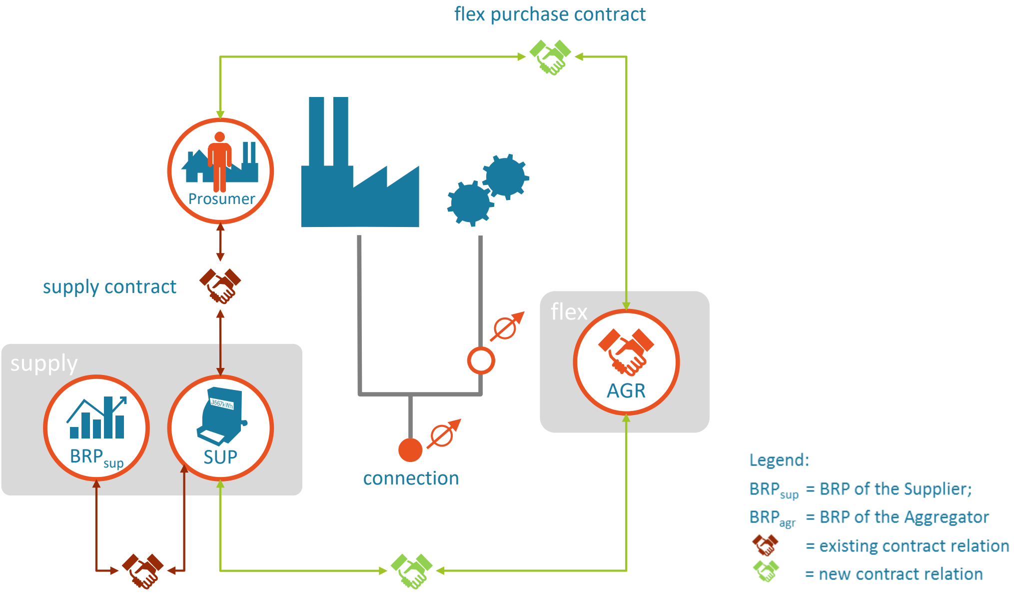


Figure 5-6 Broker model

Note that since BRP_{sup} can profit from the activations initiated by the Aggregator, the BRP_{sup} may choose to share the profit with the Aggregator, to stimulate the Aggregator to activate the flex resource more often (e.g. by lowering its position on the merit order).

Note that the broker model could be considered as a contractual model (cf. 5.2.3) where the two BRP roles (BRP_{sup} and BRP_{agr}) are mapped to a single party.

[14] If Aggregator is participating in a TSO product, it needs to nominate the activated volume per BRP. Perimeter of BRP needs to be corrected by the ARP according to nomination, analogously to current active balancing mechanism.

Use case

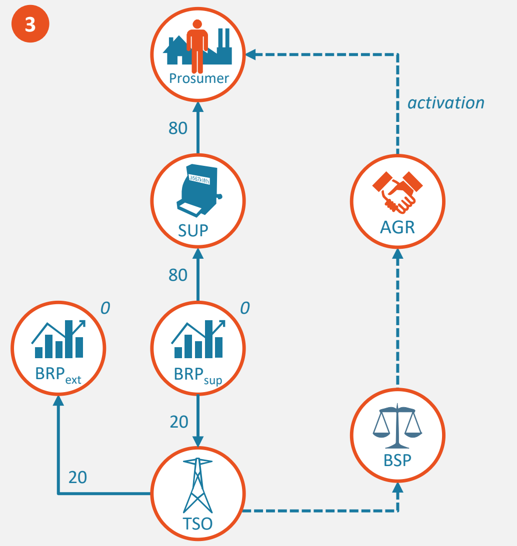


Figure 5-7 Use case step 3
(Operate phase, BSP releases balancing energy)

BSP releases balancing energy by activation of flexibility through the Aggregator. The consumption reduces from 100 to 80 units.

The activation of flex restores the system balance. The BSP needs to inform both the BRP$_{sup}$ and the TSO about its intention to activate 20 in the BRP$_{sup}$'s portfolio.

Through the balancing mechanism, 20 is delivered to BRP$_{ext}$, restoring the balance in its portfolio.

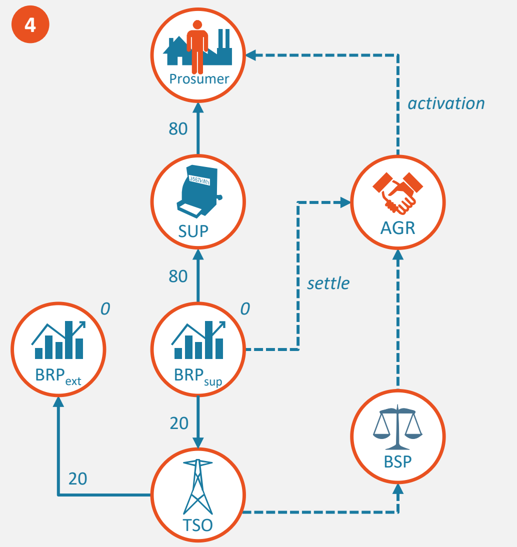


Figure 5-8 Use case step 4
(Settle phase, restoring energy balance)

In the broker model, the BRP$_{sup}$ delivers balancing energy to the TSO, which was activated by the AGR. The balancing energy is remunerated against the clearing price of the balancing market. This automatically corrects the perimeter; the open supply position may be settled with the AGR according to the contract.

In this model the BRP$_{sup}$ benefits from each DR activation. However, the AGR does not directly benefit from an activation, and may choose to place the flexibility high on the merit order. This may be solved by introducing a settlement between the BRP$_{sup}$ and the AGR for each activation.

Alternative use case

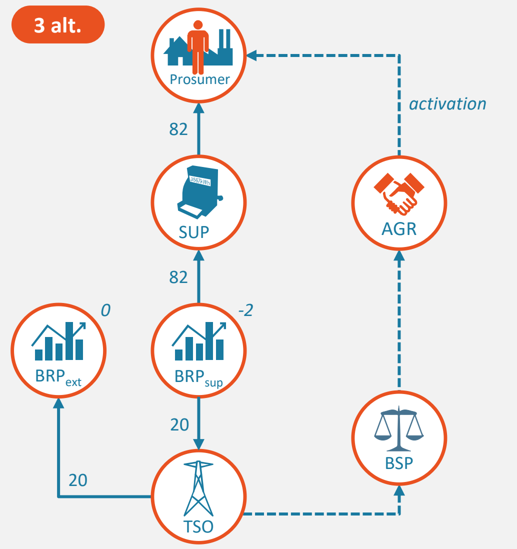


Figure 5-9 Alternative Use case step 3 (Operate phase)

BSP tries to reduce the load of the Prosumer by 20, but only achieves 18. This partly contributes to the restoration of the system balance, but an imbalance of 2 remains.

Although the imbalance caused by the BRP_{ext} may be resolved in the same iteration as the imbalance caused by BRP_{agr} (through its AGR), we separate this in individual steps to clearly point out the energy transactions.

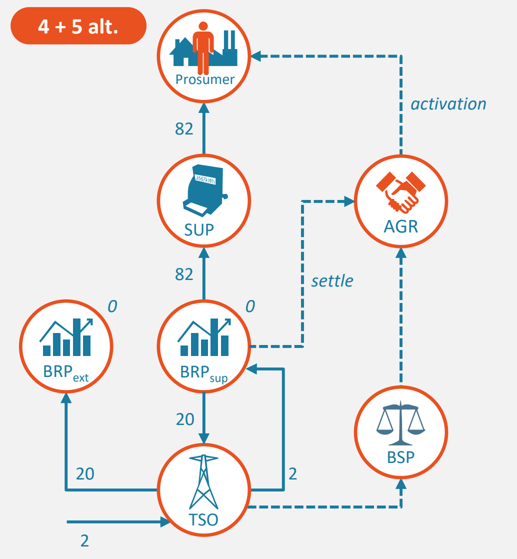


Figure 5-10 Alternative Use case steps 4-5 (Settle phase, imbalance settlement)

The BSP has indicated upfront (to the TSO and BRP_{sup}) that the full 20 will be activated in the BRP_{sup}'s portfolio.

The TSO corrects the perimeter of BRP_{sup} with 20. The BRP consequently has:

- An open supply position of 18
- An imbalance of 2

Both elements will be settled with the AGR according to the contractual agreement. This removes the need for a BRP_{agr} associated with the AGR. It also works for multiple BRP_{sup}'s.

5.2.3 Contractual model

Table 5-5 characteristics contractual model

Synopsis	In the contractual model, the Aggregator associates with his own BRP. Balancing parameters are corrected through a hub-deal (ex-post) between BRP_{agr} and BRP_{sup}, transfer prices are based on contractual arrangements.	
Main characteristics	Aggregator needs to assign its own BRP?	Yes
	Aggregator needs contract with Supplier?	Yes
	Energy transfer method?	Bilateral
Contractual relationships	Aggregator has a contract with BRP_{agr} for entering energy markets and to cover imbalance. Aggregator has a bilateral contract with Supplier about the Transfer of Energy (possibly based on a standardized contract). Aggregator has a flexibility service contract with a BSP, who is offering the flexibility to the TSO.	
Balance responsibility	BRP_{sup} holds full balance responsibility. During activation periods, the DR impact is neutralized with BRP_{sup} through the hub-deal. BRP_{agr} holds (implicit) balance responsibility for the flexibility during activation periods, as it needs to balance the sold energy with the energy sourced through the hub-deal.	
Perimeter correction	No perimeter correction by ARP needed, this is covered by the hub-deal.	
Transfer of Energy	Aggregator will source the energy ex-post from BRP_{sup} through a hub-deal. Sourcing volume equals the difference between measurement and baseline. A price formula needs to be agreed upon, preferably using a standardized method.	

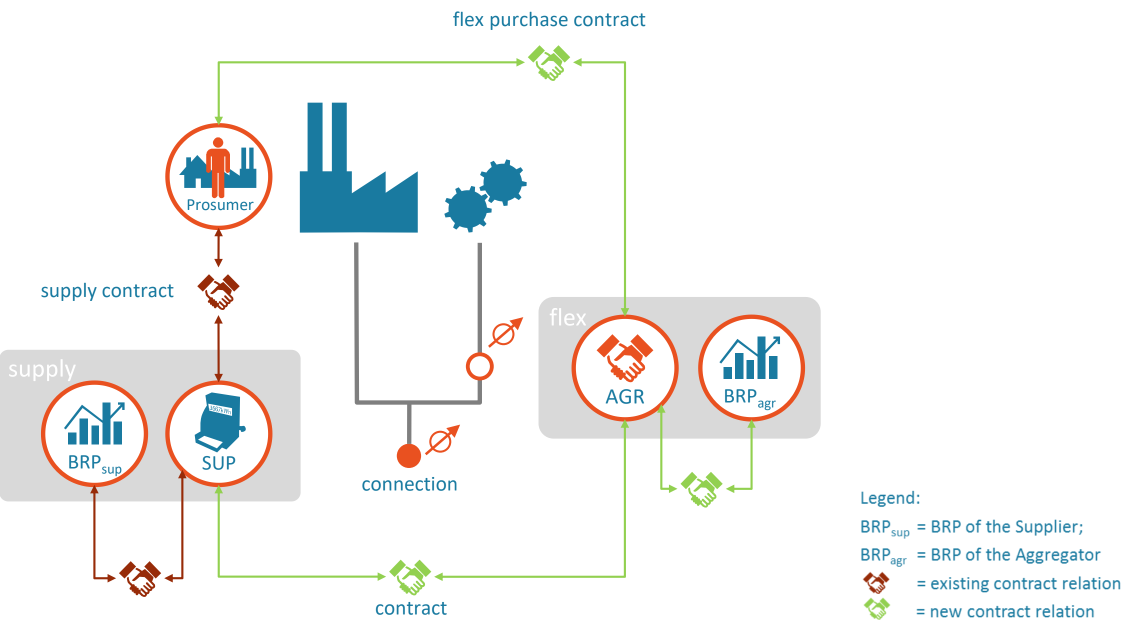


Figure 5-11 Contractual model

use case

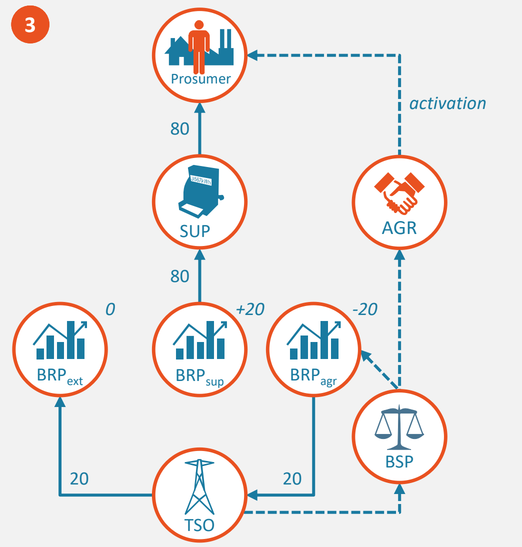


Figure 5-12 Use case step 3
(Operate phase, BSP releases balancing energy)

BSP releases balancing energy by activation of flexibility through the Aggregator. The consumption reduces from 100 to 80 units.

The BSP associates with BRP_{agr} to be able to deliver 20 to the TSO. Through the balancing mechanism, 20 is delivered to BRP_{ext}, restoring the balance in its portfolio.

However, the supplier, having sourced 100 but only delivering 80 to Prosumer, is faced with an open supply position of +20 and the BRP_{SUP} has an imbalance position of +20. The aggregator on the other hand has delivered 20, yet did not source this energy, leaving an imbalance position of -20 in his associated BRP_{AGR}.

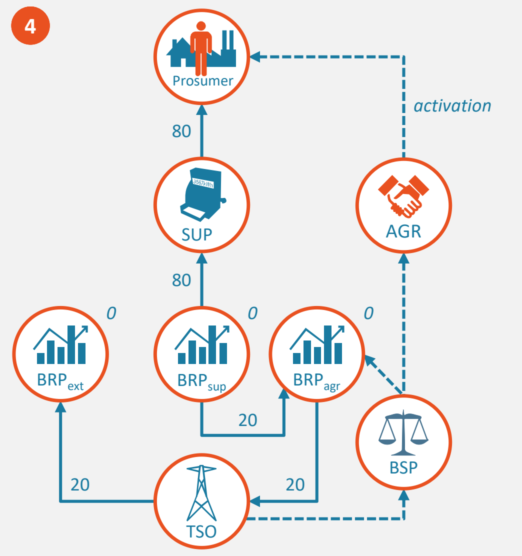


Figure 5-13 Use case step 4
(Settle phase, restoring energy balance)

In the contractual model, the BRP_{agr} sources the balancing energy (that it has sold to the TSO) from the BRP_{sup}. This bilateral deal both corrects the perimeters (both BRP's portfolios are balanced again); the open supply position may be settled with the AGR according to the contract.

Alternative use case

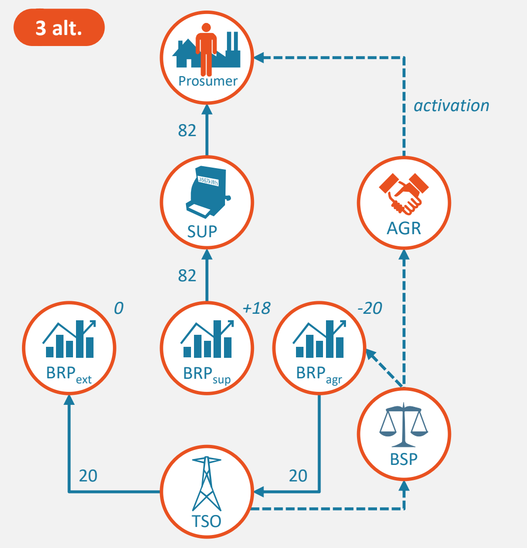


Figure 5-14 Alternative Use case step 3
(Operate phase, BSP releases balancing energy)

BSP tries to reduce the load of the Prosumer by 20, but only achieves 18. This partly contributes to the restoration of the system balance, but an imbalance of 2 remains.

Although the imbalance caused by the BRP_{ext} may be resolved in the same iteration as the imbalance caused by BRP_{agr} (through its AGR), we separate this in individual steps to clearly point out the energy transactions.

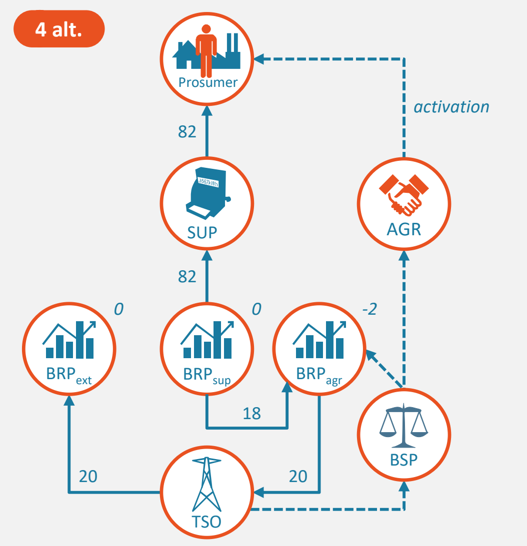


Figure 5-15 Alternative Use case step 4
(Settle phase, restoring energy balance)

Since only a volume of 18 was activated, the energy transferred ex-post equals 18. Since the AGR provided 20 to the TSO, the imbalance of 2 ends up in the perimeter of BRP_{agr}, as the AGR has sold more energy than it activated/sourced.

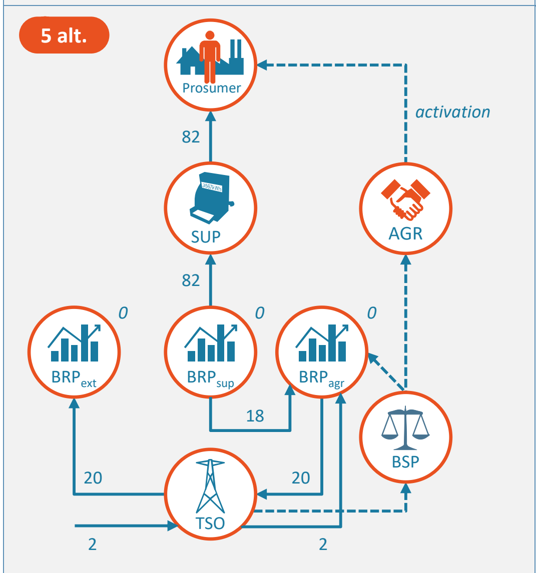


Figure 5-16 Alternative Use case step 5
(Settle phase, imbalance settlement)

The imbalance of the BRP_{agr} is settled through the regular balancing mechanism.

5.2.4 Uncorrected model

Table 5-6 characteristics uncorrected model

Synopsis	In the uncorrected model, no perimeter correction is performed and no volume transfers occur between the AGR and SUP. The activated volume is settled through the regular balancing mechanism.	
Main characteristics	Aggregator needs to assign its own BRP?	No
	Aggregator needs contract with Supplier?	No
	Energy transfer method?	None
Contractual relationships	If the flexibility, operated by the Aggregator, is included in a balancing product, Aggregator has a flexibility service contract with a BSP, who is offering the flexibility to the TSO.	
Balance responsibility	Balance responsibility for the connection is with BRP_{sup}	
Perimeter correction	The perimeter is **not** corrected by the ARP (therefore named uncorrected)	
Transfer of Energy	Energy is not transferred. In general, DR activation will result in imbalance for the BRP_{sup}. BRP_{sup} is remunerated through the regular balancing mechanism, if passively contributing to balance restoration is incentivised by the balancing mechanism. If the Aggregator is active on balancing or adequacy services, the remuneration takes place against (in general favourable) balancing prices.	

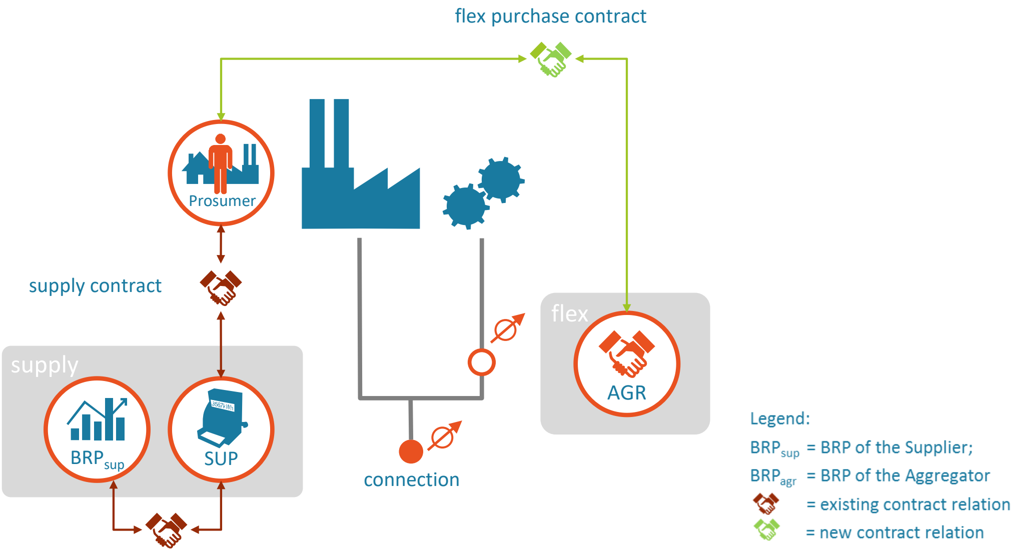


Figure 5-17 Uncorrected model

use case

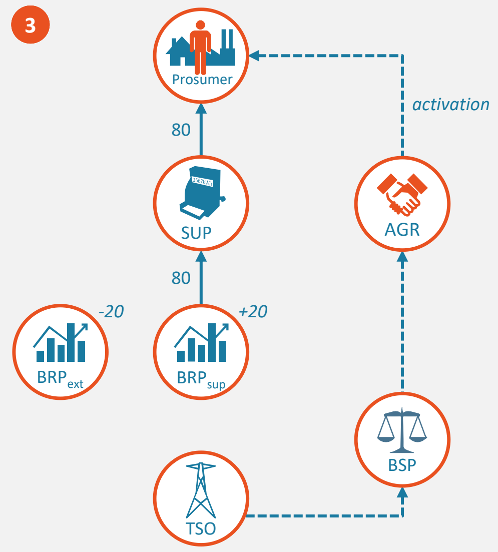


Figure 5-18 Use case step 3
(Operate phase, BSP releases balancing energy)

In the uncorrected model, the AGR associates with a BSP. DR activation is triggered by BSP. In response, AGR reduces the load at the Prosumer by 20. As a result, the AGR creates an imbalance of +20 with BRP_{sup}.

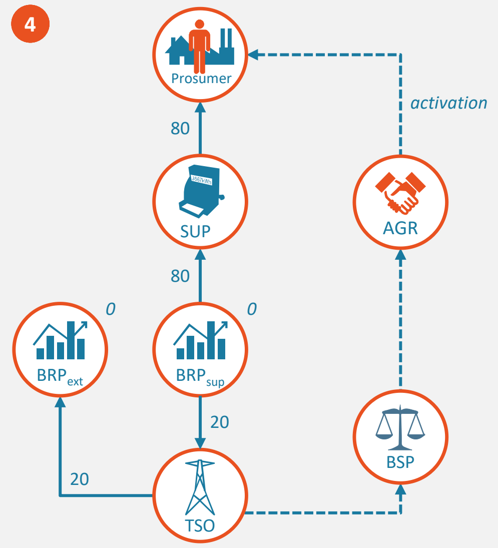


Figure 5-19 Use case step 4
(Settle phase, Restoring energy balance)

Through the regular balancing mechanism, the imbalance of BRP_{sup} passively contributes to the restoration of the system imbalance.

SUP has sourced 100 but only delivering 80 to the Prosumer. BRP_{sup}, delivers the remaining +20 through the balancing mechanism to BRP_{ext}. Assuming a market in which passive contribution to balance restoration is rewarded by the balancing mechanism, BRP_{sup} is remunerated against balancing prices.

Alternative use case

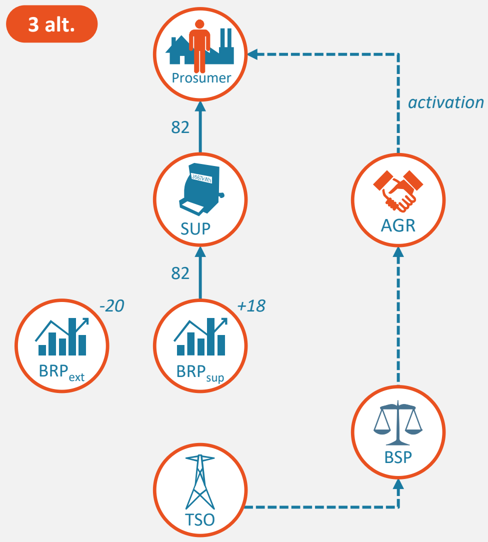


Figure 5-20 Alternative Use case step 3
(Operate phase, BSP releases balancing energy)

BSP tries to reduce the load of the Prosumer by 20, but only achieves 18. This partly contributes to the restoration of the system balance, but an imbalance of 2 remains.

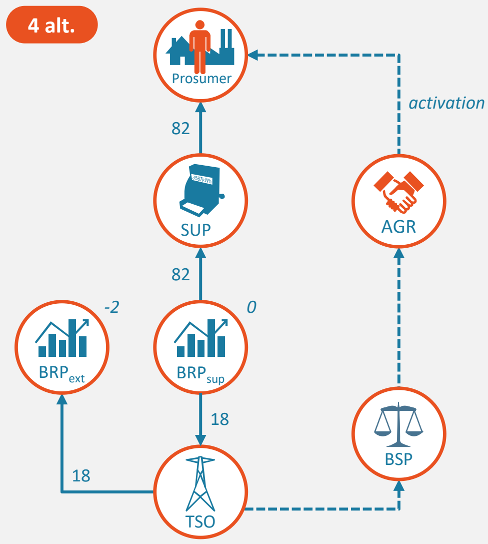


Figure 5-21 Alternative Use case step 4
(Settle phase, restoring energy balance)

Since only a volume of 18 was activated, the BRP_{sup} still passively contributes to the balance restoration, but is not able to fully restore balance.

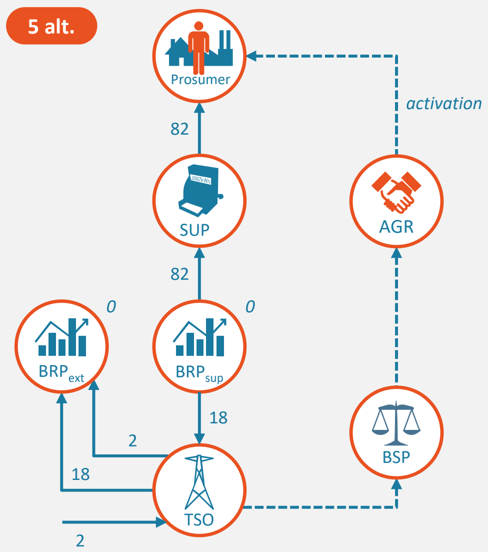


Figure 5-22 Alternative Use case step 5
(Settle phase, imbalance settlement)

The remaining imbalance of 2 needs to be acquired by the TSO, e.g. by requesting another AGR to deliver the remaining 2.
The BSP may be penalized for not delivering according to contract, but not through the volume mechanism of the balancing markets.

5.2.5 Corrected model

Table 5-7 characteristics corrected model

Synopsis	In the corrected model, the Prosumer's consumption profile is modified, based on the amount of flexibility that has been activated (realised) by the Aggregator. In general, this is done either by directly modifying the meter reading. The remuneration for energy takes place through the prosumer, based on retail prices. The Aggregator associates with his own BRP	
Main characteristics	Aggregator needs to assign its own BRP?	Yes
	Aggregator needs contract with Supplier?	No
	Energy transfer method?	via Prosumer
Contractual relationships	Aggregator has a contract with BRP_{agr} for entering energy markets and to cover imbalance	
Balance responsibility	BRP_{sup} holds full responsibility for the connection, where the allocation is based on the measurements, i.e. during activation periods on the *corrected* measurements (baseline). During activation periods, BRP_{agr} holds balance responsibility for the difference between the actual consumption (non-corrected measurements) and the baseline.	
Perimeter correction	The MDC will correct the meter readings of the connection with the increased or decreased amount of energy triggered by the Aggregator. The MDC will inform the TSO both about the corrected values, as well as of the amount of increased/decreased energy, per ISP. The ARP needs to correct the perimeters of the BRP_{sup} and BRP_{agr} with the activated energy.	
Transfer of Energy	No financial remuneration needed, since the SUP can bill the same energy volume as if no activation has occurred. Since energy is transferred through the Prosumer, the Aggregator will (in general) compensate the Prosumer for the energy that has been billed, but not consumed (or vice versa in case of load enhancement), depending on contract conditions.	

Note that the billing to the Prosumer can be organized in two different ways [8], the so-called *single billing* vs *double billing*[15]. In single billing the Prosumer receives an energy bill from its Supplier that only shows the corrected volume; in double billing the bill shows both the measured volume and the corrections. In single billing supplier is not aware of the DR volume, in double billing the supplier is, which could be considered as commercially sensitive information. Single billing gives rise to complexities with grid tariffs, taxes and levies; in double billing this is simpler. In the double billing method, the meter readings may not be modified explicitly. Yet both allocation and billing processes will be executed as if the meter readings have been modified.

Also note that in the corrected model the Transfer of Energy price is by definition the retail price.

[15] Here we adopt the definitions of ENTSO-e [8]. The terms are also being used in a different way: single billing where the customer receives a single bill from the supplier including network fees and dual billing where the customers receives two bills, one from the supplier and one from the network company.

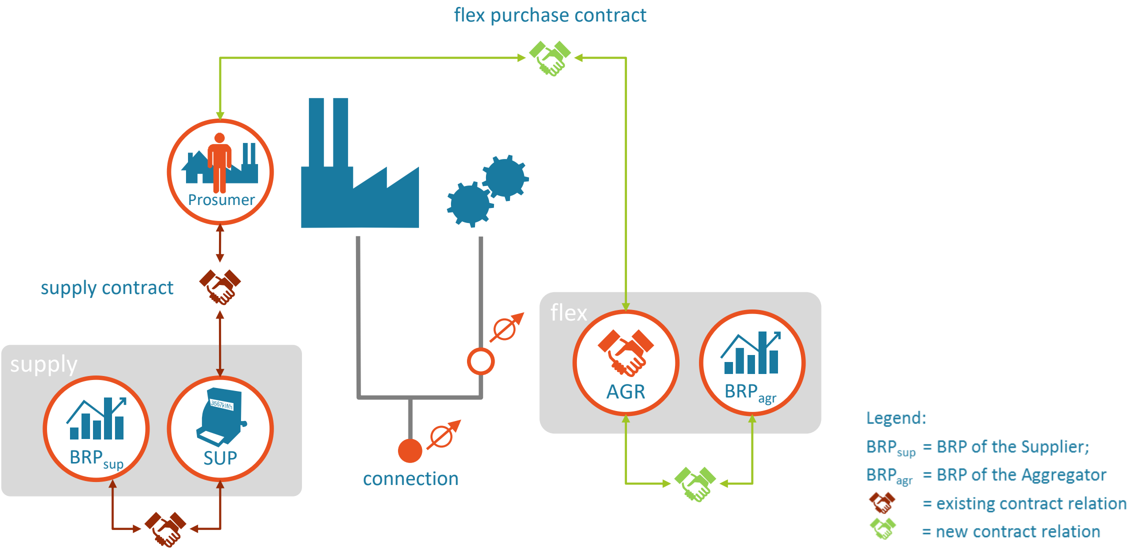


Figure 5-23 Corrected model

use case

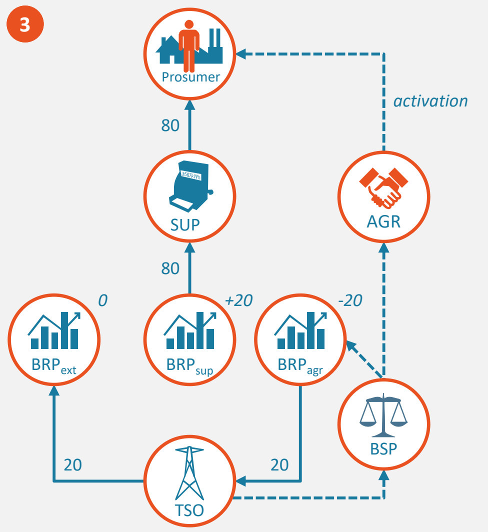


Figure 5-24 Use case step 3
(Operate phase, BSP releases balancing energy)

BSP releases balancing energy by activation of flexibility through the Aggregator. The consumption reduces from 100 to 80 units.

In the corrected model, the BSP associated with a BRP_{agr} is delivering 20 to the TSO. Through the balancing mechanism, 20 is delivered to BRP_{ext}, restoring the balance in its portfolio.

The AGR has reduced the consumption of the Prosumer to 80. Without a correction, the SUP (having sourced 100) would only be able to bill 80, rendering an open supply position and for BRP_{sup} an imbalance of +20, as depicted in the graph.

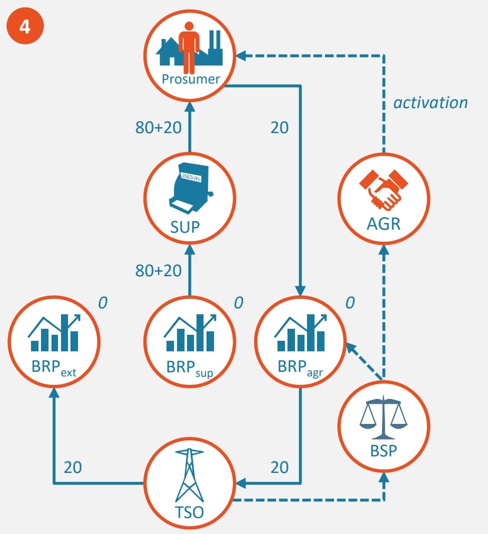


Figure 5-25 Use case step 4
(Settle phase, restoring energy balance)

In the corrected model, the MDC corrects the measurements of the Prosumer during times of DR activation. The measurements are changed into fictive value that would have been realized if no DR activation had occurred (the baseline).
In this case the delivered volume (based on the corrected measurements) equals 100. Thus, SUP has sourced 100 and has delivered 100. The Prosumer buys 100 from SUP, uses 80 and re-sells the remaining 20 to BRP_{agr}. BRP_{agr} has sold these 20 to the TSO.

The correction of the measurements thus restores the energy balance of the BRPs. The grid tariffs will still be based on the uncorrected values. Taxation, however, becomes more complex.

Alternative use case

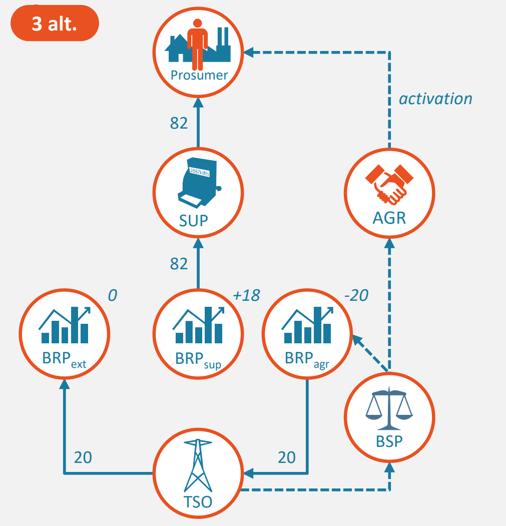


Figure 5-26 alternative use case step 3 (Operate phase, BSP releases balancing energy)

BSP tries to reduce the load of the Prosumer by 20, but only achieves 18. This partly contributes to the restoration of the system balance, but an imbalance of 2 remains.

Although the imbalance caused by the BRP_{ext} may be resolved in the same iteration as the imbalance caused by BRP_{agr} (through its AGR), we separate this in individual steps to clearly point out the energy transactions.

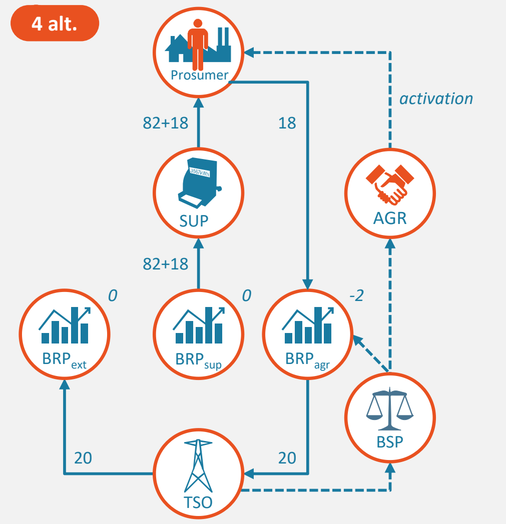


Figure 5-27 alternative use case step 4 (Settle phase, restoring energy balance)

Since the baseline is independent of the activated flexibility, SUP will still supply 100 to the Prosumer.

Aggregator can only buy 18 from the Prosumer, so the imbalance of -2 ends up in the perimeter of BRP_{agr}.

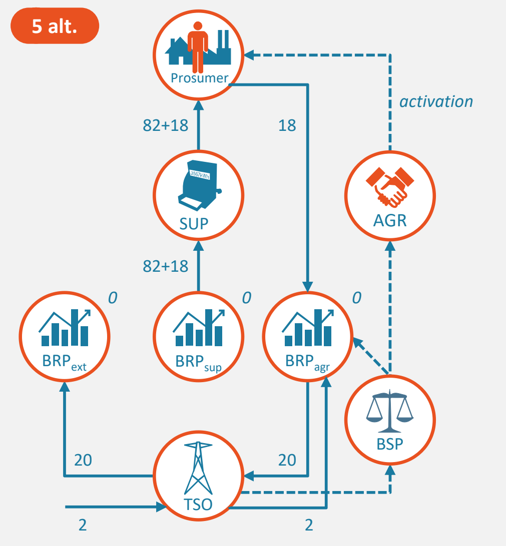


Figure 5-28 Alternative Use case step 5 (Settle phase, imbalance settlement)

The imbalance of the BRP_{agr} is settled through the regular balancing mechanism.

5.2.6 Central settlement model

Table 5-8 characteristics central settlement model

Synopsis	In the central settlement model, the Aggregator associates with his own BRP. A central entity (the ARP[16]) corrects the balancing perimeters following a DR activation. Compensation for the open supply position is also settled by this central entity, based on a pre-defined price formula.	
Main characteristics	Aggregator needs to assign its own BRP?	Yes
	Aggregator needs contract with Supplier?	No
	Energy transfer method?	central
Contractual relationships	Aggregator has a contract with BRP_{agr} for entering energy markets and to cover imbalance	
Balance responsibility	Balance responsibility for the flexibility is with BRP_{agr}. BRP_{sup} holds full responsibility outside activation periods, during activation periods the allocation of the flexibility resource is set equal to the corresponding baseline. During activation periods, BRP_{agr} holds balance responsibility for the difference between the actual consumption and the baseline.	
Perimeter correction	ARP corrects perimeters of both BRP_{sup} and BRP_{agr}	
Transfer of Energy	Rules are required to enable the ARP to transfer the energy between BRP_{sup} and BRP_{agr}. In addition a price formula is needed that is applied for the transferred energy and paid by the party into which perimeter the energy is transferred into.	

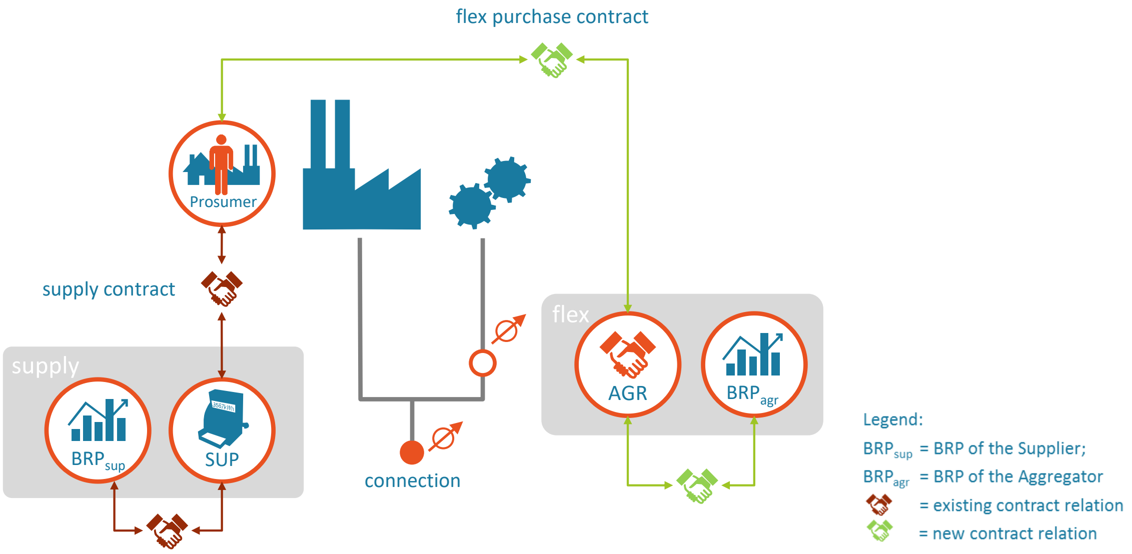


Figure 5-29 Central Settlement model

[16] In most countries the ARP role is performed by the TSO

Use case

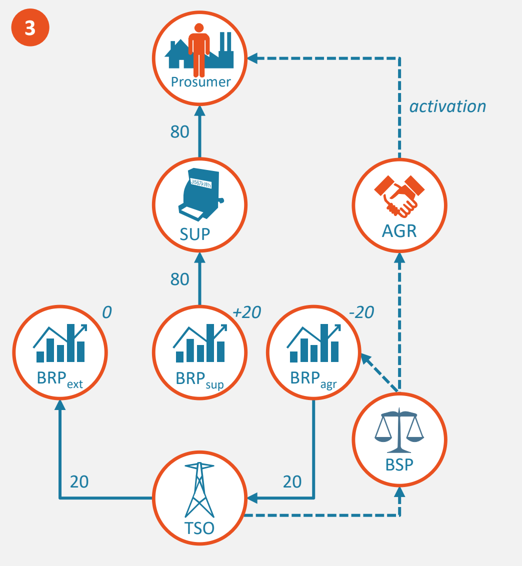


Figure 5-30 Use case step 3
(Operate phase, BSP releases balancing energy)

In the central settlement model, the BSP associates with a BRP to be able to deliver 20 to the TSO. Through the balancing mechanism, 20 is delivered to BRP_{ext}, restoring the balance in its portfolio.

However, the supplier, having sourced 100 but only delivering 80 to Prosumer, is faced with an open supply position of +20 and the BRP_{SUP} has an imbalance position of +20. The aggregator on the other hand has delivered 20, yet did not source this energy, leaving an imbalance position of -20 in his associated BRP_{AGR}.

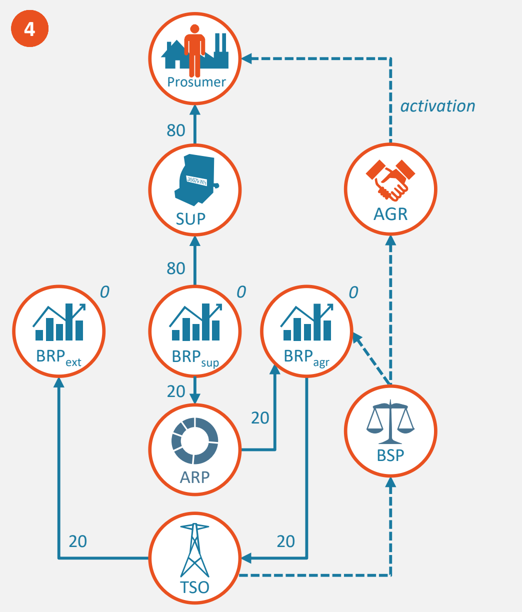


Figure 5-31 Use case step 4
(Settle phase, restoring energy balance)

A central entity (the ARP) corrects perimeters of BRP_{sup} and BRP_{agr} by transferring energy from BRP_{sup} into BRP_{agr}.

*This entity also takes care of the financial settlement based on a predefined price formula that is applied to the transferred energy. Specifically, in this case, AGR pays 20*price (€/MWh) to SUP.*

Alternative use case

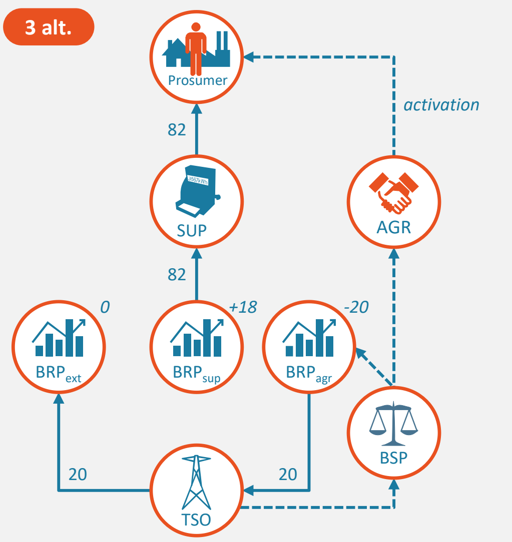


Figure 5-32 Alternative use case step 3
(Operate phase, BSP releases balancing energy)

BSP tries to reduce the load of the Prosumer by 20, but only achieves 18. This partly contributes to the restoration of the system balance, but an imbalance of 2 remains.
Although the imbalance caused by the BRP_{ext} may be resolved in the same iteration as the imbalance caused by BRP_{agr} (through its AGR), we separate this in individual steps to clearly point out the energy transactions.

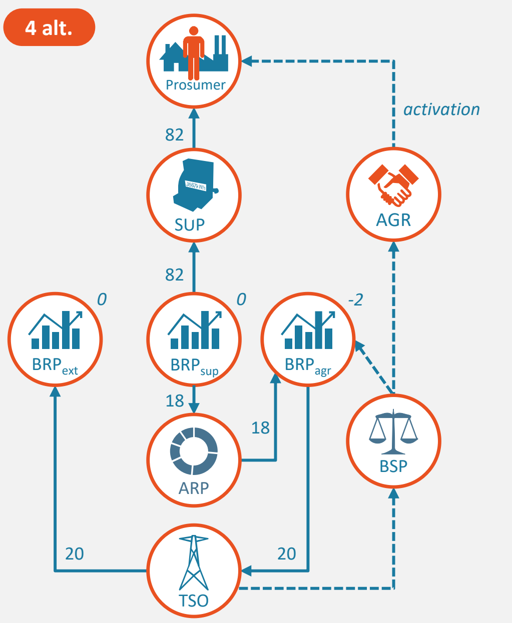


Figure 5-33 Alternative use case step 4
(Settle phase, restoring energy balance)

Since only a volume of 18 was activated, the perimeter correction equals 18. Since the AGR provided 20 to the TSO, the imbalance of 2 ends up in the perimeter of BRP_{agr}, as it has sold more energy than it activated/sourced.

Alternative use case

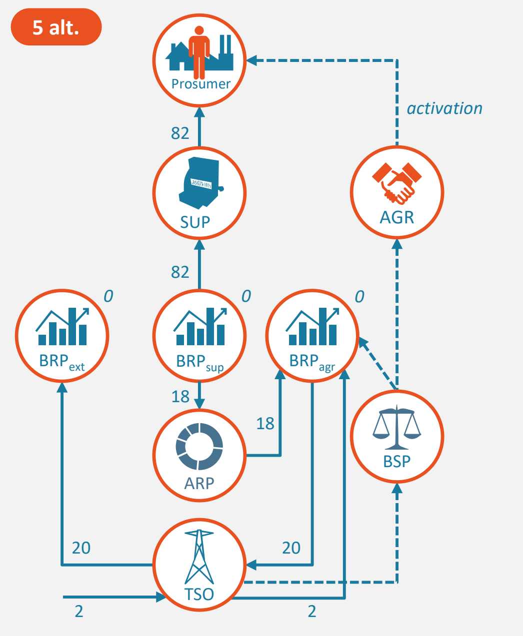


Figure 5-34 Alternative Use case step 5 (Settle phase, imbalance settlement)

The imbalance of the BRP_{agr} is settled through the regular balancing mechanism.

5.2.7 Net benefit model

A specific variant of the Central Settlement Model is the so-called net benefit model.

Table 5-9 characteristics net benefit model

Synopsis	The net benefit model is similar to the central settlement model, yet the cost of compensating the BRP_{sup} is not born by the Aggregator but partly or entirely socialized. Socialization may be limited to situations where DR brings energy savings.	
Main characteristics	Aggregator needs to assign its own BRP?	Yes[17]
	Aggregator needs contract with Supplier?	No
	Energy transfer method?	Central/socialized[18]
Contractual relationships	Aggregator has a contract with BRP_{agr} for entering energy markets and to cover imbalance	
Balance responsibility	Balance responsibility for the flexibility is with BRP_{agr}. BRP_{sup} holds full responsibility outside activation periods, during activation periods the allocation of the flexibility resource is set equal to the corresponding baseline.	
Perimeter correction	ARP corrects perimeters of both BRP_{sup} and BRP_{agr}	
Transfer of Energy	The impacted supplier is compensated for the sourced but not delivered energy based on a regulated price formula. The cost of this compensation is socialized if certain conditions are met. In the US, a net-benefit test [17] determines the price level from which the cost gets socialized. Under that price it is paid by the Aggregator.	

Note: although the net benefit model is classified as a sub-model of the central settlement model, the net benefit principle can in principle also be applied to other models where a transfer of energy is in place (for example the corrected model). A specific

[17] In the US, the Aggregator does not take balance responsibility (as in uncorrected model); this variant is not elaborated
[18] No energy transfer occurs from/toward BRP_{agr}. However, BRP_{sup} is compensated by all other BRPs.

financial flow can be implemented in order for the aggregator not to bear the entire cost of the transfer of energy, and to reimburse part of it.

In order to determine if it is worth socializing the cost of the transfer of energy, some preconditions are implemented: a net benefit test in the US, % of energy savings of DR in France. Those preconditions ensure that DR is only dispatched according to this socialization principle when the added value for the system is higher than the cost of the compensation.
Underlying principle: When the total sourcing costs diminished (because of lower spot price) by an amount higher than the cost of transfer of energy, the latter is taken in charge by the society (net benefit positive).

5.3 Aggregator Implementation Models based on reference profiles

In the *reference profile models* the separation of responsibility between AGR and SUP is based on a reference profile (baseline) that is defined ex-ante and serves as basis for the allocation. The Supplier sources and supplies the energy (actual consumption). The Aggregator optimizes the actual profile and may deviate from the reference profile when activating DR for specific products or markets. Differences between reference profile and actual (measured) profile is within the balance responsibility of $BRP_{agr.}$

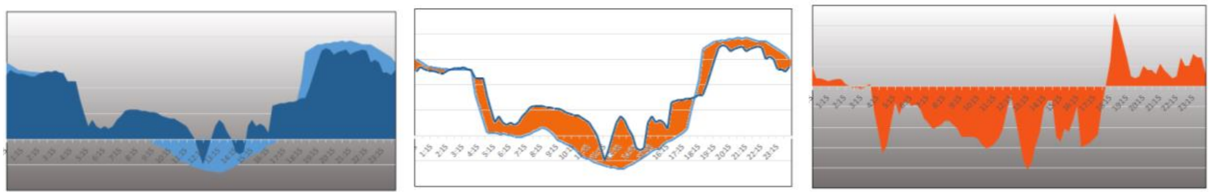


Figure 5-35 A typical reference profile for residential customers with solar PV. In the picture left is the reference profile in light blue and the realized profile in dark blue; the middle picture highlights the difference and the right picture shows the allocation for BRP_{agr}

As the purpose of the reference profile is to split balance responsibility, the reference profile models are only sensible in a dual-BRP configuration, leading to the configuration in the picture below.

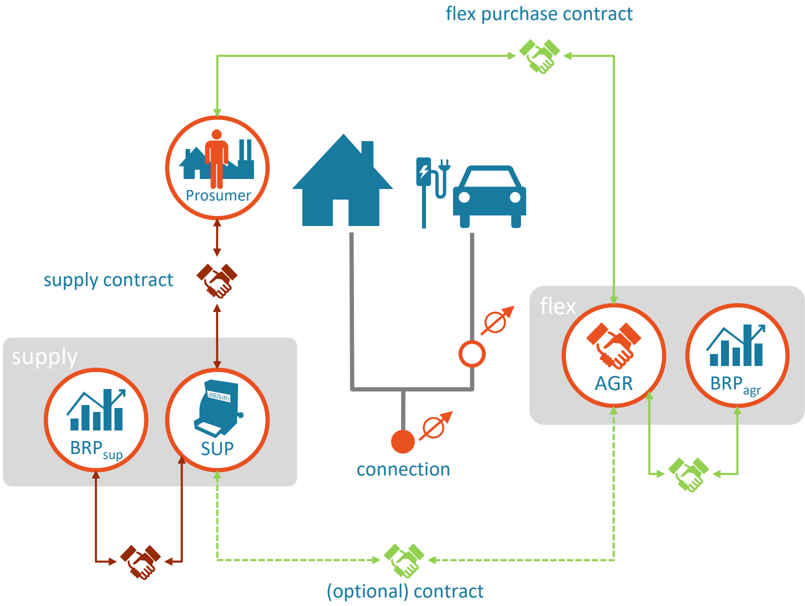


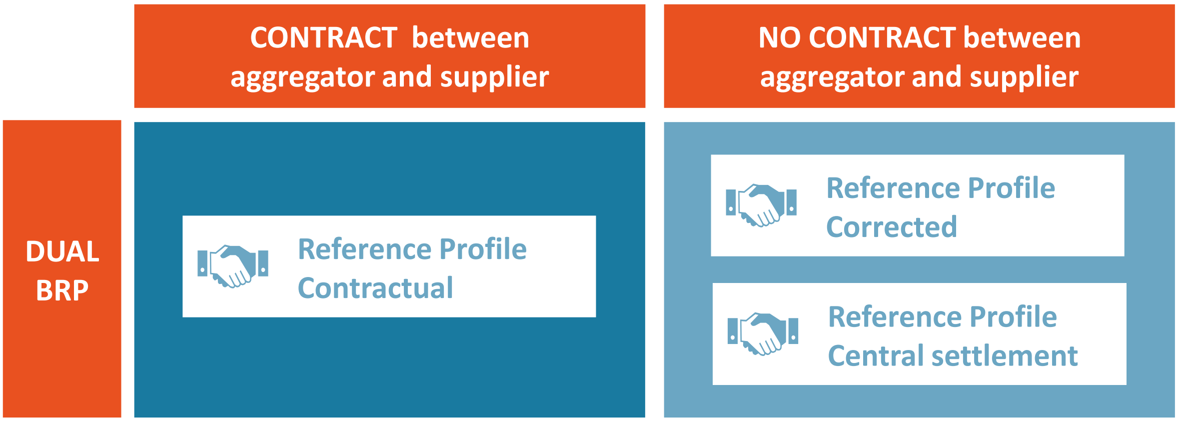
Figure 5-36 context of the reference profile models

In the regular aggregator implementation models (Section 5.2), the baseline for the Transfer of Energy is either equal to the baseline defined by the product (cf. recommendation 201, Section 6.2), or equal to the baseline defined by the regulator (cf. recommendation 203, Section 6.2)) – i.e. the same baseline is used for checking delivery performance and for Transfer of Energy. In the reference profile models the reference profile (baseline) serves as a separate baseline for splitting of imbalance volumes, and is likely to be different from baselines defined for the product (which is still used for checking delivery performance). The Supplier supplies and sources the energy for the actual consumption (i.e. reference profile plus deviations). The imbalance risk for all deviations from the reference profile resides at BRP_{agr}. After hand-over AGR is free to use the flexibility in different products, each with its own, product-defined baseline.

Similar to the standard Aggregator Implementation Models, the transfer of energy can be organized in three different ways, which gives the following variants for reference models (cf. Table 5-10):

- contractual (ToE conditions are part of the contract)
- corrected (ToE via the Prosumer)
- central settlement (ToE via perimeter correction by the ARP).

Table 5-10 Aggregator model classification scheme reference profile models



In the contractual variant, the reference profile is established between Prosumer, Supplier and Aggregator. In the non-contractual variants, the profile is determined by the regulator.

The reference profile models have been introduced to provide an alternative for specific situations where the regular models may prove insufficient (e.g. flexibility that is activated on a daily basis). For the rest, the reference profile models follow the same logic as the regular models. In principle, the recommendations and considerations of Chapter 6 will also apply to reference profile models, except for recommendation 201, which is the main distinction between the regular models and the reference profile models, and the recommendations on rebound effects, since this effect is implicitly covered via the reference profile.

Note that it is also possible to organize reference profiles in an alternative way, in which SUP supplies and sources according to the reference profile and AGR supplies the deviations (hence becoming a supplier as well). This way of separation has similarities with split-supply models (Section 5.1.3) with a time-dependent separation of responsibilities based on the reference profile. In this case, there is no transfer of energy needed and consequently no distinction between a central settlement variant and a corrected variant. The main question is who bears responsibility for defining the profile, leading to either a contractual or a non-contractual variant. This alternative is not further discussed in this document.

6 Recommendations and considerations

In this section, a set of recommendations and considerations are provided with respect to seven identified complexities

- **Measurement and validation** - Ensuring correct and trustworthy data
- **Baseline methodology –** How to define appropriate baseline methodologies, roles and responsibilities
- **Information exchange and confidentiality** - Finding a balance between transparency and confidentiality
- **Transfer of energy price methodology -** How to compensate the position of the Prosumer's supplier and its BRP
- **Relationship between implicit and explicit Demand Response -** How to separate both impacts unambiguously
- **Rebound effect -** Can the BRP or Supplier be negatively impacted and if so, how can this be compensated
- **Portfolio conditions -** How to participate in TSO/DSO/BRP products through a portfolio

Recommendations are formulated in those cases where our group, from an engineering perspective, reached an agreement on a solution for a given complexity, in which the needs of all stakeholders are satisfied. Such a recommendation could be read as an advice to the EC or NRAs and/or could be a component in a standardized contract. In cases where an agreement could not be reached, we have chosen to formulate a *consideration* clearly stating the different options that could be envisaged and their implications. This provides a background for an NRA's decision or can be settled in bilateral negotiations on a case-by-case basis. For each of the recommendations and considerations, the applicability is specified for:

- The specific (flexibility) products
- The specific customer segments
- The specific Aggregator Implementation Models

The recommendations and considerations in this section apply to the seven regular models (cf. paragraph 5.2). As discussed, most recommendations and considerations may also apply to reference profile models (cf. paragraph 5.3). However, a detailed analysis for reference profile models has not been performed.

6.1 Measurement & Validation

For processes like wholesale settlement, billing and forecasting, ISP-resolution based measurements are sufficient. Roles and responsibilities with respect to measurement and validation, as needed by these processes, are well defined in all member states. Flexibility services introduce new processes (baseline calculation, quantification of delivered flexibility), and may need different types of measurements (i.e. higher resolution or kW based).

ID	Products	Segments	Models
101	All	All	All
Recommendation	A flexible resource (asset) can only be operated by one Aggregator at the same time. Contracts with different Aggregators should be sequential in time.		
Rationale	If two or more Aggregators operate the same flexible resource at the same time, it is uncertain and complicated which operation control should take precedence. Also, it is not transparent how the activated flexibility (energy volume) should be allocated to (the BRP of) the right Aggregator. Constructions where e.g. a flexible resource is operated by one Aggregator each morning, and by another each afternoon are therefore not envisaged at first.		

ID	Products	Segments	Models
102	All	All	All
Recommendation	The market rules should allow two or more Aggregators to be active at the same Prosumer at the same time, provided they operate a mutually exclusive set of resources. In this case, sub-metering is necessary to allocate the activated flexibility (energy volume) to (the BRP of) the right Aggregator.		
Rationale	In general, a sub-meter can assist to isolate the measurements of the flexible resource. In this case, also the baseline methodology (used for the quantification of the activated flexibility) should be applied on the level of the sub-meter. If a Prosumer engages with multiple Aggregators, then each Aggregator shall apply sub-metering. Although this recommendation may endanger the business case in the residential segment by requiring a sub-meter, creating an exception for Residential is not deemed relevant, since: • The Aggregator needs to monitor and control the flexibility anyway, which (in most cases) already requires a sub-meter • Quantification of flexibility should be accurate and transparent; this applies to both C&I and Residential • Technology developments such as *Internet of Things* are expected to remove investments barriers to a large extent • A common solution for C&I and Residential is simpler and easier to implement. The need for a sub-meter can only be relieved when the Aggregator is active in a primary control product, provided this product doesn't require a sub-meter and there is no ToE involved, see recommendation 103.		

ID	Products	Segments	Models
103	All	All	All
Recommendation	If a Prosumer engages with an Aggregator on main meter level, no other Aggregators are allowed during the contract period. This should be included in the contract between the Aggregator and the Prosumer.		
Rationale	If a Prosumer would engage with a second Aggregator during the contract period, the first Aggregator would also need to place and use a sub-meter, which would lead to additional (unforeseen) costs for this Aggregator. Only exception is when the second Aggregator is active in a primary control product only, without having any volume effects to the first Aggregator.		

ID	Products	Segments	Models
104	All	All	All
Recommendation	Roles, responsibilities and methods with respect to the quantification of the flexibility delivered by the Prosumer to the Aggregator (as opposed to delivered by the Aggregator to the market), do not need to be regulated.		
Rationale	It seems logical that the same method (incl. baseline) is used compared with the flexibility quantification by the flexibility customer (e.g. TSO). However, the Aggregator may not remunerate the Prosumer per DR event; which removes the direct need of quantifying the delivered flexibility towards the Prosumer. Commercial & industrial customers do not need further protection/regulation, and are well able to verify the remuneration by the Aggregator. For residential customers, it is important that the Prosumer is capable to verify the (delivery of the) service, however there is no need for ex-ante regulation, since the basic energy supply is not at risk.		

ID	Products	Segments	Models
105	All	All	All
Recommendation	If the baseline methodology of a flexibility service is based on a nomination by the Aggregator (cf. recommendations 205, 206, 207, 208), then the meter data, used for calculating the baseline, can be collected by the Aggregator, provided the meter meets the technical requirements of either TSO, DSO or ARP (depending on the type of product).		
Rationale	E.g. in case of secondary control, the ISP measurements are not sufficient. Rather, the actual power level is needed. These measurements are available within the Aggregator's infrastructure. This responsibility (collecting data for baseline calculation) can be left to the Aggregator as there are plenty ways for the flexibility customer to verify the measurements, e.g. through audits), verify the nominations (see 205, 208) and within the process of flexibility quantification by a third party (see 109).		

ID	Products	Segments	Models
106	All	All	All models that include a ToE
Recommendation	The validation of data, used as input for the Transfer of Energy, needs to be performed by a meter data company (MDC). Since the responsibilities with respect to the main meter (i.e. on connection level) are already well defined, this specifically applies to sub-metering, assuming the baseline methodology is applied on the level of the sub-meter.		
Rationale	Data that is used for wholesale settlement purposes needs to be validated by an independent party (this concerns ISP-resolution based measurements), i.e. the MDC. This role may be performed by a regulated party (e.g. TSO or DSO), depending on national regulations.		

ID	Products	Segments	Models
107	All	All	All
Recommendation	When a Prosumer enters into a flexibility contract with an Aggregator using a sub-meter, the need for the installation of an additional sub-meter should be avoided.		
Rationale	The need for two sub-meters may emerge if the meter and the data collection processes operated/performed by the Aggregator (for on-line monitoring) do not meet the legal requirements for metering / data collection for wholesale settlement purposes, and the meter infrastructure operated by the (often regulated) MDC does not meet the requirements of the Aggregator with respect to on-line monitoring. However, installing and operating two meters at the same location is cost inefficient and may seriously threaten the business case for the Prosumer to monetize its flexibility.		

ID	Products	Segments	Models
108	All	All	All
Consideration	The collection of data, used as input for the Transfer of Energy, can be performed by either one of these methods (i) The sub-meter is installed by the Aggregator and used for monitoring by the Aggregator. The sub-meter complies with the requirements stated by the MDC. The Aggregator collects the data and provides the relevant data to the MDC, as input for wholesale settlement (ii) The sub-meter is installed by the Aggregator and use for monitoring by the Aggregator. The sub-meter complies to the requirements stated by the MDC, and the Aggregator provides the MDC access to the sub-meter for data collection, as input for wholesale settlement (iii) The sub-meter is installed by the MDC and meter data is collected by the MDC. The MDC provides the Aggregator access to the sub-meter for real-time monitoring purposes.		
Rationale	Main attention points ▪ Costs of the sub-meter and metering process. When the costs are borne by the Aggregator of the Prosumer, this may threaten the business case on Prosumer level. If the costs are borne by a regulated party, the societal costs need to be		

	considered. In the third option, the need for on-line monitoring data and access may increase the overall costs. ▪ Trustworthiness of meter data Data used for wholesale processes needs to be of high quality and trustworthy. In the first two options, the MDC may need additional verification options, either through the main meter, and/or through audits.

ID	Products	Segments	Models
109	All	C&I	All
Recommendation	The quantification of the delivered flexibility (based on measurement on either main or sub-meter level and the corresponding baseline), for the purpose of both performance quantification and Transfer of Energy (when applicable), is performed by the TSO for TSO services, the DSO for DSO services and by the ARP for BRP services (the latter is only relevant for the Corrected, Central settlement and Net benefit models).		
Rationale	In case of TSO services: in its contractual relation with the Aggregator/BSP, the TSO needs to remunerate the Aggregator/BSP based on the delivered flexibility. The TSO also needs to correct the perimeter (depending on the implementation model). The Aggregator/BSP is well able to verify these calculations as they have all input data at their disposal. For congestion management a similar argument holds for the DSO, with the exception that a redispatch mechanism is needed (cf. recommendation 804), rather than a perimeter correction. For BRP services (esp. wholesale trading), there is no unique customer, and there is no flexibility service quantification needed. Therefore, the Allocation Responsible Party, responsible for the correct allocations of energy volumes to BRPs, is the logical role to quantify the delivered flexibility (cf. also recommendation 203). The latter is restricted to the Corrected, Central Settlement and Net benefit models, since the ToE takes place through a bilateral deal in the Contractual model.		

ID[19]	Products	Segments	Models
111	All	Residential	All
Consideration	The quantification of the delivered flexibility (based on measurement on either main or sub-meter level and the corresponding baseline), for the purpose of both performance quantification and Transfer of Energy (when applicable), is performed by either • the TSO for TSO services, the DSO for DSO services and by the ARP for BRP services (equivalent to C&I segment, cf. 109). • The MDC for all services		
Rationale	Advantage of the first option is simplicity: no differences between segments. Drawback of the first option is that all measurement data needs to be transferred through the full chain to the flexibility customer. As the data needs to be transferred to the MDC anyway (to perform its validation responsibility, cf. 106) the MDC is an apt role to bear this responsibility. Also, the MDC may safeguard that flexibility is not allocated to different Aggregators (cf. 102) or services (cf. 110).		

ID	Products	Segments	Models
110	All	All	All
Recommendation	In general, the Aggregator should be allowed to sell the same flexibility to different markets. However, the energy that is associated with a flexibility activation can only be sold once, per resource, per time unit (ISP).		
Rationale	If flexibility can contribute to different markets at the same time (e.g. restoring system balance and resolving local congestion), then this may be rewarded. Disallowing this could limit the availability of		

[19] Numbering is not logically ordered, but kept consistent with the previous (Nov 2016) version of this report.

	flexibility in e.g. a congested area, if the resource is already participating in a balancing product. If the flexibility market is sufficiently liquid (in the long term), the Aggregator can/will place a lower flexibility bid on the second market, if the costs are already covered through the first market. In the short term, this can fuel the Aggregator business. Flexibility can be offered to different markets at the same time, however when a specific “unit of flexibility” is sold, it is uniquely associated with a specific flexibility service, and can trigger only one energy-remuneration. However: ▪ The total flexibility of one resource at a specific time may be split into different parts, which can be sold to different markets (see 703) ▪ A resource may participate in a capacity product; its flexibility can be sold to a different market when the capacity mechanism is not activated, in this case a capacity and energy remuneration from different markets can be combined ▪ An Aggregator can serve different markets from one portfolio (see 702)

ID	Products	Segments	Models
112	All	Residential	All
Recommendation	The requirements on the accuracy level for sub-meters in the Residential segment can be less strict, compared to the C&I segment. The accuracy only needs to be reached on aggregated level.		
Rationale	The accuracy level of the meter can be eased in the residential segment, since the accuracy is only required on aggregated level. I.e. the measurement accuracy for a 100 kW level does not need to be copied to a 1 kW customer, it is sufficient if the measurement accuracy for a portfolio of 100x1 kW is similar to the measurement accuracy of a single 100 kW customer. This implies that the required accuracy level should be based (a.o.) on the minimum pool / bid size of the product.		

6.2 Baseline Methodology

A baseline methodology is used to find the best approximation of the energy consumption or production that would have occurred if no DR event would have been triggered. It is needed, not only as a basis for the Transfer of Energy, but also to quantify the performance of the flexibility service provider and for the contribution/performance of the Prosumer. In this section recommendations are made about the responsibilities with respect to baseline design, baseline calculation and flexibility quantification. Also baseline methodologies are discussed.

ID	Products	Segments	Models
201	All except wholesale	All	All models that include a ToE
Recommendation	The baseline methodology used as basis for the Transfer of Energy (when applicable) is equal to the baseline used for flexibility service quantification (thus the volumes for delivered flexibility, perimeter correction and Transfer of Energy are equal).		
Rationale	Although the purpose of the calculation of the delivery flexibility may be different (either assessing whether the delivery meets the contractual obligations towards the flexibility customer, or determining the volume of energy that needs to be transferred between two BRPs), both baseline calculations have the same intention: to find the best approximation of the energy consumption or production that would have occurred, if no DR event would have been triggered. Using two different methods would, in general, lead to different approximations, implying that one is erroneous. Also, the transparency of the process would be violated if different methods would be applied. As a consequence: Since not all flexibility services will use the same baseline methodology, the Transfer of Energy will need to be based on more than one transfer of energy method, depending on the market (characteristics) where the flexibility is sold.		

ID	Products	Segments	Models
202	All except wholesale	All	All
Recommendation	The baseline methodology should be defined by the purchaser of the flexibility service, e.g. the TSO for balancing services, the DSO for congestion management. The regulator may need to approve this methodology, depending on its exact role and responsibility.		
Rationale	The purchaser of a service bears responsibility for defining the characteristics of the service delivery and the method to measure and validate the quality and quantity of the delivery. This is in line with current practices, e.g. for ancillary services (currently aimed at large generators). As a consequence, the baseline methodology is product dependent. Since this also defines the basis for the Transfer of Energy (see 201), the regulator may need to approve the baseline methodology, depending on its exact role and responsibility per member state. In 204, 205, 206 we provide further recommendations what this methodology could look like for specific products.		

ID	Products	Segments	Models
203	Wholesale	All	Corrected, Central Settlement, Net Benefit
Recommendation	The baseline methodology for wholesale markets should be defined by the regulator.		
Rationale	Since there is not a single buyer in wholesale markets, the baseline methodology needs to be defined by a central authority. In wholesale markets there is no need to quantify the delivered flexibility, because this is implicit in the portfolio of the BRPs. The baseline methodology is therefore only used to quantify the Transfer of Energy. This only needs to be regulated for the Corrected, Central Settlement and Net Benefit models. In 207, 208 we provide further recommendations what this methodology could look like for specific products.		

ID	Products	Segments	Models
204	Primary control (FCR)	All	All
Recommendation	The baseline methodology should be a 'Meter-Before/Meter-After' (MBMA) method ▪ The baseline for each event is a constant, equaling the most recent measured power level ▪ The measurement resolution is prescribed by the FCR product ▪ The baseline should be determined on unit (resource) level The requirement to fully base the baseline on actual measurements can be eased for the Residential segment, in case no ToE occurs (Integrated, Broker or Uncorrected model)[20].		
Rationale	Given the very short notification, activation and duration times of this service, the current power level is sufficiently accurate as baseline methodology, which is also in line with current practices. A unit level is needed in case of partial activation of a portfolio, in which case the baseline of the activated part needs to be derived from the baseline on unit level.		

ID	Products	Segments	Models
205	Secondary control (aFRR)	All	All
Recommendation	The baseline methodology should be based on ▪ Rolling nomination by the Aggregator / BSP for the next period (e.g. 15 minutes) ▪ The nomination should start at the current power level (most recent measured power level prior to the activation), fully based on actual measurements ▪ Resolution and time window of the nomination should be aligned with the specific aFRR characteristics		

[20] Provided consistency with the system operation guideline [20] (specifically article 154. Point 9) is ensured.

	▪ The nominations should be updated with the same frequency as prescribed by the FRR product ▪ The nomination should be on unit level The quality of the nomination should meet the requirements of the FRR product. The quality of the nomination will be checked by the TSO at times when no activation has occurred. The proposed methodology is thus technology-independent.
Rationale	Given the relatively short notification, activation and duration times of this service, the current power level should be the main component of the baseline methodology, which is also in line with current practices. The current power level can only be determined by actual measurements. However, since demand side resources introduce new complexity (compared to “traditional” generators participating in ancillary services), the current power level needs to be extrapolated to the next ISP, for the following reasons: ▪ Demand side resources, but also (e.g.) large wind parks, may show high volatility already within 15 minutes. In this case, a flat baseline would not meet the accuracy levels. ▪ If the resource shows high volatility, using a flat baseline would on one hand open up gaming options (by activating a resource that is about to ramp up/down anyway), or may pose problems on the Aggregator to deliver the required flexibility. The Aggregator is best capable of defining an accurate baseline, as it is the only party that knows its portfolio, and the characteristics and actual status of the resources within this portfolio. All complexity is isolated and placed with the Aggregator, and it is up to the Aggregator which types of resources he can include in its portfolio that meet the accuracy requirements of the TSO. Therefore, both the product and the baseline methodology can be technology-agnostic. Finally, it is up the Aggregator to include historical information, meteorological information etc. in its forecasting process; this does not need to be included in the baseline methodology. A unit level is needed in case of partial activation of a portfolio, in which case the baseline of the activated part needs to be derived from the nomination on unit level.

ID	Products	Segments	Models
206	Tertiary control	All	All
Recommendation	The baseline methodology for tertiary control shall be equal to the methodology for secondary control, with two exceptions: ▪ Nomination by the Aggregator / BSP for the next ISPs (e.g. 2 hours, depending on product definition – the length of the nomination should equal the full duration of the product) ▪ Baseline must be frozen shortly before or exactly at the time when the activation signal of the TSO comes in.		
Rationale	The same reasoning applies for tertiary control as for secondary control. Since activation windows, thus baseline periods, are longer for tertiary control, the nomination needs to extend further ahead in time. The acceptable error of the baseline grows proportionally to the duration. Key element is that there is no systematic bias in the baseline composed by the Aggregator.		

ID	Products	Segments	Models
207	Intraday trading	All	Dual BRP models
Consideration	The baseline methodology for intraday trading shall be depending on the time window between selling the flexibility and activation, as follows: ▪ For relatively long time windows (3 to 24 hours), the baseline methodology shall be equal to the methodology for day ahead trading ▪ For relatively short time windows (up to 3 hours), the baseline methodology shall be equal to the methodology for tertiary control.		
Rationale	For relatively long time windows intraday trading strongly resembles day ahead trading. Therefore, the		

	same methodology can be applied. For relatively short time windows intraday trading strongly resembles tertiary control, esp. free bids with tertiary control. Therefore, the same methodology can be applied. This baseline methodology is provided as a consideration, rather than a recommendation, since there remain uncertainties about whether the methodology for day ahead trading meets the requirements on (especially) accuracy and integrity (see 208).

ID	Products	Segments	Models
208	Day ahead trading	All	Dual BRP models
Consideration	The baseline methodology for day ahead trading should be based on ▪ Nomination by the Aggregator / BSP per ISP (limited to the ISPs that are included in the bid) ▪ The nomination should be on unit level ▪ Baseline must be frozen before market clearing. Accuracy level of the nomination needs to be prescribed by the regulator. Quality of the nomination can be safeguarded in two ways: ▪ Through the market: By making the BRP_{agr} balance responsible for (part of) his portfolio, whether or not the energy has been traded day ahead, a correct incentive is created for the BRP_{agr} to meet the desired / required accuracy level. ▪ Through regulation: Quality needs to be defined in market rules and market control instances must manage market access. The baseline should be unbiased. The regulator needs to define the acceptable error margin. Additional auditing on the quality of the provided nominations (also when the bid is not taken) may be needed to safeguard the quality and prevent gaming.		
Rationale	The alternative approach would be to apply a mathematical method; this however has major drawbacks: ▪ The method then needs to be technology-dependent, since e.g. a baseline for PV can only be accurate when meteorological information is included. This will make the methodology very complex ▪ Specific information about the Prosumer cannot be included, such as maintenance schemes, which will decrease the accuracy level ▪ Contrary to the residential segment, for commercial and especially industrial customers, the law of large number cannot be applied to reach a sufficient accuracy level on portfolio level, as the number of Prosumers is relatively low and the load patterns are in general heterogeneous. ▪ A mathematical method, in combination with a large, heterogeneous portfolio can provide gaming options. The Aggregator can select, shortly before the DR event, which units in its portfolio will be activated. He can then strategically choose the units that are already diverging from their baseline (calculated day ahead). This will also negatively influence the quality of the baseline of the part of the portfolio that is not activated, but the Aggregator is not responsible for the quality of the baseline. ▪ Portfolio gaming can, in this case, presumably only be avoided by trading on unit level rather than portfolio level. This will however limit the resource types to those that are highly predictable (some generation types and highly predictable load), which will strongly limit the resource types eligible for DA trading. When the baseline is constructed based on a nomination, the question is who should be responsible for creating this nomination. When the baseline is not sufficiently accurate, either the BRP_{sup} or the BRP_{agr} will suffer the consequences. Therefore, either one these roles (or together, in case of a contractual model) should be responsible for the nomination. Consequently, a second alternative is to make the BRP_{sup} responsible for the nomination (and thus baseline). Major drawbacks for this option are: ▪ BRPs often forecast on portfolio level, not (necessarily) on Prosumer level. This would create an administrative burden with no direct benefits for the BRP_{sup}.		

	▪ It is often not possible to create a sufficiently accurate baseline for a single Prosumer. Therefore, the BRP_{sup} cannot be held responsible (or penalized) for the accuracy of the nomination. Analogously to the balancing methodology for secondary and tertiary control, the Aggregator is responsible for managing all the complexity related to reaching the required accuracy level. Both the long time between trading and activation, and the absence of an external trigger, highly increase the possibilities for gaming / arbitrage. Therefore, the proper incentives and/or control mechanisms are needed to prevent gaming. Also in this option, issues remain: ▪ Options for strategically selecting the units within its portfolio remain (cf. the mathematical model above). Although in this case the Aggregator is responsible for the quality of the baseline of the not-activated resources, he may still be able to reach the accuracy levels when the frequency of activation is very low. ▪ A flex resource tripping during a DR event may impose a large financial risk to the Aggregator, as the balance responsibility is with the BRP_{agr} and his position will be extremely long. Discontinuing the DR event (and switching to another flex resource) in this situation may not be an option. This baseline methodology is provided as a consideration, rather than a recommendation, since there remain uncertainties whether this methodology meets the requirements on (especially) accuracy and integrity.

ID	Products	Segments	Models
209	Wholesale	All	Dual BRP models
Recommendation	In general, a maximum number of activations need to be stated for wholesale trading, to ensure sufficient baseline quality.		
Rationale	For resources that are activated on a (nearly) daily basis, it is impossible to distinguish the behavior resulting from demand response activations, from "normal" behavior. Therefore, a limit needs to be defined for the number of activations, to be able to quantify the activated energy volume, as part of the Transfer of Energy.		

ID	Products	Segments	Models
210	All	All	Dual BRP models
Recommendation	Ramp times (up and down) either need to be part of the activation window, or not. All products, as well as the Transfer of Energy, should apply the same strategy to ramp times.		
Rationale	If ramp rates fall outside the activation window of the product, but inside the activation window of the ToE, the Aggregator faces imbalances during ramp times. In the opposite case, the BRP_{sup} faces imbalances.		

6.3 Information exchange and confidentiality

For our recommendations, we assume that all information exchanged between market roles is performed on a need-to-know basis. BRP_{sup} and/or SUP may need specific information concerning the contracting and activation of flexibility at a Prosumer by an Aggregator, to perform its own responsibilities. However, parts of this information may also contain commercially sensitive information about the Aggregator's portfolio and business model. This confidentiality issue is only relevant for non-contractual, dual-BRP models, as we assume that the BRP_{sup} and Supplier will know about the identity of the Aggregator and Prosumer in the contractual models.

This section focuses on the balance between confidentiality and transparency. The relevant processes of the different market roles are identified including their information need, the required aggregation level, and the extent to which this information is deemed confidential. For the confidentiality aspect, we indicate which aggregation level is deemed commercially sensitive (in general, this is the case for the *Prosumer level*, since this reveals the identity of the Prosumer).

Table 6-1: Information need

Market player	Process	Information need	Timing	Aggregation level	Rationale	Recommendation / consideration
BRP	Long Term /Day Ahead Forecasting	Activated flexibility per ISP	Together with allocation data	- BRP - Prosumer (switching in/out)	Activated flexibility should be excluded in forecast	303, 304
BRP	Intraday forecasting	Activated flexibility per ISP	Next ISP	- BRP - Prosumer (only if on-line metered)	Activated flexibility should be excluded in forecast	303, 305
BRP	Real time balancing	Dispatch information	Real time	- Prosumer (only if on-line metered)	Prevent counter balancing in portfolio	305
SUP	Billing	Activated flexibility (resolution depending on contract type)	Next month	- Prosumer (only in case of corrected model combined with double-billing)	Bill needs to reflect activated flexibility	304
SUP	Billing	Activated flexibility per ISP	Next month	- Prosumer (only when Prosumer is exposed to intraday/balancing prices / risks)	Prosumer should not receive double remuneration through alleged passive contribution	306, 503
SUP	Contracting	Basic characteristics	After contract signing AGR-PRO	- Prosumer	SUP may need to check whether Prosumer is not violating SUP contract	301,302

Table 6-1 identifies the information needs of the market roles BRP (in this case BRP_{sup}) and the Supplier, for relevant processes. The column *timing* states at what time this information is needed, the next column states which aggregation level is required (either on Prosumer level, or aggregated on BRP or Supplier level). The rationale states why this information is needed. The final column refers to the recommendations and considerations that address this specific information need.

Our analysis shows that often the information need can be fulfilled by providing information on aggregated level, however, in several specific cases, information on Prosumer level may be needed. Information on Prosumer level is always considered commercially sensitive, except in the case of the switch-out process of the BRP and/or Supplier.

Based on the information needs of the BRP_{sup} and Supplier and the commercial sensitivity of part of the data, we formulate the following recommendations and considerations.

ID	Products	Segments	Models
301	All	All	Non-contractual
Recommendation	The Aggregator (or its BRP) does not need to inform the BRP_{sup} nor the Supplier of the Prosumer about the closed (new) flexibility contract.		
Rationale	If the BRP_{sup} or Supplier should be informed, the responsibility lies with the Prosumer. Whether the Prosumer should inform its Supplier is (partly) determined by the specifications of its supply contract (see also the next consideration).		

ID	Products	Segments	Models
302	All	All	All
Consideration	The regulator should determine if, and to what extent, the Supplier, through its supply contract can (i) prohibit the Prosumer to sign a separate flexibility contract (ii) change the energy price when the Prosumer signs a separate flexibility contract, or (iii) oblige the Prosumer to inform the Supplier about a separate flexibility contract.		
Rationale	The right balance should be sought between the information need of the Supplier, the compensation of the Supplier, the free choice of the Prosumer, the market functioning and the commercial interests of the Aggregator.		

ID	Products	Segments	Models
303	All	C&I	All, except Corrected
Recommendation	The BRP should receive information regarding the activated flexibility in its portfolio on aggregated level per ISP (i.e. not revealing the Prosumer or Aggregator involved).		
Rationale	For forecasting purposes, the BRP needs to know the activated volume on portfolio level. If the BRP constructs its forecast bottom up (i.e. based on individual measurements), it will include the effect of the activation in its forecast (except in the Corrected model), which should be avoided as the activated volume has been transferred.		

ID	Products	Segments	Models
304	All	C&I	All
Recommendation	In specific situations (see rationale below) It is necessary for the BRP and/or the Supplier to receive information regarding the activated flexibility in its portfolio on Prosumer level per ISP.		
Rationale	Information on Prosumer level may improve the quality of forecasting and balancing processes of the BRP, is inherent to the Contractual and Broker model, and is required in specific situations (cf. 305, 306, but also for a corrected model with double billing). This information would therefore be sufficient for the BRP and Supplier to perform its responsibilities. Yet it raises the issue of misuse of commercially sensitive data that must be handled if such data is to be exchanged (as in the corrected model – double billing case). There is no need for the BRP_{sup} to receive information (well) prior to the event, nor at the start or during the event (unless the uncorrected model is applied and the BRP_{sup} has an incentive to counteract on the activated volume). On one hand the BRP_{sup} cannot act on this information, on the other hand the information cannot be trustworthy as the Aggregator only decides shortly before activation (or even during the event) which resources to activate. The only (possible) exception is stated in consideration 305.		

ID[21]	Products	Segments	Models
309	All	Residential	All, except Corrected
Recommendation	The BRP should receive information regarding the activated flexibility in its portfolio on aggregated level per ISP (i.e. not revealing the Prosumer or Aggregator involved).		
Rationale	There is no need in the Residential segment for a BRP to receive information on Prosumer level. The only exception could be the corrected model, yet we advise against this model in the Residential segment (cf. 811)		

[21] Numbering is not logically ordered, but kept consistent with the previous (Nov 2016) version of this report.

ID	Products	Segments	Models
305	All	C&I	Corrected, Central settlement, Net benefit
Consideration	Special attention should be given to Prosumers where the BRP_{sup} acts on on-line metering facilities. Without information on Prosumer level, there is the risk of counter balancing by the BRP_{sup}.		
Rationale	The BRP_{sup} may need to receive information on a DR event on Prosumer level for all Prosumers with on-line metering. A sudden change in load/generation may trigger the BRP_{sup} to balance its portfolio (and counter balance the system) if he is unaware that the change will be levelled through the ToE. Even when information about the DR event is provided on portfolio level, the BRP_{sup} cannot be certain that the change is caused by this specific DR event.		

ID	Products	Segments	Models
306	All	C&I	Central settlement
Consideration	Special attention should be given to Prosumers that are exposed to either intraday or real time market prices (specific form of implicit DR by the Supplier). Without information on Prosumer level, the Prosumer will be remunerated twice after activation, both by the Aggregator for providing flexibility, and by the Supplier through the intraday and/or balancing provision of his supply contract.		
Rationale	The Supplier needs to receive the activated flexibility on Prosumer level for all Prosumers with this specific type of supply contract, otherwise he will pay the Prosumer for the activated flexibility against intraday / balancing process, which is sold against ToE prices. As an alternative, the combination of such a supply contract and an explicit DR contract with an Aggregator should be prohibited. This needs to be included in the regulatory framework for Aggregators. See also recommendation 501.		

ID	Products	Segments	Models
307	Balancing	All	Non-contractual
Consideration	For other information needs (see Table 6-1) a balance should be sought between transparency and confidentiality.		
Rationale	Arguments are provided in the Table 6-2 below. Additionally, information exchange on unit level may be easier to implement, e.g. in TSO IT infrastructures, since this is in line with current practices. There are other reasons to support trading (and the associated information exchange) on portfolio level however, see section 6.7.		

Table 6-2: Arguments on the balance between transparency and confidentiality

Transparency argument	Refutation
Providing activation volumes on Prosumer level as part of the allocation process for Prosumers switching in or out (of supply contract), will increase the quality of LT/DA forecasts that are constructed top-down.	▪ A DR event is not essentially different than any other Prosumer-triggered event, such as maintenance. These other types of events need also to be considered in any forecasting methodology.
Providing activation volumes on Prosumer level in the consecutive ISP for Prosumers with on-line metering, will increase the quality of short term forecasts.	▪ As above; ▪ the cause of the event can be inquired at the Prosumer; ▪ activation volumes on portfolio level could be sufficient to determine current position.
Providing real-time dispatch information on Prosumer level for Prosumers with on-line metering will decrease the risk for counterbalancing by the BRP_{sup}.	▪ As above; ▪ Value is arguable, as validity, total duration and impact may still be unknown at time of dispatch ▪ Possible latency when sent through TSO

Confidentiality argument	Refutation
Providing information on Prosumer level may trigger the Supplier to negotiate the supply contract.	▪ Negotiation may lead to the Prosumer switching to a Supplier that does not charge additional costs (this possibility may be limited for large industrial customers).
Providing information on Prosumer level will reveal sources of flexibility, which could be targeted by the Supplier (and only this Supplier) if he combines his role with the role of Aggregator.	▪ A Supplier should be able to identify the (C&I) Prosumers with a flexibility contract through data analysis, or by asking the Prosumer. ▪ In a competitive market an Aggregator needs to develop USPs anyway to differentiate from a Supplier with a large customer base.

ID	Products	Segments	Models
308	All	All	All
Recommendation	After signing a contract with a Prosumer, the Aggregator should communicate the technical characteristics of the flexibility contract to the TSO or DSO (depending whether the associated Prosumer is connected to the TSO or DSO grid).		
Rationale	For grid management and grid safety analysis, the TSO and DSO need to know the basic characteristics of the load and generation connected to their grid. This includes information about DR contracts (available power, ramp up/down rates, type of flexibility service). This information exchange should however not be limited to DR contracts with an Aggregator. The DSO should e.g. also be informed about flexible load that is exposed to implicit DR by the Supplier.		

6.4 Transfer of Energy price methodology

This section provides recommendations and considerations about the energy settlement between BRP_{agr} and BRP_{sup}., also known as the Transfer of Energy. It not only refers to Aggregator Implementation Models that are based on a regulated price, it also refers to contractual models where standardized contracts (including standardized transfer price methodology) may be used. This section is not relevant for single-BRP models since no Transfer of Energy occurs within these models.

ID	Products	Segments	Models
401	All	All	Dual-BRP models
Recommendation	The price profile used for the Transfer of Energy should have a high resolution, preferably on ISP level or on DA spot market resolution, rather than a single price per year, month or day.		
Rationale	The ToE price should reflect actual sourcing costs or actual energy prices, which may have high volatility.		

ID	Products	Segments	Models
402	All	All	Dual-BRP models
Recommendation	Ideally the ToE price should be determined on Prosumer level. When this is not possible, price methodologies and price levels need to be based on meaningful clustering of customer segments. A clear distinction can be made between the C&I segment and the Residential segment. Within these main segments, the number of price levels should be minimized.		
Rationale	Both sourcing strategies of Suppliers and retail price structures can be Prosumer or segment dependent, therefore ideally/conceptually the ToE price should be determined on Prosumer level. However, a Prosumer-depending price level has three disadvantages: (i) it may reveal commercially sensitive information from the Supplier/BRP (either sourcing costs or retail prices) – this is specifically relevant for C&I customers (ii) it may induce high costs to discuss / determine the price for each Prosumer		

	separately – this is specifically relevant for the Residential sector (iii) it may reveal commercially sensitive information from the Aggregator disclosing which Prosumer has valuable flexibility at its disposal. Out of all dual-BRP implementation models only the Corrected model circumvents these obstacles by its nature, since the price is already given (retail price), without (necessarily) disclosing the Aggregator's customer to the Supplier. For other models, to reduce complexity, the number of price methodologies / price levels should be minimized. A diversification is needed between C&I and Residential, since the sourcing strategies and costs may differ strongly. As different C&I client will have different consumption profiles and therefore different sourcing costs, a further diversification within this segment may be needed. However, this segmentation may also reveal commercial sensitive information, if the identification of the Prosumer is not known to the Supplier. A further diversification within the Residential segment will typically be based on the type of retail contract (single tariff, double tariff or more complex variants).

ID	Products	Segments	Models
403	All	All	Dual-BRP models
Consideration	The ToE price methodology should either reflect sourcing costs, or avoided (retail) revenues.		
Rationale	The Transfer of Energy can be considered in two ways: (i) ToE is there to correctly remunerate energy at (wholesale) market value (at sourcing time) and has no relation with end-consumer billing. There is no difference between cases where energy is shifted (cold store) and where energy is saved or transferred to another energy sort (Genset). (ii) Remuneration of Supplier needs to be based on the avoided revenues, which are based on retail prices. In the corrected model, the ToE reflects avoided revenues by definition. For other models (Central Settlement, Contractual) this choice may turn out to be less fundamental for C&I customers, since the margin between retail prices and sourcing costs are relatively low.		

ID	Products	Segments	Models
404	All	All	Dual-BRP models
Recommendation	The ToE price methodology should be resource type independent.		
Rationale	This supports the ambition of a technology-agnostic solution. There may be an indirect dependency if the ToE occurs on Prosumer level, in which case the retail price may be partly depending on the resource type (thus technology) (assuming the retail price forms the basis for the price methodology, such as in the Corrected model).		

ID	Products	Segments	Models
405	All but Intraday	All	Central settlement, Contractual
Recommendation	The ToE price methodology should be activation-time dependent. We distinguish two time windows, one methodology (cf. 408) should be used for all services where flexibility is traded intraday up to real-time (passive balancing, ancillary services, DSO congestion management), another (cf. 407) for all services where flexibility is traded up to day ahead (spot market, strategic reserves / national capacity markets, BRP hedging products).		
Rationale	Main arguments for this recommendation: ▪ Earning model for energy trading by the Aggregator is based on the price spread between the Transfer of Energy price and the prices on the market where the energy is sold or acquired; ▪ Remuneration of the BRP / Supplier has a time dependency, since the value of energy for a specific ISP changes over time (from long term, via DA, to real-time). ▪ According to most current market/product design, bids for secondary and tertiary control need to be placed DA on the bid ladder. This means that the associated costs, amongst which the		

	sourcing costs (ToE), need be known day ahead A wide range of price methodologies (rather than 2), depending on activation-time, will become complex and less transparent. However, intraday trading in particular may require additional methodologies, depending on its characteristics, see 406.

ID	Products	Segments	Models
406	Intraday	All	Central settlement, Contractual
Consideration	The ToE price methodology for Intraday trading should be activation-time dependent. Contrary to 405, the product of Intraday trading cannot be limited to one methodology. If Intraday focuses on 0-3 hours before real time, methodology 408 could be applied. For Intraday trading 3-24 hours before real time, methodology 407 may be applied. However, more methodologies may be needed.		
Rationale	Intraday trading close to real time has different characteristics then intraday trading close to day ahead. Therefore, intraday trading is excluded from recommendation 405, since it cannot be associated with only one price methodologies. Even more than 2 may be needed.		

ID	Products	Segments	Models
407	DA products	All	Central settlement, Contractual
Consideration	The ToE price methodology for day ahead products should be based on dual-pricing, i.e. different for load reduction and load enhancement. The price spread should guarantee the BRP_{sup} sufficient remuneration in line with his sourcing costs, based on spot-market prices. This implies that the ToE price methodology has a high resolution (typically 1-hour).		
Rationale	When an Aggregator activates flexibility in a day ahead product (i.e. spot market), the BRP_{sup} needs to be remunerated for the activated energy, which is typically based on an average of OTC and spot market prices. Flexibility is typically only activated in DA markets if the spot market price is sufficiently high, therefore a remuneration based on average DA prices may not be sufficient to cover the sourcing costs. A similar argument holds for load enhancement. A separate methodology is needed for all products up to day ahead, since the proposed method for ID until real-time products (see 408) does not allow a business case for an Aggregator (energy sourcing costs would then equal the revenues). It should be noted that for contractual models, prescribing a detailed standardized price methodology/price level may violate market competition rules.		

ID	Products	Segments	Models
408	ID until real time products	All	Central settlement, Contractual
Recommendation	The ToE price methodology intraday (with limitations, see 406) until real-time, should be based on the DA spot market prices for that specific ISP.		
Rationale	The DA spot market price is the commonly accepted value of electricity. It aligns with the accounting value of energy also for in-house generation assets. All assets that run have accepted to run for that price.		

ID	Products	Segments	Models
409	All	All	Dual-BRP models
Recommendation	The ToE price methodology should be flex-market independent.		
Rationale	Remuneration for the BRP_{sup} and SUP should be independent of the exact market where the Aggregator valorizes the flexibility. This could also reveal potentially confidential information. There is an indirect dependency through the activation-time dependency (which puts all markets in distinct categories), yet there is no need to further differentiate on market level.		

ID	Products	Segments	Models
410	All	All	Dual-BRP models
Consideration	It should be considered whether the BRP_{sup} and Supplier should be compensated for handling costs (i.e.		

	initial and recurring costs, e.g. on IT) to handle the consequences of DR activations at his customers.
Rationale	In general, compensation only covers the sourcing costs (or avoided revenues), not the initial costs that are needed to adapt IT systems. There are two options: (i) Including this in the ToE price methodology. One of the consequences is that (also) the *short-term* price methodology (cf. 408) will be asymmetrical. (ii) Not including this (no compensation). The argument for this option is that once a framework for DR is in place, following the rules of the framework becomes part of playing the game / part of being in the market. When regulations change, everyone in the market has to bear his own costs for necessary process / IT changes.

6.5 Relation between implicit and explicit Demand Response

A flexible resource may be subject to both implicit and explicit DR at the same time. This section provides recommendations on how to separate both impacts, a separation needed for performance quantification, transfer of energy, etc.

ID	Products	Segments	Models
501	All	All	All
Recommendation	In general, the combination of implicit and explicit DR should be allowed.		
Rationale	In general, a resource can be subject to implicit and explicit DR at the same time. However, certain combinations should be avoided or disallowed. Table 6-3 shows all possible combinations of implicit and explicit DR, and indicates which combinations are allowed and which are not. The main criterion is that implicit DR should be deployed during an earlier time frame than explicit DR. If they coincide, it is impossible to determine whether the DR activation should be contributed to the Supplier (implicit DR) or to the Aggregator (explicit DR). If explicit DR precedes implicit DR, the impact of implicit will be contributed to the (BRP of the) Aggregator. In general, the combination is possible when implicit DR precedes explicit DR, yet also in this situation an Aggregator may decide to exclude resources with high load/generation volatility (due to the effects of implicit DR) if the required baseline accuracy is not sufficient.		

Recommendation 501 is further elaborated in Table 6-3 below[22]. The left column indicates to which market / product the flexibility of a Prosumer is brought by an Aggregator through explicit DR. The top row shows to which type of implicit DR the same Prosumer is exposed. If a Prosumer is exposed to a combination of DA, ID and/or RT, the shortest time window to RT should be considered. If a Prosumer has a single tariff, he is obviously not exposed to implicit DR. This options is included in the table, to indicate that in this case explicit DR is always possible.
Green shading means that the combination is possible, amber shading means that the combination is only possible under certain conditions (or undecided), red shading means that the combination is not allowed/ not possible. The numbered fields are further explained below the table.

Table 6-3: Possible combinations of implicit and explicit DR

Implicit DR / Explicit DR	Single tariff Double tariff	Based (partly) on DA prices	Based (partly) on ID prices	Based (partly) on balancing prices
Primary control (FCR)			1	2
Secondary control (aFRR)			1	
Tertiary control (mFRR)			1	
National CM/ strategic reserves (through DA)				
National CM/ strategic reserves (dedicated)		3	3	3
TSO Congestion management		4		

[22] Please note that this assessment is based on the set of recommendations provided in this document, most notably on the ToE price level (section 6.4).

Explicit DR \ Implicit DR	Single tariff Double tariff	Based (partly) on DA prices	Based (partly) on ID prices	Based (partly) on balancing prices
Day ahead trading				
Intraday trading				
Self-balancing / passive balancing			1	
Hedging/portfolio adequacy		5	5	
DSO Congestion management		6	6	
Voltage control		6	6	

1. Combination is allowed, provided the Supplier receives information from the Aggregator about activation on Prosumer level (cf. recommendation 306). For FCR, this provision is only necessary when a ToE occurs.
2. Only possible if FCR is a capacity-only product (no ToE).
3. Depending on product definitions, most probably products will pose requirements on price-inelasticity, ensuring availability of the resource at times when needed. Time-of-Use contracts are in theory still possible in this situation, but especially contracts based on ID or balancing prices are not very likely.
4. Depending on product definition, currently most congestion management products are organized in DA, making this combination not possible.
5. Depending on product definition. If hedging is limited to ID or real-time, this combination could be possible.
6. Depending on product definition (timelines of nomination, trading and baseline).

ID	Products	Segments	Models
502	All	All	All
Recommendation	The baseline methodology should include the effects of implicit DR.		
Rationale	The baseline serves as a proxy during a DR event for the actual consumption without this DR event. Where a resource is subject to implicit and explicit DR at the same time, its actual consumption/production may be influenced by implicit DR. Therefore, the baseline needs to include the effect of implicit DR. In the case of e.g. secondary control, the current power level already reflects the (possible) effects of implicit DR. Also the nomination of the Aggregator should include the effects of implicit DR for the next ISP.		

ID	Products	Segments	Models
503	Day ahead trading	All	All dual-BRP models
Recommendation	Demand side flexibility cannot be traded through explicit DR at day ahead markets, if this flexibility is subject to a ToU supply contract (on ISP basis). This should be enforced by the regulator, by disallowing the Aggregator to participate in day ahead wholesale markets with flexibility that is subject to a ToU supply contract.		
Rationale	This combination of explicit and implicit DR is already addressed inTable 6-3, but further emphasized for its relevance, see also section 7.3. This recommendation can be justified from different angles: ▪ In this case the same flexibility will be brought to the same market. Since implicit DR provides direct access, explicit DR cannot add any value, so there is no business case for explicit DR ▪ In this case the impact of implicit BR cannot be dissociated from the impact from explicit DR ▪ If the Aggregator can earn money through arbitrage between ToE prices and DA prices, it means that the BRP_{sup} loses money based on the same spread, which implies that the BRP_{sup} is not properly remunerated. As a consequence, DA trading through explicit DR is limited to Prosumers with single or dual tariff contracts. As an alternative, this combination can be prevented by setting the ToE price equal to the DA price (also for DA markets). The disadvantage of this method is that it would also prevent hedging products (based on demand side flexibility), that mitigated the risks of high DA prices to emerge, since the marginal costs of activating flexibility in this situation would equal the (high) DA prices.		

ID	Products	Segments	Models
504	All	Residential	All dual-BRP models
Recommendation	No special arrangements should be made to facilitate a transfer of energy when flexibility is activated with customers for which wholesale settlement is based on synthetic profiles. Rather, the regulatory framework should support the settlement of all customers based on (smart) meter data. Consequently, customers that are allocated based on synthetic profiles, can only participate in DR services that are not subject to a ToE.		
Rationale	Shifting load with customers that are allocated based on synthetic profiles, will not have a direct impact on the position of the BRP. This effect may be indirect, depending how the residential balancing surplus is allocated. A transfer of energy from/to the residential balancing surplus is imaginable, yet very cumbersome and not logical considering the trend to move away from synthetic profiles, and to base wholesale settlement on actual measurements (i.e. smart meter data for residential customers). If the ToE cannot be facilitated, the flexibility can only be used for flex services without a transfer of energy. An example could be primary control, yet this is depending on the regulatory framework and product definition.		

6.6 Rebound effects

The term rebound effect refers to the phenomenon that the load reduction (or increase) triggered by a demand response event, is compensated partly or fully outside the activation period or by other resources. We distinguish three possibilities:

1a. Most commonly, the compensation happens after the demand response event, at the flexibility resource. This can be shortly after the event (within 15-60 minutes), but may also take several days. An air conditioner that has temporarily been turned off, is likely to start operating shortly after the DR event. An industrial production process may take several days to compensate.

1b. The compensation happens before the event. This is only possible for events that are scheduled (well) in advance. An example is the pre-cooling of a building before the electricity price peak.

2. The compensation happens during the event through another resource. This other resource may or may not be subject to the same DR program/service. It may or may not be located at the same Prosumer / connection. An example is a Prosumer that has two air conditioning devices at his home, with only one subject to a DR service. A DR event may trigger the second air conditioner to increase its load at the same time. We will refer to this effect as *synchronous rebound effect*.

Note that in the context of Demand Response and Energy Efficiency, the term rebound effect is sometimes also used to describe the effect where people tend to use more energy when the price of energy decreases, which e.g. could apply to the cheaper periods when Prosumers are subject to Time-of-Use tariffs. This effect is not discussed here.

This section describes if and how the possible effects of rebound should/can be compensated towards the BRP_{sup} or Supplier.

ID	Products	Segments	Models
601	All	All	All
Consideration	A choice needs to be made whether the (possible) compensation of rebound effects needs to be organized between the Prosumer and the Supplier, or between the Aggregator/BRP_{agr} and the Supplier/BRP_{sup}.		
Rationale	A fundamental question with respect to rebound is whether the Aggregator is ▪ acting on behalf of the Prosumer, and thus activating flexibility within the Prosumer's contractual right to modify its own consumption / generation pattern (assuming the rebound effect stays within the contractual load variation), or ▪ acting on its own behalf and possibly creating a rebound effect with financial consequences for the BRP_{sup} and/or Supplier.		

ID	Products	Segments	Models
602	All	All	All
Recommendation	If rebound effect needs to be organized between the Prosumer and the Supplier, then this effect needs to be taken into account in consideration 302.		
Rationale	If e.g. the Supplier is allowed, under certain conditions, to renegotiate the Supply contract, then the rebound effect could be part of these conditions for example if the rebound effect has a certain (relative) size, provided the rebound effect is actually measured / identified.		

ID	Products	Segments	Models
603	All	All	All
Consideration	If the rebound effect needs to be organized between the Aggregator/BRP_{agr} and the Supplier/BRP_{sup}, then a choice needs to be made between ▪ transferring the risk of the rebound effect to the BRP_{agr}, e.g. by extending the activation period to include rebound ▪ financial compensation for the rebound effect, e.g. by including it in the transfer price ▪ ignoring the rebound effect. ▪ Risk of rebound stays at Supplier/BRP_{sup} in exchange for additional information from Aggregator/BRP_{agr} to Supplier/BRP_{sup} to cover that risk, i.e. meaningful clustering per asset type. This choice can be tailored to specific rebound categories, e.g. (i) no to little rebound (0-20%) (ii) significant rebound (20-80%) or (iii) load / generation shift (80% +). Also the rebound moment can be placed in categories: (i) within 2 hours (ii) within 24 hours or (iii) over more than 1 day.		
Rationale	The provided options are more or less suitable depending on the rebound categories. Therefore, a further categorization would make sense. Quantifying the impact for each category by examining current practices could move this discussion forward.		

ID	Products	Segments	Models
604	All	All	All
Consideration	The Prosumer should bear the responsibility for avoiding synchronous rebound effects. This should be included in the contract between the Aggregator and the Prosumer.		
Rationale	From a system perspective, synchronous rebound effects should be avoided, because: ▪ these effects increase the balancing risks for the BRP_{sup} ▪ it reduces the effectiveness of the service provided by the Aggregator to its customer, e.g. it will counterbalance the DR activation by the Aggregator in the context of a balancing service, rendering the result on system level lower or void. This will reduce the value and attractiveness of the service of the Aggregator to its customer. ▪ the TSO is affected when balance restoration services are counteracted ▪ the security of supply is affected when adequacy services are counteracted Only the Prosumer is capable of assessing whether synchronous rebound effects are likely to occur. The risk of synchronous rebound effects can be reduced by allowing aggregation only on main-meter level. However, this impedes the many advantages of sub-metering, and provides no solution for cases where load is shifted to resources at other connections.		

6.7 Portfolio conditions

Key differentiator for an Aggregator is that the offered flexibility is not provided by a single resource, but by a portfolio of resources. This has consequences for flexibility service level (e.g. ancillary services), which are currently (and typically) designed for single assets.

ID	Products	Segments	Models
701	All	All	All
Recommendation	Aggregator (or their BRP/BSP) should be allowed to offer flexibility services on portfolio level for all relevant markets. This includes the possibility to pre-qualify portfolios rather than individual assets (e.g. for balancing services).		
Rationale	A wider range of flexibility resources can be unlocked towards different markets. Resources may possess characteristics that do not meet the product requirements, yet could add value to the portfolio of an Aggregator, e.g. with respect to: ▪ Ramping rate up and down ▪ Sustain requirements ▪ Single side flexibility (only ramp up or down) in a symmetrical product ▪ Availability requirements ▪ Activation frequency As a consequence, prequalification also needs to be performed on portfolio level, in order to assess whether the Aggregator is able to meet the service requirements of the customer (TSO/DSO).		

ID	Products	Segments	Models
702	All	All	All
Recommendation	Aggregator (or their BRP/BSP) should be allowed to offer different flexibility services from the same portfolio at the same time.		
Rationale	Combining different services will create more opportunities to bring demand side flexibility to the different markets. However, the following complications need to be taken into account: ▪ Our recommendations on baseline design (cf. 205, 204, 206, 207, 208) implicate that the Aggregator needs to be able to generate an accurate forecast for its portfolio. However, the accuracy of the DA forecast (used for DA trading) will be affected if the same portfolio is used for secondary control). This could be a reason for the Aggregator to use separate portfolios for separate services. ▪ Combining services in one portfolio increases complexity and reduces transparency, esp. since different services may use different baselines. This increases the risk of gaming. ▪ Some restrictions apply on resource level, cf. recommendation 110.		

ID	Products	Segments	Models
703	All	C&I	All
Recommendation	In theory, the flexibility of a resource per ISP can be split in smaller pieces that are sold on different markets. This should (at least) be limited to markets that use the same or similar baseline methodology.		
Rationale	The flexibility of a resource may be volatile over time. The minimum available flexibility can be sold in e.g. a capacity product. If more flexibility is available on specific days, this can be brought to a day ahead market. However, the same complications as stated in recommendation 702 apply. Due to its complexity, and the relative small size of flexibility in the residential segment, we recommend to limit this option to the C&I segment.		

ID	Products	Segments	Models
704	All	All	All
Consideration	If an Aggregator (or its BRP/BSP) offers flexibility on portfolio level, a choice needs to be made whether the BRP_{agr}, during DR activation, in a dual-BRP model, holds balance responsibility for its full portfolio, or only for the resources it activates during this event.		
Rationale	We list the main advantages for both choices: ▪ BRP_{agr} holds balance responsibility only for the resources it activates: this is in line with the general principle for all dual-BRP implementation models, where balance responsibility (on the level of the meter where the baseline is defined) is with BRP_{sup}, unless during activation period. This ensures that the Aggregator's BRP is not held responsible for flexibility it doesn't activate. ▪ BRP_{agr} holds balance responsibility for its full portfolio: In balancing markets, the Aggregator calculates a forecast for the next ISP, which is used as a baseline. The Aggregator may be better able to reach the desired level of accuracy on portfolio level, rather than on resource level. This higher accuracy level can only be exploited if the BRP_{agr} holds balance responsibility for its full portfolio, otherwise the baseline is restricted to a set of individual resources with poorer accuracy level.		

ID	Products	Segments	Models
705	All	C&I	All
Recommendation	If an Aggregator (or its BRP/BSP) offers flexibility on portfolio level, and if the BRP_{agr} holds balance responsibility only for the resources it activates, the Aggregator still needs to provide the forecast on resource level (to TSO, ARP, DSO or BRP_{sup})		
Rationale	In general, the Aggregator will decide which flexibility resources to activate after the activation request has been received from the TSO, or close to real-time for DA and ID products. Since the forecast is supplied day ahead, the exact baseline can only be constructed at activation time when the resources are known, since the baseline is depending on which resources are activated. To increase transparency and avoid gaming options, the forecast should be supplied on resource level. The Aggregator may be inclined to activate only resources where the actual load equals the forecast, however the TSO may still check the quality of the forecasts of the not-activated resources.		

ID	Products	Segments	Models
706	Passive balancing, portfolio balancing	All	Corrected, Central Settlement, Net Benefit
Consideration	In member states where passive contribution is rewarded, the regulator needs to decide whether the ToE can be used for passive contribution. In countries where this is not allowed, the regulator needs to decide whether the ToE can be used for portfolio balancing services to a third BRP.		
Rationale	Both in the integrated model and in the contractual model, the BRP_{agr} is allowed to use explicit DR for passive balancing and portfolio optimization. However, for non-contractual models, it is unclear whether the BRP_{agr} is allowed to use the ToE for intentionally creating an imbalance position within its BRP's portfolio, or restoring the balance in a third BRP's position. The Transfer of Energy can be considered as a means for the Aggregator to provide balancing, adequacy and wholesale services, it is however for the regulator de decide if the ToE can be used to deliberately create a balancing position, without an underlying product.		

ID	Products	Segments	Models
707	Balancing and adequacy	All	Dual-BRP model
Recommendation	In member states where passive contribution is rewarded, but the ToE may not be used for passive balancing (cf. 706), the Aggregator should not be incentivized to deliver more flexibility than required by its customer ("overshooting"). A choice needs to be made between: ▪ adding a cap on the perimeter correction (equal to the required balancing volume) – i.e. asymmetric balance responsibility, or ▪ raising a penalty on the additional activated flexibility (as part of the product definition).		
Rationale	In general, in dual-BRP models, the BRP_{agr} is held responsible for the imbalance it causes when not delivering the required volume. If the Aggregator falls short in activating the necessary flexibility as requested by its customer (either TSO, DSO or BRP), his BRP needs to buy the deficit against balancing prices (which are normally unfavorable). However, if the Aggregator activates more flexibility than required, the BRP_{agr} also passively contributes to restoring the system balance, and may be rewarded for this contribution (esp. in balancing and adequacy products). Since this recommendation assumes that the ToE may not be used for passive balancing, this situation needs to be discouraged.		

7 Implementation model assessment

Based on the recommendations and considerations provided in the previous chapter, we will provide some observations on two aspects of the Aggregator Implementation Models:

1. An analysis per AIM which topics needs to be addresses in a regulatory framework, if the regulator decides to support this AIM (section 7.1))
2. Assessment of viability and limitations of certain AIM, for a specific product (section 7.2))

Furthermore, this chapter provides a model selection guideline (decision tree) for Aggregators active in the residential customer segment (section 7.3) and finally a possible roadmap for demand response (section 7.4).

7.1 Required elements of a regulatory framework

Table 7-1: required elements for a regulatory framework

Implementation model \ .Product level	Measurement & validation	Transfer of Energy price methodology	Baseline methodology	Rebound effects	Relation implicit explicit	Information exchange and confidentiality	Portfolio conditions
	S		S		S		S
Integrated Aggregator model [23]	--	--	--	--	--	--	--
Broker model	C	--	C	C	C	C	C
Contractual model[24]	C	C	C	C	C	C	C
Uncorrected model	--	--	--	--	--	R	--
Corrected model	R	--	R	R	R	R	R
Central settlement model	R	R	R	R	R	R	R
Net Benefit model	R	R	R	R	R	R	R

The topics discussed in the previous chapter need, to a larger or lesser extent, to be addressed in the regulatory framework, the product definitions and/or standardized contracts. This dependency is shown in the table above, where

- R indicates that this topic (and our associated recommendations) needs to be addressed in the regulatory framework
- C indicates that this topic (and our associated recommendations) needs to be addressed in the standardized contract between the Aggregator and BRP_{sup}.
- S indicates that this topic (and our associated recommendations) needs to be addressed in the product definition.

[23] Although all topics may emerge inter-company
[24] market must allow for ex-post nomination

7.2 Viability and limitations of specific AIMs

This section provides several recommendations concerning the suitability of models for certain products and markets.

ID	Products	Segments	Models
801	Capacity-only products	All	Uncorrected
Recommendation	Capacity-only products that require very few to no activations at all, may fit well in the uncorrected model.		
Rationale	Without activation. no transfer of energy needs to take place irrespective of the current implementation model. Where there are very few activations (1-3 per year) the associated volume may not justify the costs of regulatory, process and IT modifications. In some member states, for these specific activations, the BRP_{sup} is compensated implicitly through normal imbalance price arrangements when applying the uncorrected model (this holds true for balancing and adequacy products, not for congestion management or voltage control, see 803).		

ID	Products	Segments	Models
802	All	All	Single-BRP
Recommendation	In markets where passive contribution is not rewarded, the Transfer of Energy should be organized, unless the volumes are negligible (see 501).		
Rationale	If the BRP_{sup} is penalized for the imbalance caused by the Aggregator, rather than rewarded through the imbalance mechanism, a correction is needed to compensate the BRP_{sup}.		

ID	Products	Segments	Models
803	DSO products, TSO congestion management	All	Uncorrected
Recommendation	The uncorrected model can only be used for products that aim to solve local problems if the energy volumes are negligible.		
Rationale	There is no direct relationship between local issues (congestion, voltage) and the balance between demand and supply in the system. Therefore, solving local issues through the demand side, may counteract the balancing need of the overall system. The BRP_{sup} should not be held responsible for this imbalance unless the volumes are negligible (see 501). However, if the energy volumes are negligible, then the Uncorrected model may still be a viable model (see 501).		

ID	Products	Segments	Models
804	DSO products, TSO congestion management	All	Dual-BRP
Consideration	Products that aim to solve local problems may require a redispatch mechanism, to compensate the effect of the local DR activation on system level. Either the Aggregator or the DSO/TSO should be responsible for the redispatch.		
Rationale	The need for a redispatch mechanism only emerges if the energy volumes are relatively large. In this case, either the Aggregator or the DSO/TSO should be held responsible for the redispatch • If the Aggregator (or its BRP) is held responsible for the redispatch, he needs to include the costs of redispatch in his bid. However, the redispatch takes place after the bid has been placed (redispatch is typically intraday or real time, where the bid is typically day ahead). Therefore, the costs of redispatch are unknown at time of bidding. The BRP_{agr} can choose to redispatch through the Aggregator (activate DR outside the region), in its own portfolio (generation or demand side) or on energy markets. • If the DSO (or TSO) is held responsible for the redispatch, the DSO (or TSO) takes a position in the energy market when performing congestion management. It is therefore vital for the DSO/TSO whether the foreseen congestion in a specific area is correlated with the situation on the balancing market (e.g. when caused by a surplus of PV, the redispatch requires the DSO/TSO to		

	buy energy, which is cheap since the surplus of PV will also impact the intraday / real-time energy prices).

ID[25]	Products	Segments	Models
812	Hybrid and energy	All	All but Integrated
Recommendation	If an Aggregator wants to participate in an energy market, or any product with a significant energy component, the Transfer of Energy needs to be organized.		
Rationale	There are two main reasons why the transfer of energy is necessary under this condition: 1. From the Aggregator perspective: When an Aggregator sells or buys energy, it needs to associate with a BRP. If an Aggregator does not source the energy it sells (or vice versa), it will face imbalance penalties that will obstruct any viable business model. The only possible source for the Aggregator is the ToE. 2. From the Supplier / BRP_{sup} perspective: The ToE is needed to compensate the negative effects for the Supplier (supply position) and its BRP (balance position), see section 5.1.1.		

ID[25]	Products	Segments	Models
813	Hybrid and energy	All	Contractual, Central Settlement
Recommendation	Whenever a Transfer of Energy is organized (cf. recommendation 812), the energy that is transferred should be properly remunerated. Note that the transfer, and thus the remuneration, can be bi-directional.		
Rationale	Whereas the transfer of energy, through the perimeter correction, already restores the position of both the BRP of the Supplier and the BRP of the Aggregator (except for possible rebound effects, see section 6.6), the energy position of the Supplier and Aggregator can only be restored if the transferred energy is properly remunerated (the Supplier needs to be remunerated in case of load reduction / generation enhancement, whereas the Aggregator needs to be remunerated in case of load enhancement / generation reduction). Compensating (or restoring) the balance and supply position is one of this workstream's principles (cf. section 5.1.1). The ToE is an administered trade (contractual model), or can be considered as an administered trade (central settlement); the transferred energy has been sourced by the Supplier (or Aggregator) and need therefore to be remunerated. Recommendations 407 and 408 further describe what is considered to be a "proper" remuneration.		

ID[25]	Products	Segments	Models
814	All	All	All
Recommendation	A level playing field between all actors providing implicit and/or explicit demand response need to be maintained		
Rationale	Traditional players (BRP or Suppliers) activities are subjected to extensive customer protection regulation. When allowing new type of players to enter the market the NRA should ensure that the regulation is adapted to be the same for all players competing. This ensure that an integrated player can compete on equal terms with an independent aggregator, for example with regards to contract termination fee and firmness of the contract.		

[25] Numbering is not logically ordered, but kept consistent with the previous (Nov 2016) version of this report.

ID	Products	Segments	Models
805	Hybrid and energy	All	Uncorrected
Recommendation	The uncorrected model is not suitable for hybrid markets and energy-only products.		
Rationale	The uncorrected model does not include a Transfer of Energy, and is therefore not suitable for any hybrid or energy market/product, see 812. Also the broker model has no Transfer of Energy. However, in this model, contrary to the uncorrected model, Aggregator and Supplier act both under the same umbrella of the BRP_{sup} and can therefore both trade energy.		

ID	Products	Segments	Models
806	All	All	Integrated
Recommendation	The Integrated model doesn't need to be assessed		
Rationale	The integrated model will, by default, always be a valid option. The main question is which models will co-exist with the Integrated model. The integrated model still may serve as a benchmark, in terms of: ▪ There needs to be a level playing field for flexibility, also in terms of the applied implementation model. This means that from a flexibility resource or Prosumer point of view, it should be indifferent which of the allowed models will be applied. ▪ Also incentives should be avoided that stimulate an integrated Aggregator to apply other models (which should theoretically be possible), to avoid complexity.		

ID	Products	Segments	Models
807	All	All	Contractual
Recommendation	The assessment of the contractual model should focus on standardized contracts		
Rationale	The (dual-BRP) Contractual model will, by default, always be a valid option, since in a free market, parties are allowed to close bilateral agreements. To stimulate this fully market-based option, the design of standardized contracts will help market parties to reach an agreement in an efficient way. The recommendations in this document provide input for such a standard contract.		

ID	Products	Segments	Models
808	All	All	Contractual
Recommendation	The number of allowed models in a member state should be minimized		
Rationale	In order to limit the complexity and implementation costs, the number of allowed models should be minimized. This may conflict with the observation that different products require different implementation models. Therefore, a balance needs to be struck between the suitability of models for certain products, and the number of models.		

ID	Products	Segments	Models
809	All	All	Non-contractual
Recommendation	To allow for independent aggregation, at least one of the non-contractual models needs to be supported by the regulatory framework.		
Rationale	According to our definition, an *independent Aggregator model* refers to the situation where an Aggregator serves a Prosumer with exploiting its flexibility, without having a contractual relationship with, or consent from the Supplier or BRP serving that same Prosumer. To allow this, at least one of the non-contractual models needs to be supported by the regulatory framework.		

ID	Products	Segments	Models
810	All	All	See below
Consideration	The NRA needs to consider whether independent aggregation should be supported, or whether contractual models are sufficient to unlock demand side flexibility through explicit DR.		
Rationale	Only allowing contractual models may hamper market entry by third party aggregators since, in those models. two potentially competing companies need to agree bilaterally on a set of rules that allow the separation of energy supply and flexibility services. The need for such a contract may create a barrier for third party aggregation. It may also affect the level playing field for aggregation, since the aggregator may be forced to share commercially sensitive information with the Supplier, who may be in direct competition with the Aggregator. These effects may hamper competition for demand-side flexibility services. On the other hand, in non-contractual models, these complexities need to be resolved through a regulatory framework. For example, it may prove difficult to provide sufficient information to the Supplier/BRP to carry out its responsibilities, without revealing commercially sensitive information. Additionally, each non-contractual model has its own drawbacks: • The uncorrected model (in general) does not compensate the BRP or its Supplier, allowing the Aggregator to source its energy for free • The central settlement model introduces a regulated price for the transfer of energy, which is at odds with the free market • The corrected model is complex to implement, less transparent for the Prosumer and (depending on its form) may also reveal commercially sensitive information.		

ID	Products	Segments	Models
811	All	Residential	Corrected
Recommendation	The corrected model is not suitable for the Residential segment.		
Rationale	The key feature of the corrected model is that, opposed to all other possible models, the billing to the end-consumer is impacted. This mean that the effort is proportional to the number of end-consumer and cost escalate once residential consumers get involved. To allow residential DR to compete with I&C DR and other sources of flexibility one needs a settlement solution that is neutral to the number and size of end-consumers, therefore the corrected model is not suitable for the Residential segment.		

7.3 Model selection guide

7.3.1 residential customer segment

A Supplier (acting as an Aggregator) can easily bring residential flexibility to energy-only markets, either implicitly (through dynamic price contracts) or explicitly (by dispatching the flexibility in its portfolio). This is, however, more complicated for an Independent Aggregator. The options for an Independent Aggregator are limited, and depend on several aspects, i.e. the type of supply contract of the customer, the allocation method for this customer and the baseline requirements. The decision tree depicted in Figure 7-1, shows for a specific customer which options the aggregator has. A further explanation is provided in Table 7-2.

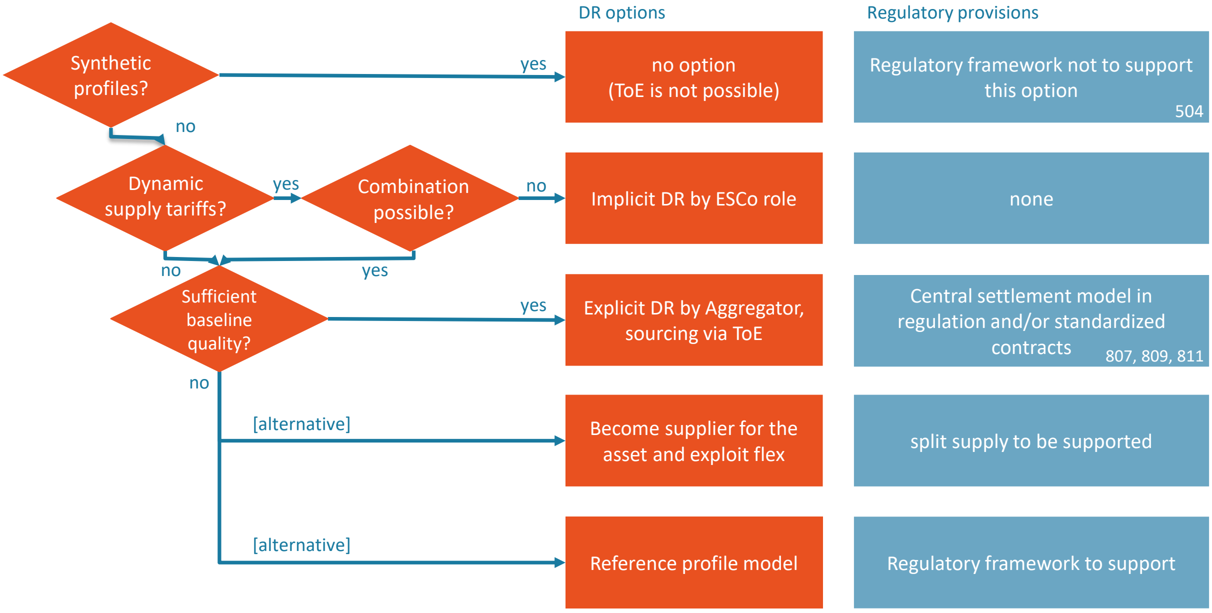


Figure 7-1 Decision tree for independent Aggregator acting in energy markets in residential customer segment. The numbers in the blue boxes refer to related recommendations & considerations

Table 7-2 explanation of the different steps in the decision tree depicted in Figure 7-1

Question	DR options	Regulatory provisions
Is the customer's load allocated based on synthetic profiles	None. Since the perimeter of the Supplier's BRP will not be affected (directly), the energy cannot be transferred	We assume (and recommend) that the regulatory framework does not support this option (cf. 504). Rather, the customer chooses to be allocated on its measured consumption.
Is the customer exposed to dynamic supply tariffs?	The Aggregator can optimize the customer's load against the dynamic (ToU) supply tariffs and thus perform an ESCO role.	None. In this case flexibility is valorised through an implicit-DR mechanism (cf 306, 503).
Is the combination of implicit and explicit DR allowed?	Dynamic supply tariffs imply that the customer is exposed to implicit DR. Whether the customer can sell (the remainder of) his flexibility to an Aggregator, is determined by the market/product where the Aggregator is active. All possible combinations are shown in Table 6-3	Limitations can be included in supply contracts, or in the regulatory framework for aggregation; see also recommendation 308.
Does the load characteristic and (intended) activation frequency match the ToE requirements[26]? (sufficient baseline quality?)	Independent aggregation through the Central Settlement model or Contractual model, sourcing of energy through ToE (central or bilateral).	ToE requirements, more specifically the baseline methodology, are defined (cf. 203, 209). Central Settlement Model is implemented in the regulatory framework or standardized contracts are in place for a contractual agreement.[27]
Does the Aggregator aspire to take the role of Supplier or cooperate with a Supplier, and deliver energy to the isolated flex resource?	Split supply, in combination with the Integrated or Contractual model applied to the submeter.	Split supply should be supported by the regulatory framework. Cf. section 5.1.3.
Does the Aggregator aspire to take over full balance responsibility for the customer?	Reference profile model, central settlement or contractual variant.	Reference profile model, central settlement or contractual (based on standardized contracts) should be supported by regulatory framework. Cf. section 5.1.4.

7.3.2 C&I customer segment

The decision tree for C&I customers is very similar to that of residential customers with one exception that synthetic profiles are not applicable and that the corrected model is an option.

[26] For the Transfer of Energy, which is performed either as part of the Central Settlement Model scheme, or in a contractual arrangement (preferably based on standardized contracts) a baseline methodology needs to be described. For flexibility that is activated frequently, a proper baseline is hard to determine, since there is no "normal behaviour" anymore. Therefore, the ToE / baseline methodology will either prescribe a maximum number of activations per year, or it will require a certain accuracy level that cannot be reached with any baseline methodology (cf recommendations 203 and 209).

[27] We assume (and recommend) that the corrected model is not a suitable model for the Residential segment (cf. recommendation 811).

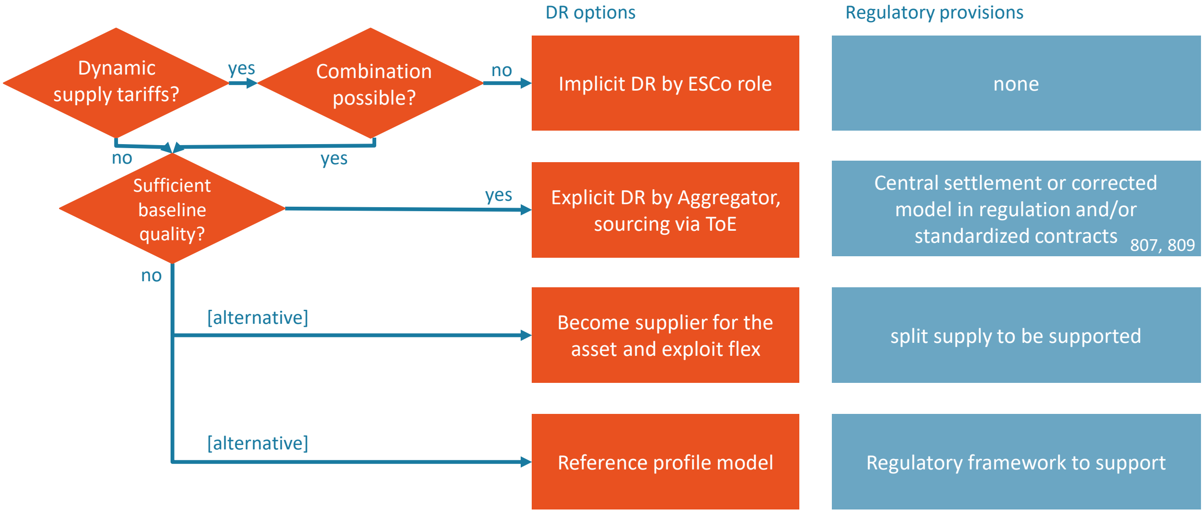


Figure 7-2 Decision tree for independent Aggregator acting in energy markets in C&I customer segment. The numbers in the blue boxes refer to related recommendations & considerations

7.4 Demand response roadmap

We believe that USEF's work will provide valuable input to member states that are developing a regulatory framework for Demand Response in response to the EC directive [18]. Since the implementation of a regulatory framework may take several years, USEF can also provide input to parallel activities that can speed up parts of this market. As depicted below, next to providing the building blocks for a regulatory framework, USEF principles can be applied to capacity products based on an *uncorrected* model, or can provide input to standardised contracts in the *contractual* model. Lessons learned from the first and second track can provide input for the development of a regulatory framework.

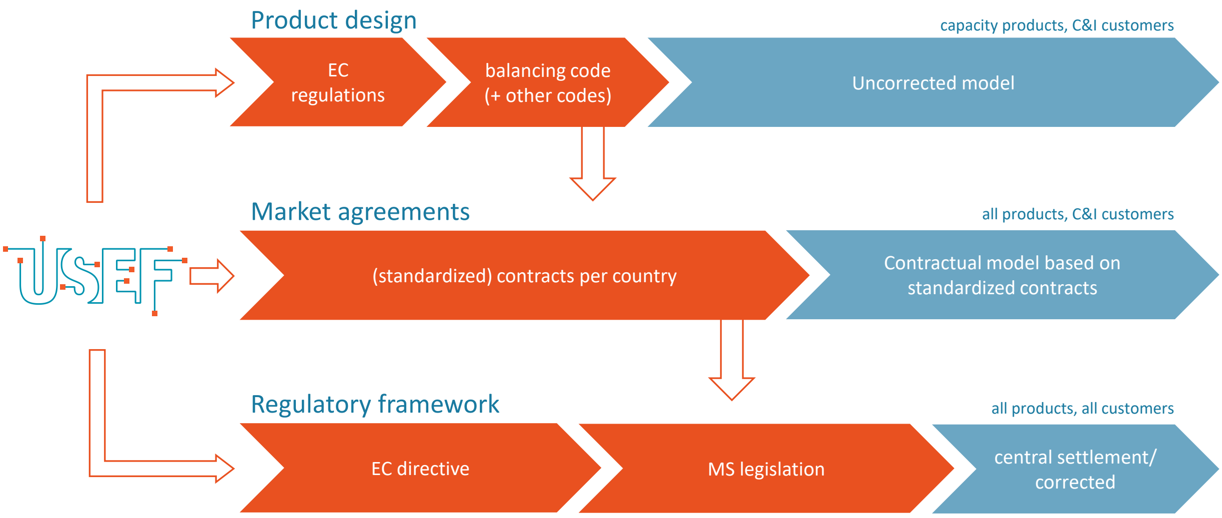


Figure 7-3 Possible Demand Response roadmap

Appendix 1 Sequences for settlement phase in different AIMs

In the use case presented in Section 3.6 the different interactions were shown for a secondary control service from a portfolio. In the Contract, Plan/Validate and Operate phase these interactions are highly similar. In the Settle phase however, interactions are very different for the various Aggregator Implementation Models, especially due to the different ways to organize the Transfer of Energy. This appendix shows the interaction in Settle phase for the tree different dual-BRP models.

1.1. Contractual Model

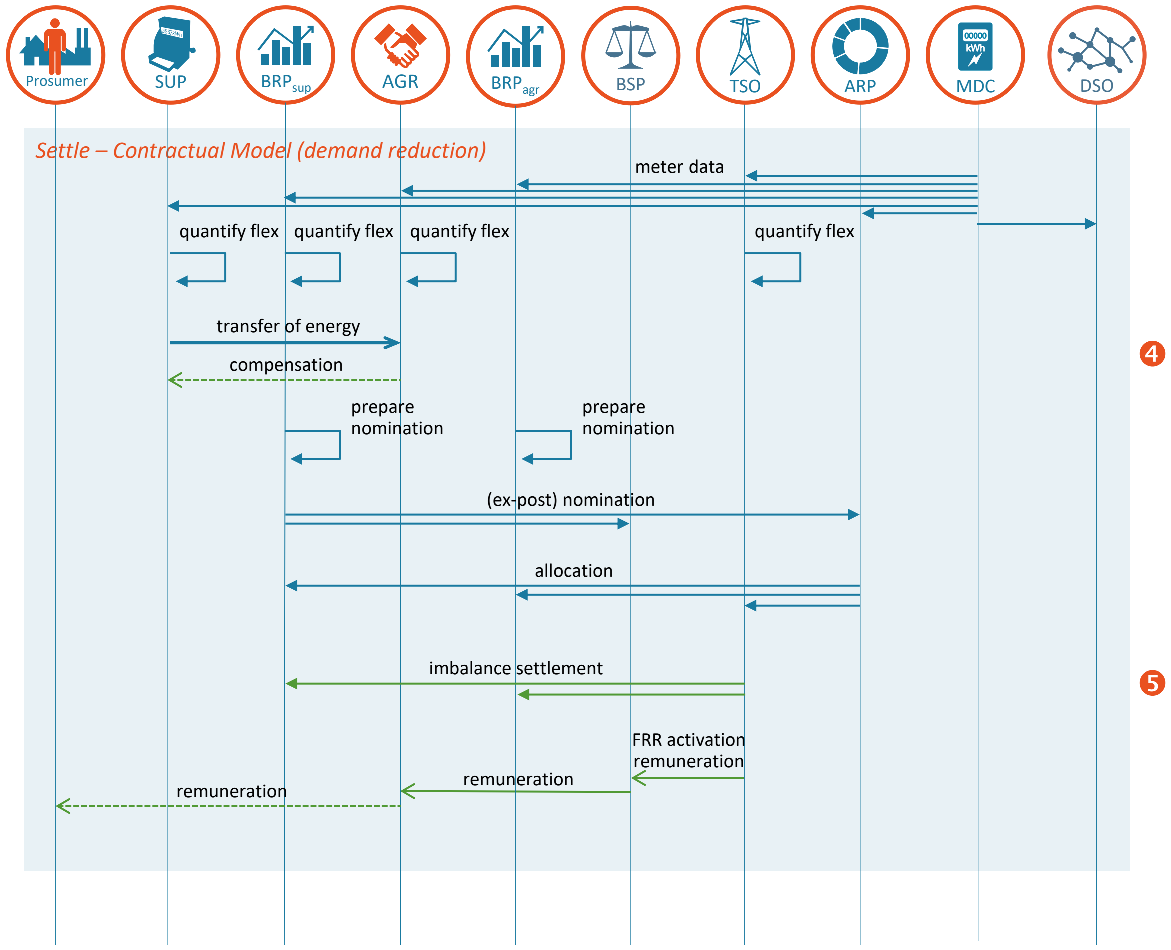


Figure 7-4 Settlement phase for contractual model. AGR and SUP transfer the energy via a bilateral deal ❹. As a result both BRP's change their nomination and send that ex-post to the ARP. Both balancing perimeters are now in balance again, no perimeter corrections are necessary. If AGR has only partly activated, there is a resulting imbalance that is covered in the normal imbalance settlement ❺.

1.2. Corrected Model

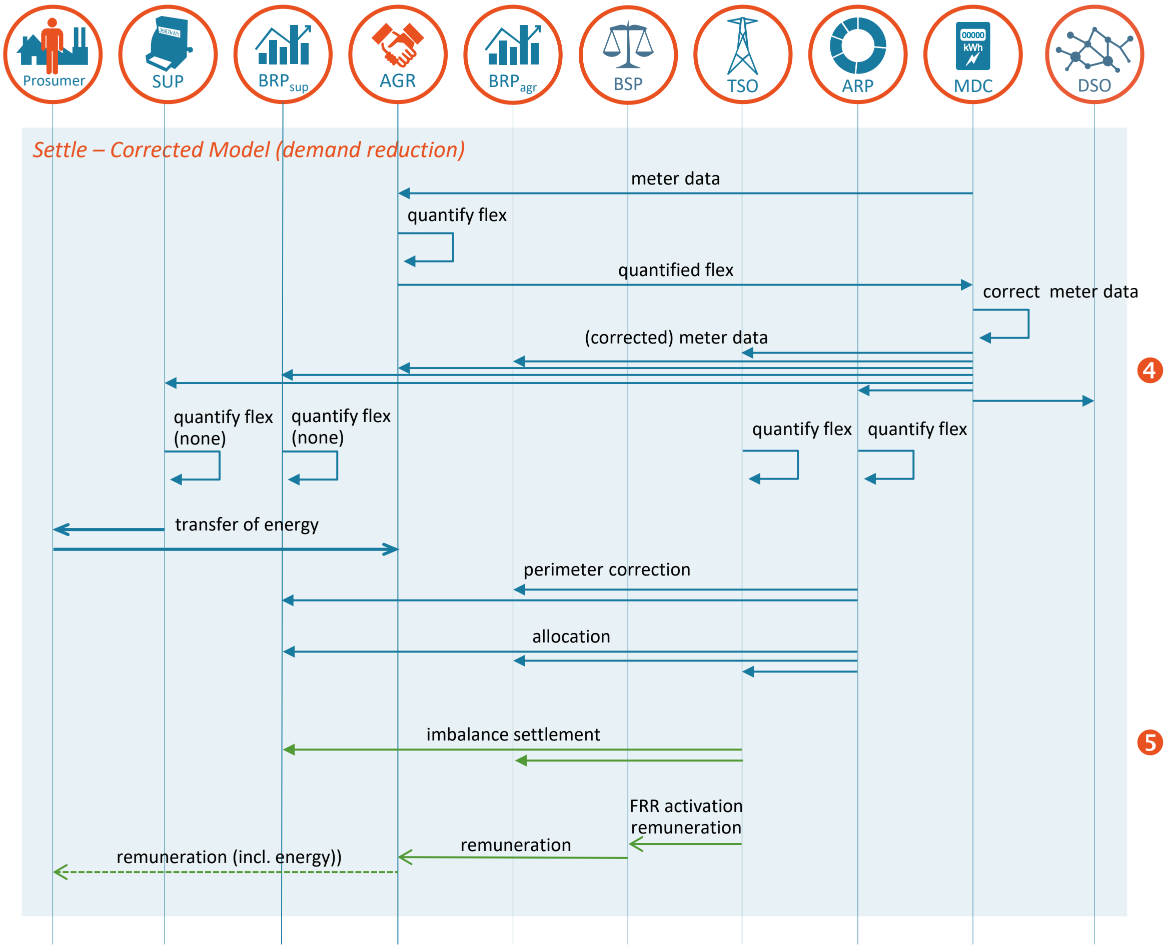


Figure 7-5 Settlement phase for corrected model. The MDC modifies the meter readings based on the activated flexibility ❹. Via this correction the activated volume is transferred from SUP to AGR via the Prosumer. The corrected meter data is distributed to all parties involved. Due to this correction, SUP sees the same volume as if activation wouldn't have occurred. The ARP needs to correct the perimeter of the BRP_{sup} and BRP_{agr} with the activated energy (this step could be considered as part of the meter reading corrections). After this the normal allocation process will proceed. If AGR has only partly activated, there is a resulting imbalance that is covered in the normal imbalance settlement ❺. Note that TSO and ARP needs both the uncorrected and corrected measurements to quantify the flexibility.

1.3. Central Settlement Model

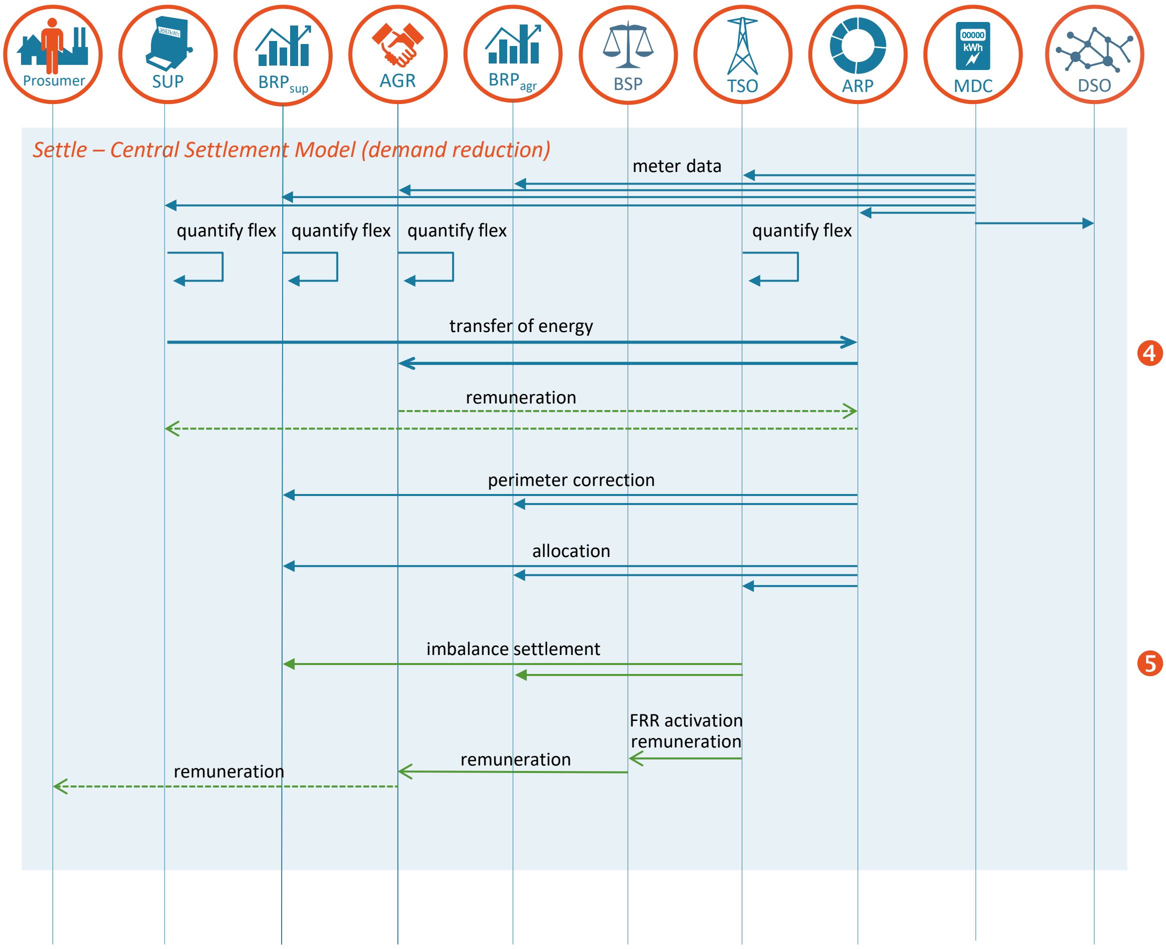


Figure 7-6 Settlement phase for central settlement model. The transfer of energy is organized via a central entity, the Allocation Responsible Party (ARP) ❹. The ARP compensates for the open supply position of SUP, based on a pre-defined price formula. The ARP also corrects the balancing perimeters of BRP_{sup} and BRP_{agr}. After this the normal allocation process will proceed. If AGR has only partly activated, there is a resulting imbalance that is covered in the normal imbalance settlement ❺.

Appendix 2 Glossary

Abbreviations:

ADS	Active Demand & Supply
AGR	Aggregator. Role whose goal it is to maximize the value of flexibility, taking into account customer needs, economical optimization and grid capacity.
AIM	Aggregator Implementation Model
BRP	Balance Responsible Party
BSP	Balancing Service Provider
C&I	Commercial & Industrial
D-prognosis	Prognosis regarding the Distribution of energy
DA	Day-ahead
DAC	Dynamically Allocated Cluster
DNO	Distribution Network Operator
DR	Demand Response
DSF	Demand Side Flexibility
DSO	Distribution System Operator
DSR	Demand Side Response
ENTSO-E	European Network of Transmission System Operators for Electricity
ESCo	Energy Service Company
EV	Electric Vehicle
FCR	Frequency Containment Reserve
FRR	Frequency Restoration Reserve
ID	Intra-day
ISP	Imbalance settlement period — smallest energy trading period used in balancing markets
MBMA	Meter-Before / Meter-After
MCM	Market-based Coordination Mechanism
MCF	Measurement Correction Factor
MDC	Meter Data Company
NRA	National Regulatory Authority
P&S	Privacy & Security
RR	Replacement Reserve
RT	Real-time
Prosumer	A consumer which is capable of producing energy as well
SAU	Standard Annual Usage – synthetic energy profile of retail customer
SUP	Supplier. Has a contractual relationship with Prosumers to source, supply and invoice energy
ToE	Transfer of Energy
TSO	Transmission System Operator
USEF	Universal Smart Energy Framework

Specific terms used in this document

Adequacy	General meaning: the state or quality of being adequate; sufficiency for a particular purpose. Specific in energy markets: whether the generation capacity is sufficient to meet the demand http://www.dictionary.com/browse/adequacy?s=t
Adequacy product	Product that is intended to increase the adequacy of the system. Is one of the possible flexibility products.
Allocation	Allocation of measured energy consumption in a certain control area to the different BRPs.
Ancillary services	Ancillary services refer to a range of functions which TSOs contract so that they can guarantee system security. These include black start capability (the ability to restart a grid following a blackout); frequency response (to maintain system frequency with automatic and very fast responses); fast reserve (which can provide additional energy when needed); the provision of reactive power and various other services https://www.entsoe.eu/about-entso-e/market/balancing-and-ancillary-services-markets/Pages/default.aspx
Arbitrage	In economics and finance, *arbitrage* is the practice of taking advantage of a price difference between two or more markets: striking a combination of matching deals that capitalize upon the imbalance, the profit being the difference between the market prices. https://en.wikipedia.org/wiki/Arbitrage
Asymmetrical balance responsibility	Unidirectional Balance Responsibility. A situation where the BRP is only balance responsible for surplus and not for deficit (or vice versa)
Balancing	The act of reducing/increasing load/generation by a BRP in an attempt to restore its portfolio imbalance. Similarly, the act of reducing/increasing load/generation by a TSO in an attempt to restore the system imbalance. In the latter case, the TSO uses balancing services for this purpose. Balancing refers to the situation after markets have closed (gate closure) in which a TSO acts to ensure that demand is equal to supply, in and near real time. https://www.entsoe.eu/about-entso-e/market/balancing-and-ancillary-services-markets/Pages/default.aspx
Baseline	is the best approximation of the energy consumption or production that would have occurred, if no DR event would have been triggered. Used a.o. to quantify the delivered flexibility
Bid ladder	A mechanism to show price information for bids of regulating power and reserve power offered to a TSO for real-time balancing. Used in NL, BE, …
Contracted bidding	The acts of placing bids on a market which was committed beforehand via a (contractual) obligation. This is a way for the contracting party to ensure certain market volume. Opposite of free bidding.
Counterbalancing	The act of reducing/increasing load/generation by a BRP in an attempt to restore its portfolio imbalance, whereas the imbalance was intentionally caused by a flexibility activation. This may occur when an Aggregator activates flexibility in the portfolio of a BRP. During settle phase, the BRP will be compensated for this effect by a perimeter correction, but if the BRP has online metering he will act on the actual imbalance without knowing the cause.
Dispatch	Turn on or off a power generation unit or adjust their power output according to an order. Dispatching of a generation unit is generally at the request of power grid operators or of the plant owner to meet the demand in the power system, and based on the merit-order. Opposite of intermittent energy sources https://en.wikipedia.org/wiki/Dispatchable_generation

Dispatch information	Information about the dispatch-status and/or dispatch-history of units.
Drop-by	The ability to reduce generation or load (power) by a specified amount. The reduction is a relative amount; hence the resulting power is unknown. See also drop-to.
Drop-to	The ability to reduce generation or load (power) towards a specified amount. See also drop-by.
Dual pricing	(In balancing markets) Different price for positive and negative imbalance. See also single-pricing http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2015.pdf
Ex-ante	The term ***ex-ante*** is a phrase meaning "before the event".[1] *Ex-ante* is used most commonly in the commercial world, where results of a particular action, or series of actions, are forecast in advance (or intended). The opposite of *ex-ante* is *ex-post* (actual). https://en.wikipedia.org/wiki/Ex-ante
Explicit demand response	Form of demand response where customer makes an explicit change in demand in response to a signal, and is specifically rewarded (remunerated) for that demand change.
Ex-post	"Afterward", "after the event". Based on knowledge of the past. Measure of past performance. https://en.wikipedia.org/wiki/Ex-post
Ex-post nomination	The possibility for BRPs to include transactions after the Operation phase (i.e. after the associated ISP) by a change in their approved nominations. This changed is processed by the TSO before the allocation. Via this mechanism BRPs can mutually settle imbalances and avoiding the imbalance penalties raised by the TSO.
Flexibility service quantification	Determination of the amount of load/generation reduction/increase in terms of instantaneous power [W] or energy during a certain time interval [Wh]. To determine whether the service was actually delivered with the right quantity. A *baseline* is needed for this purpose.
Free bidding	The act of placing bids on a market without a (contractual) obligation to do so. Opposite of contracted bidding
Gaming	Using the rules and procedures meant to protect a system in order, instead, to manipulate the system for a desired outcome. Gaming is a form of abuse. See also *arbitrage*
Grid	Network for the transport and distribution of energy
Hub deal	A bilateral deal through a platform (hub)
Implicit demand response	Situation where customers are exposed to varying energy prices and/or grid tariffs and respond by adapting their energy demand profile. In general, consumers exposed to such tariffs might have an automated system or a 3rd-party (ESCO) service that helps them to consume their energy at optimal prices.
Marginal pricing	Selling at a price that is above the marginal cost but below the total or full cost which includes all overheads. Marginal pricing is based on the assumption that since fixed and variable costs are covered by the current output level, the cost of producing any extra unit (marginal output) will comprise only of variable costs of additional labor and material consumed. http://www.businessdictionary.com/definition/marginal-pricing.html In the context of energy markets, marginal pricing is referred to as a policy to set the clearing price for all bids equal to that of the highest bid that was called. Also known as pay-as-clear or uniform pricing. Opposite to pay-as-bid policy. See pay-as-bid
Merit-order	The **merit order** is a way of ranking available sources of energy, especially electrical generation, based on ascending order of price (which may reflect the order of their short-run marginal costs of production) together with amount of energy that will be generated. In a centralized management, the ranking is so that those with the lowest marginal costs are

	the first ones to be brought online to meet demand, and the plants with the highest marginal costs are the last to be brought on line. Dispatching generation in this way minimizes the cost of production of electricity. Sometimes generating units must be started out of merit order, due to transmission congestion, system reliability or other reasons. https://en.wikipedia.org/wiki/Merit_order https://www.febeg.be/merit-order (Dutch)
Nomination	The act of informing the counterparty about the forecasted energy profile for the near future. For example, a day-ahead nomination for the full next day, an intra-day nomination for the remainder of the day or short-term nomination for one or more ISPs.
Pay-as-bid	In the context of energy markets, pay-as-bid pricing is referred to as a policy to have a different clearing price for each accepted bid, equal to the bid price. Opposite to pay-as-clear or marginal pricing policy. See marginal pricing
Passive balancing	A BRP helps reduce the imbalance for the whole control area by deviating from its own electricity program. If this contributes to reducing the total imbalance, the BRP may receive remuneration for its passive contribution, depending on market design
Perimeter correction	Adjustment of the imbalance volume of the corresponding BRP. Normally performed by the ARP role to avoid that flexibility activation would result in an imbalance due to the changed energy volume. http://www.elia.be/~/media/files/Elia/users-group/Presentation_AS-from-distributed-Resources-2014_2015_Expert-WG-20130322.pdf
Pre-qualification	A check whether the assets participating in a flexibility service respond in the way specified by that flexibility service.
Redispatch	The act to compensate a demand/generation increase/reduction of an asset by an opposite change at another asset within the same portfolio or region such that the remaining profile at portfolio level or region level remains constant. This mechanism is sometimes used to solve grid congestion issues.
Schedule	A reference set of values representing the generation, consumption or exchange of electricity for a given time period (source [19])
Settlement	Determining the energy production and consumption and used flexibility as preparation for the billing process.
Single pricing	(In balancing markets) Same price for positive and negative imbalance. See also dual-pricing http://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER%20Recommendation%2003-2015.pdf ACER recommends to standardize on a single pricing strategy across Europe.
Sourcing (of energy)	Purchasing of energy
Spot Market	A spot market or is a public financial market in which financial instruments or commodities are traded for immediate delivery. Day-ahead markets and intra-day markets are both spot markets. https://en.wikipedia.org/wiki/Spot_market
Symmetrical product	A balancing product in which the client can request demand changes in both directions, i.e. demand increase and demand reduction. E.g., the Dutch primary reserve product is symmetrical; whereas the Belgian TSO has both symmetrical products and asymmetrical products.
System adequacy	Existence within a system of sufficient generation and transmission capacity to meet the load, whether under normal or unusual conditions, such as unavailability of facilities, unexpected high demand, low availability of renewable resources, etc. Adequacy is the power system's ability to meet demand in the long term. Adequacy (long-term) and security (short-term) together determine the reliability of the power system. Source:

	https://ec.europa.eu/energy/sites/ener/files/documents/Generation%20adequacy%20Final%20Report_for%20publication.pdf
Transfer of Energy	Energy volumes transferred between the BRP of the aggregator and the BRP of the supplier. In this text the Transfer of Energy is used to compensate the BRP of the supplier for the effects of flexibility activation by an Aggregator, and to source the energy needed this activation.
Tripping (of a resource)	Tripping in a power plant/station/power line occurs whenever fault happens. It is a protective measure which essentially isolates the important devices from the faulty section and thus saving it from getting destroyed.

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