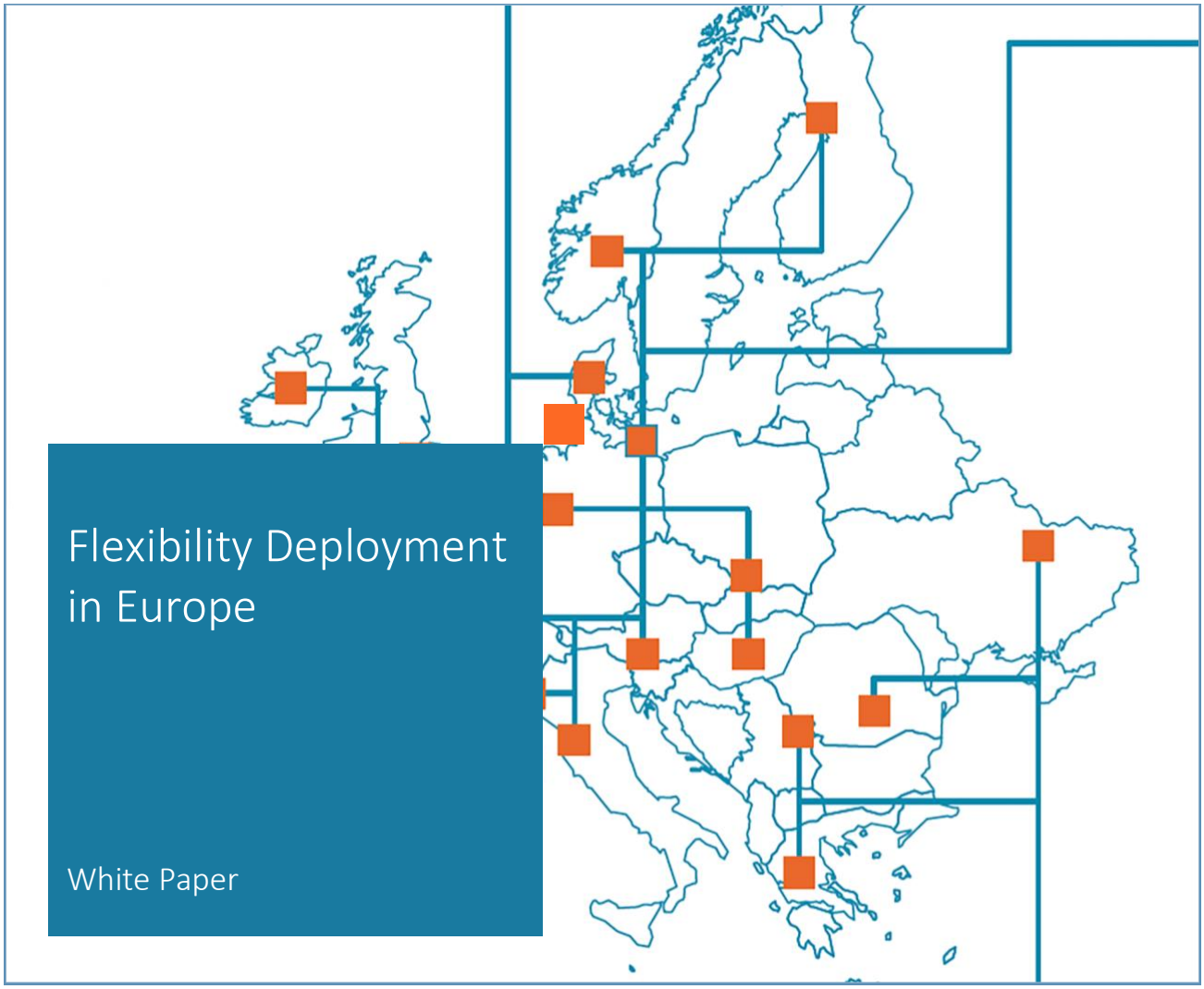

Flexibility Deployment in Europe

White Paper

USEF

A solid foundation for smart energy futures

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1 Introduction

There are a range of distributed flexibility products, markets and regulations across Europe. This paper presents an overview of current deployments by mapping them according to the USEF Flexibility Value Chain, USEF Aggregation Implementation Models and USEF market roles.

1.1 Purpose of this document

The release of the European Commission's 'Clean energy for all Europeans package' further encourages Member States to adopt and enable demand response via aggregation. In particular, *Article 17* of the Directive 2019/944 on electricity market design addresses the need to implement (independent) aggregators, compelling Member States to develop the necessary regulatory framework to allow their participation in the market. In addition, *Article 32* deals with the use of flexibility in distribution networks, encouraging Member States to develop the necessary regulatory framework to allow system operators to procure and deploy flexibility to alleviate congestion in their networks.

In response to the above situation, this paper intends to inform readers by sharing best practices, explaining the direction each country is taking to adapt its regulatory framework, and highlight where these are harmonised. Note that it does not intend to assess or evaluate individual deployments.

Each deployment is mapped using USEF terminology - Flexibility Value Chain (FVC) [1], Aggregation Implementation Models (AIMs)[2] and roles - to support comparison of, and discussion about, implementation of flexibility services and related business cases. The following introductory sections give an overview of the USEF elements applied in this paper.

1.2 Implicit flexibility

Active Customers exposed to variable supply and/or grid tariffs, e.g. Time-of-Use (ToU) tariffs, can profit from flexibility through in-home optimization, i.e. by shifting their Active Demand & Supply to periods with favourable energy or grid tariffs. This valorisation of the Active Customer's flexibility is known as *implicit DF*.

Figure 1: Implicit flexibility serviceFigure 1 (below) lists services for local (in-home, in-factory) optimization which are provided by implicit DSF. These can be performed either autonomously, by the Active Customer, or via the services of an ESCo. The services include: Time-of-Use (ToU) optimization, control of the maximum load (kW_{max} control), self-balancing services or emergency power supply. These services are only viable if the grid and/or supply tariffs provide the appropriate structure and incentives.

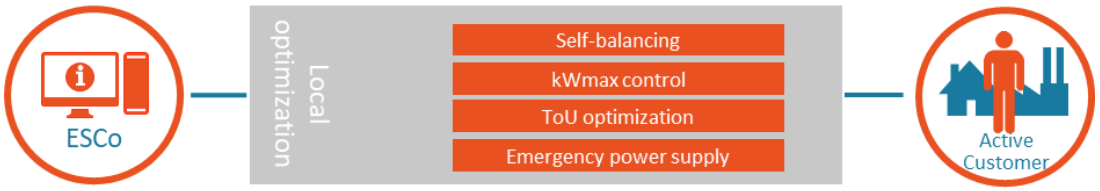

Figure 1: Implicit flexibility services

[1] The FVC is presented in the Position Paper Flexibility Value Chain (2018)
[2] The AIMS were presented in the publication *Recommended practices for DR market design* (2017) of the USEF Aggregator Workstream.

1.3 Roles and Responsibilities

USEF provides descriptions of all roles involved in the flexibility value chain but this paper particularly focuses on the implementation of the following roles:

Role	Responsibilities
	The role of the Aggregator is to accumulate flexibility from Active Customers and their flexible assets and sell it to the Balance Responsible Party (BRP), the DSO, or 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 (section 0) that has the most urgent need for it. The Aggregator is also responsible for the invoicing / remuneration process associated with the delivery of flexibility towards the Active Customer. The Aggregator and its Active Customers agree on commercial terms and conditions for the procurement and control of flexibility.
	The role of the Congestion Management Service Provider (CMSP) provides constraint management to a DSO or the TSO. In the provision of its services, the CMSP takes on specific responsibilities in communicating and coordinating flexibility transactions to effectively manage constraints between DSOs and/or the TSO.
	The Balancing Service Provider (BSP) is a market participant with reserve-providing units or reserve-providing groups able to provide balancing services to TSOs. The BSP is the trading counterparty through which the Aggregator provides Balancing Services to the TSO. BSPs are contracted by the TSO and are responsible for procuring balancing energy.
	The role of the Capacity Service Provider (CSP) is to provide adequacy services to either the TSO or a BRP. This role is similar to the BSP and CMSP roles and is applicable for adequacy services only.

Although the term 'independent aggregator' is used in this document, USEF does not recognize this as role. Rather, USEF refers to independent aggregation as the situations when the Aggregator operates without the consent from or a contract with the electricity Supplier of the Active Customer.

1.4 The Flexibility Value Chain

The USEF Flexibility Value Chain (FVC) provides an overview of the flexibility services which can be offered to all markets and products through distributed flexibility.

1.4.1 Service types

The sixteen service types for explicit distributed flexibility as defined in the FVC are shown in Figure 2. The service types are categorized by their purpose, i.e. why does the *Flexibility Requesting Party* (Balance Responsible Party, DSO or TSO) request flexibility? The categorization and definitions include examples of flexibility services already used, or in development, in existing (European) markets but do not make any recommendations related to them.

The flexibility service types can be classified as follows:

- *Wholesale services* help BRPs to decrease sourcing costs (purchase of electricity), mainly on day-ahead (DA) and intraday (ID) markets and optimize balancing costs. They include situations where the Aggregator provides flexibility either to its associated BRP or to any BRP e.g., via an Exchange or bilateral trade.
- *Constraint management services* help the grid operators (TSOs and DSOs) to optimize grid operation using physical constraints made available to them via markets.
- *Balancing services* include all ancillary services specified by the TSO.
- *Adequacy services* aim to increase security of supply by organizing sufficient long-term generation capacity. They can be provided to either the TSO or the BRP, depending on the market design. The BRP can be obliged by regulation to take responsibility for security of supply (e.g., the French capacity market) or can decide to hedge its risk.

For a definition of all sixteen service types in Figure 1, see the USEF position paper *Flexibility Value Chain* (2018).

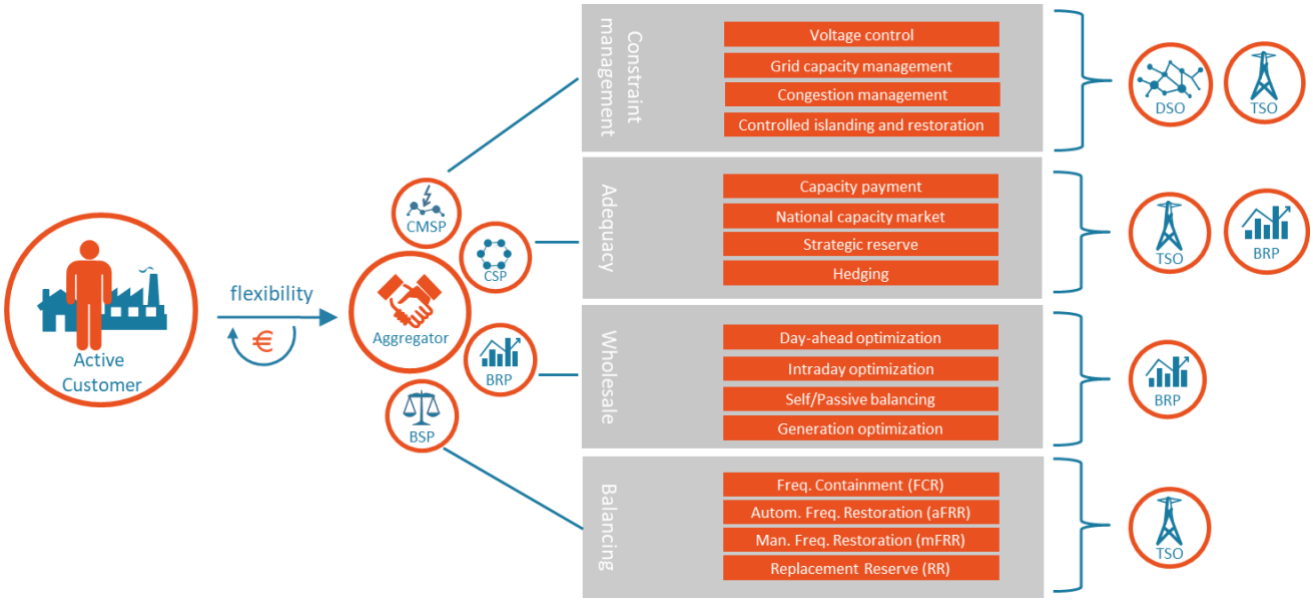

Figure 2 Explicit flexibility services

1.4.2 Value stacking

The USEF Flexibility Value Chain provides an opportunity for *value stacking*, i.e. enabling the Aggregator to provide multiple services to one or multiple Flexibility Requesting Parties (FRPs) from the same portfolio using the approaches below:

- Value stacking in time: e.g., participate in aFRR in the morning and in DSO capacity management in the afternoon.
- Value stacking in pools: activate one asset for one service, another asset for another.
- Double serving: provide multiple services at the same time by stacking activation from one asset.

All three value stacking levels allow for *dynamic pooling,* i.e., the ability to decide in real-time what assets to activate to deliver each service.

1.5 Aggregation Implementation Models

The USEF publication *Recommended practices for Demand Response market design* (2017) introduces seven Aggregation Implementation Models (AIMs). Figure 2 shows the classification of the AIMs. The classification is based on the following questions:

1. Are the roles of the Aggregator and Supplier combined in a single market party?
2. Does the Aggregator need to assign his own BRP?
3. Does the Aggregator need a contract with the Supplier's BRP?
4. For dual BRP models: how is the Transfer of Energy (ToE) organized between the Aggregator's BRP (BRP_{agr}) and the Supplier's BRP (BRP_{sup})?

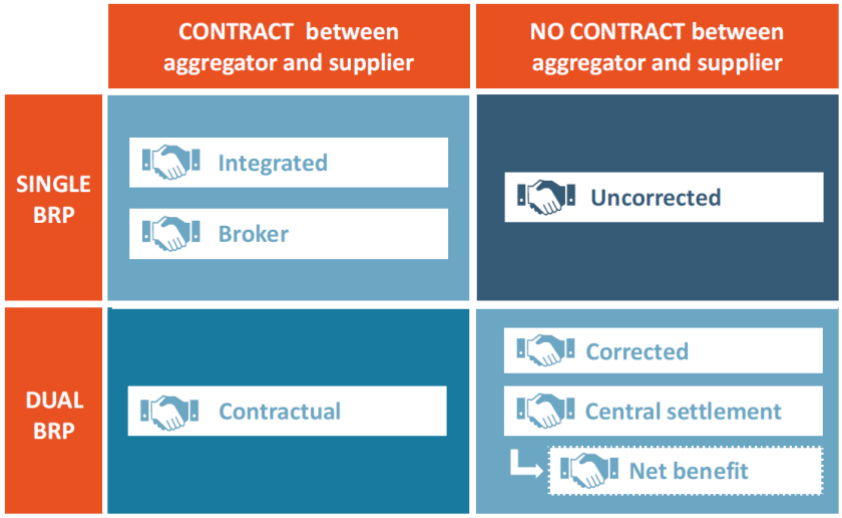

Figure 3: USEF Aggregation Implementation Models

1. **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. The Supplier/Aggregator has a contract with the Active Customer, selling energy and buying flexibility as per their contract. The Integrated Model is considered the 'default' option.

2. **Broker model:** The Aggregator transfers the balance responsibility to the BRP_{sup} . Compensation for open supply position and imbalances are settled based on contractual arrangements. The Aggregator has a bilateral contract with the Supplier or the BRP_{sup} .

3. **Contractual model**: The Aggregator uses his own BRP. The Aggregator has a contract with a BRP, to enter energy markets and cover imbalance, and a contract with the Supplier for the Transfer of Energy. BRP_{agr} is responsible for the flexibility during the activation period and will source energy ex-post from the BRP_{sup} through a hub-deal to balance the energy sold and the energy sourced. Sourcing volume equals the difference between measurement and baseline. A price formula needs to be agreed between both parties.

4. **Uncorrected model:** There is no contract between the Aggregator and the Supplier. The activated volume is settled through the regular balancing mechanism. There are no energy transfers between the Aggregator and the Supplier, nor does the Aggregator need to assign balance responsibility. Where the balancing mechanism incentivises passive contribution to balance restoration, it renumerates BRP_{sup} for energy that is sourced but not used if contributing to the system balance. If the Aggregator is active in balancing or adequacy services, the remuneration takes place against (in general favourable) balancing prices.

5. **Corrected model:** The profile of the Active Customer is modified based on the volume of flexibility activated by the Aggregator. The remuneration takes place through the Active Customer based on retail prices. The Aggregator assigns its own BRP. A central entity, i.e. the Imbalance Settlement Responsible (ISR) entity, corrects the perimeter of the Aggregator's BRP based on the activated volumes.

6. **Central settlement model:** A central entity (the ISR) corrects the perimeters of both the BRP_{sup} and the BRP_{agr} by transferring energy between them. This removes BRP imbalance positions caused by the activation of flexibility and avoids the need for direct Transfer of Energy between the Aggregator and the Supplier. In addition, the ISR financially settles the Supplier for its open position based on a predefined price formula which is applied to the volume of energy that the Aggregator has activated from the Supplier's portfolio.

7. **Net benefit model**: Like the central settlement model, the ISR corrects balancing perimeters and settles the compensation for the open supply model. The cost of this compensation is socialised if certain conditions are met; e.g. in the US, a net-benefit

test determines the price level from which the cost gets socialized. Alternatively, the Aggregator compensates the Supplier for price levels below those determined by the net-benefit test.

1.5.1 Developments triggered by the balancing guideline

Member States are implementing the Electricity Balancing Guideline[3] which includes: i) the definition of the BSP role and ii) the concept of 'imbalance adjustment,' as per Article 49 and this implies that TSOs must calculate and correct any BRP imbalances associated with energy activation. In addition, Article 17.3(d) of the Directive 2019/944 states that all market participants engaged in aggregation are obliged to be financially responsible for imbalances that they cause in the electricity system.

Both developments have triggered several Member States to decide that Independent Aggregators acting as BSP do not need to assign a BRP. Instead, TSOs correct the imbalance position of affected BRPs, and BSPs are responsible for covering the imbalance cost when they fail to deliver. The NordREG report 'Nordic Regulatory Framework for Independent Aggregation'[4] assigns the role of BSP-IA (independent aggregator) to this arrangement.

From a USEF perspective, there is a discrepancy with this approach because, while the BSP bears full balance responsibility (for cases of both under and over-delivery), it has no formal obligation to perform (or outsource) the BRP role. USEF models solve this by assuming that the BSP, like any other market party, needs to perform or outsource the BRP role. In addition, the BSP-IA arrangement only describes half (the balancing part) of the value-chain as it doesn't stipulate how the IA-BSP, Active Customer and Supplier should interact (this is the retail part which is typically outside the TSO's jurisdiction). To map the IA-BSP arrangement onto USEF models, we need to understand what will happen in practice in the relation between these three parties; this would enable them to be mapped to the following:

- Contractual model: If IA's BRP and supplier's BRP have a bilateral contract solving the imbalance and compensation issue.
- Broker model: Similar to the contractual model, where the IA-BSP does not assign its own BRP but cooperates with the Supplier's BRP.
- Corrected model: Where ToE is performed through the Active Customer. This is facilitated by the TSO, e.g. by providing specific information to the Supplier about activated flexibility.
- Central settlement: Where ToE is organised centrally (but actual payment can still occur bilaterally).
    - Net benefit model: where ToE cost is partly or fully socialised in the Central Settlement model.

If none of the above apply, the IA-BSP arrangement could be considered a ***free-rider***[5] model since the Aggregator does not pay for the energy sourced to offer the balancing service to the TSO.

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R2195
[4] http://www.nordicenergyregulators.org/wp-content/uploads/2020/02/A-New-Regulatory-Framework_for_Independent_Aggregation_NordREG_recommendations_2020_02.pdf
[5] A free rider is a person who benefits from something without expending effort or paying for it. In other words, free riders are those who utilize goods without paying for their use. Source: https://corporatefinanceinstitute.com/resources/knowledge/economics/free-rider/

2 Belgium

2.1 Implicit flexibility services

Network tariffs

The Belgian transmission tariff has both a capacity and a volumetric component. For transmission connected grid users, there is a monthly and yearly peak charge that encourages Active Customers to control and optimize their maximum capacity use (kWmax optimization). The energy component is not subject to time of use.

For distribution tariffs, depending on the meter and the type of connection, grid users can have a monthly and annual energy and capacity charge. Grid users under 56kVA are able to choose between flat and peak/off-peak (day/night) tariffs.

Supply tariffs

Dynamic supply tariffs are available for industrial customers on request but are not very common. Dynamic tariffs are not yet available for domestic customers. The roll-out of smart meters is expected to stimulate the enablement of dynamic tariffs and, thus, time of use optimisation of energy consumption.

2.2 Roles and responsibilities

The roles of Aggregator (called *Flexibility Service Provider* in Belgium), Balancing Service Provider (BSP) and, Capacity Service Provider (*Capacity Provider*) are recognized by regulation.
Once the iCAROS project is implemented, the *Scheduling Agent* role will be responsible for bidding for redispatch to solve congestion problems at transmission level. The role of *Voltage Service Provider* has also recently been implemented. Both roles would fall into the USEF Constraint Management Service Provider (CMSP) role.
There is an additional role for the provision of restoration services (*Restoration Service Provider)*which is not yet recognised by USEF.

2.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) (called *R1*) is open to demand-side participation, aggregation and independent aggregation. Resources connected to the distribution grid are theoretically allowed to participate but, in practice, the process is quite complex and involves DSO verification.
- Automatic frequency restoration reserve (aFRR) (called *R2*) is expected to open to demand-side response (with independent aggregation still limited to Active Customers with certain types of contracts).
- Manual frequency restoration reserve (mFRR) (called *R3*) is open to demand-side response (and independent aggregation) participation. This product can be offered through an availability contract and/or free bids.

Currently, while participation from distributed flexible assets is theoretically possible, it is very complex and there are few providers offering it. In future, the Internet of Energy (ioEnergy)[6] initiative, facilitated by Elia and major Belgian DSOs aims to develop a DSO/TSO platform that will unlock demand-side response potential for balancing services and wholesale.

Adequacy services

A capacity remuneration mechanism (CRM) is currently being designed to ensure security of supply. The current CRM rules proposal (Nov 2019) allows for demand-side response and aggregation. DSO connected capacities will be able to participate either individually or via aggregation but a derating factor will be applied to DSF and storage, in order to reflect each asset's[7] contribution to security of supply.

Constraint management services

[6] https://www.ioenergy.eu/
[7] https://www.elia.be/en/users-group/crm-implementation

At transmission level, Elia manages congestion via redispatching actions, sourced mainly from non-contracted reserves offered by production units under a CIPU[8] contract. In 2018, Elia launched the iCAROS project[9] which aims to open congestion management services to storage and demand facilities. Although the ioEnergy platform, mentioned above, has not yet considered the procurement of constraint management services, Elia expects to include it in future trials.

Wholesale

Grid users can valorise their flexibility on the day-ahead and intra-day markets via their Supplier/BRPs, with or without the collaboration of third parties (e.g. Aggregators). Currently, DSF and aggregation can only be utilized if agreed with the Supplier/BRP and so independent aggregation is not allowed. Elia aims to implement the Transfer of Energy (ToE) mechanism in the ID/DA markets in April 2021. [10]

2.4 Aggregation models

In Belgium, there is a transfer of energy (ToE) mechanism in place that allows independent aggregation to provide services without an agreement with the BRP/Supplier. In addition, there are a range of AIMs in place, as listed in Table 1.

Services	Model	Notes
FCR (R1)	Uncorrected	FCR is a symmetric product and so the energy component is cancelled.
aFRR (R2)	Contractual or Corrected	The need for regulated ToE is being reassessed.[11] Currently, Aggregator can only offer aFRR under a contractual model or a type of corrected model. The corrected option is called 'pass-through' contract. This type of contract is only possible for Active Customers that can nominate their consumption day-ahead to the supplier and will pay, against imbalance price, any deviations to their nomination. These arrangements make it possible for ToE to occur through the Active Customer, without the need for perimeter corrections.
mFRR (R3)	Integrated, Contractual or Central Settlement	The Aggregator and Supplier are initially encouraged to negotiate a Contractual Model. If negotiations fail, the Central Settlement Model acts as a fall back, with a Transfer of Energy formula set by the regulator. The perimeter correction is performed by Elia. On the financial side, the Belgian system varies from the USEF model which requires a contract between Aggregator and Supplier to perform the ToE financial settlement, in order to facilitate the financial flow and without sharing commercially sensitive information.
Capacity Remuneration Mechanism	-	The capacity remuneration mechanism will be a financial layer. Energy will be activated via other

[8] Contract for the Injection of Power Units

[9] Integrated coordination of assets for redispatching and operational security https://www.elia.be/-/media/project/elia/elia-site/electricity-market-and-system---document-library/outage-planning-and-scheduling-agents/2018/2018-design-note-icaros-future-scheduling--redispatching.pdf

[10] https://www.elia.be/-/media/project/elia/elia-site/public-consultations/20190617_final-study_toedaid.pdf

[11] https://www.elia.be/-/media/project/elia/elia-site/public-consultations/20180903_consultation_document_1_proposal_for_afrr_product_design_note_en.pdf?la=en

		mechanisms e.g. balancing services or wholesale, whose respective models would apply.
Day-ahead and intraday optimization	Contractual or Integrated	A central settlement and corrected model are being studied. Elia would perform the perimeter correction and the financial flow would happen bilaterally.

Table 1: Aggregation Implementation models implemented in Belgium

2.5 Value stacking

Balancing services can be offered at pool level but each asset should be prequalified and the bid must include a list of those assets. The Capacity Remuneration Mechanism (CRM) also allows participation via a pool of assets and prequalification of DR and storage is not mandatory.

Value stacking of balancing services in time is possible, with dynamic pooling gradually becoming more practically plausible as Elia is moving to shorter- term procurement. FCR and aFRR moved from weekly to daily procurement in July 2020.[12] In addition, mFRR and aFRR can also be offered with free bids in near real time which allows aggregators to better optimize. The provision of capacity via the CRM is expected to be stackable with other services.

The ioEnergy initiative also aims to enable the real-time control and monitoring of flexibility transactions, to facilitate dynamic pooling.

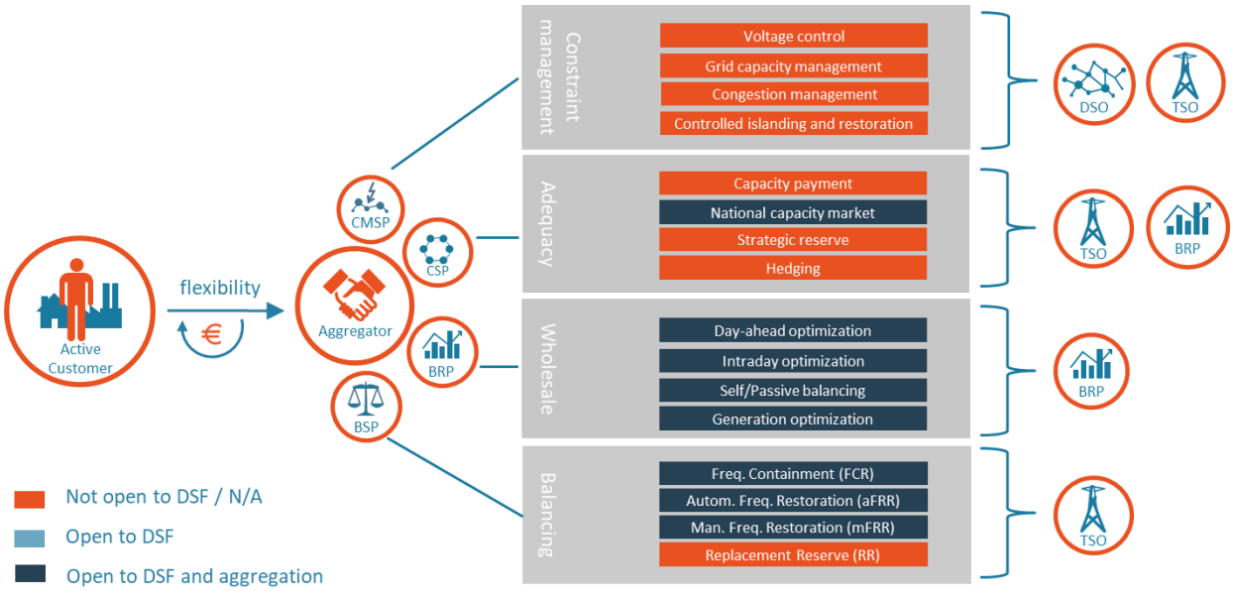

Figure 4: Overview of flexibility services in Belgium

[12] https://www.elia.be/-/media/project/elia/elia-site/electricity-market-and-system---document-library/balancing---balancing-services-and-bsp/2019/2019-design-note-fcr-for-2020.pdf

3 Denmark

3.1 Implicit flexibility services

Network tariffs

Both transmission and distribution tariffs are heavily volumetric. Transmission has a flat kWh tariff which does not allow for grid tariff optimisation. Unlike transmission tariffs, some DSOs have advanced time of use tariffs. The finalisation of the smart meter rollout scheduled at the end of 2020 will help unify the distribution tariff structure.

DSOs do not generally offer interruptible tariffs, i.e. tariffs offered to customers that are willing to reduce load when instructed by the DSO, although it is possible in certain cases.[13]

Supply tariffs

Larger consumers (>100.000 kWh) already have hourly settlements but so far had little interest in demand response; for small consumers hourly settlement is gradually being introduced. Few Suppliers offer dynamic pricing tariffs as it is not currently the customers' preferred option. Only 7,5% of the contracts are dynamic and these types of contract are not always available to customers with smart meters[14] although this was expected to change by the end of 2020, when the smart meter rollout was finalised.

3.2 Roles and responsibilities

The Aggregator and Balancing Service Provider roles are formalised in Denmark. Both parties need to be either Balance Responsible Parties (BRP) or assign balance responsibility to another BRP to provider flexibility.

3.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) is open to DSF and (independent) aggregation. This product is slightly different in DK1 (Denmark West) and DK2 (Denmark East). In the latter there is an energy transaction and remuneration for the activated volume.
- Automatic frequency restoration reserve (aFRR) is open to DSF and (independent) aggregation. In principle, however, the minimum bid size of 5MW and the product design make it difficult for new market players to bid into the market.
- Manual frequency restoration reserve (mFRR), also known as *regulerkraft*, is open to DSF and (independent) aggregation.

Adequacy services

Adequacy services are not currently available in Denmark.

Constraint management services

Congestion at transmission level is regulated by the TSO, Energinet. Congestion at distribution level is not yet a problem but the Danish ambition to increase renewable generation is envisaged to cause congestion problems in the near future. To explore local flexibility trading for solving congestion at transmission level, Energinet has set up a project in cooperation with Danish Energy, DSOs and market participants. The long-term objective is to implement similar flexibility trading at DSO level.[15] The test period began in April 2020.

Wholesale

DSF and aggregation are allowed for intra-day and day-ahead optimisation. However, independent aggregation is not allowed.

[13] https://www.nordicenergy.org/wp-content/uploads/2017/12/Demand-side-flexability_-DSO-perspective.pdf
[14] https://smarten.eu/wp-content/uploads/2019/12/the_smarten_map_2019.pdf
[15] https://www.engerati.com/transmission-distribution/danish-tso-dsos-to-launch-a-flexibility-pilot/

3.4 Aggregator implementation models

Services	Model	Notes
FCR	Uncorrected	Also called 'frequency stabilization model'. This model is being trialled in one of the pilots, based on the fact that there is no significant energy transfer and hence no imbalance implications for the BRP.
aFRR **mFRR**	Contractual or Integrated	The Aggregator needs be a BRP or appoint a BRP for large energy activations and have a contractual agreement with the Supplier's BRP.
Day-ahead and intraday optimization	Contractual or Integrated	

Table 2: Aggregation Implementation Models implemented in Denmark

In addition to the models described in the table above, a split-supply model (flexibility service model with energy supply) is already in place and being piloted to facilitate independent aggregation. However, there are discussions around the cost of sub-metering for distributed assets which can be quite expensive. Certain assets, like EVs and heat pumps, can use their own integrated meter but DSO approval is a problem. In the pilot, asset meters will be used. This model intends to split supply between assets with flexibility and other loads. This will allow electricity supply and flexibility management to be integrated into a single service received by the Active Customer from the Aggregator.

3.5 Value stacking

It is possible to stack different balancing services from committed availability windows but dynamic pooling is not yet allowed.

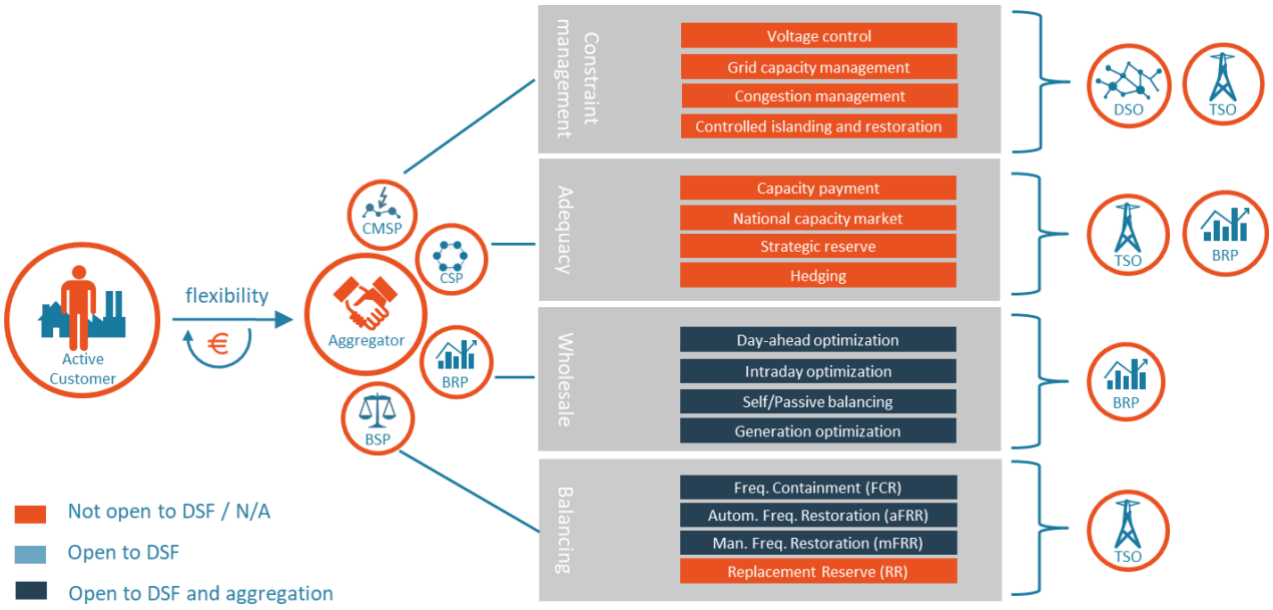

Figure 5: Overview of flexibility services in Denmark.

4 Finland

4.1 Implicit flexibility services

Network tariffs

Transmission and distribution tariffs in Finland are mostly volumetric. Transmission tariffs are flat or peak/off-peak tariffs (winter working day or other). Most DSOs only have peak/off-peak tariffs but there are others also offering tariffs based on peak capacity (*Tehotariffi*). It is also possible to choose a 'night tariff' or 'night control.' The Active Customer pays a cheaper tariff and allows the DSO to control household electrical heating (using smart meters) at night. However, the control is similar every day and there are no other explicit control commands from the DSO. Two years ago, the national Smart Grid Working group in Finland outlined a plan to end this type of night control in order to open this flexibility to dynamic markets and allow commercial parties to take up the business of demand response control.

Supply tariffs

There are dynamic supply tariffs for industrial and residential customers. The roll-out of smart meters is complete (with second generation now in roll-out), offering the possibility to make hourly energy prices available to the customers. In 2019, approximately 10% of domestic customers chose dynamic supply tariffs.[16]

4.2 Roles and responsibilities

The Aggregator role has not been formalised yet but this is expected during 2020. The Balancing Service Provider (BSP) role is recognised in Finland. There is no specific role assigned for either the Capacity Service Provider or Constraint Management Service Providers.

4.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) is divided into two products: FCR-N, for normal operation, and FCR-D, for disturbances. Both are open to DSF and (independent) aggregation.
- Automatic frequency restoration reserve (aFRR) is open to DSF. There are also plans to open it to independent aggregation. This will be done in accordance with the result from the mFRR pilot.
- Manual frequency restoration reserve (mFRR) is open to DSF and aggregation. Independent aggregation is in pilot phase and larger scale testing will start soon.

Adequacy services

In Finland there is a strategic reserve, procured by the National Regulatory Agency (NRA) and operated by Fingrid, the TSO. This product is open to DSF but not to independent aggregation.

Constraint management services

Congestion management at transmission level is open to DSF and aggregation but independent aggregation is not allowed.
At the distribution level, there have been innovation projects trialling demand-side response but, due to grid over-dimensioning, there is no real need yet for congestion management.[17]

Wholesale

DSF can participate in the day-ahead and intra-day market but only within the BRP portfolio. Independent aggregation cannot participate.

[16] https://smarten.eu/wp-content/uploads/2019/12/the_smarten_map_2019.pdf
[17] http://www.nordicenergyregulators.org/wp-content/uploads/2018/05/Demand-side-flexibility-Nordic.pdf

4.4 Aggregator implementation models

Services	Model	Notes
FCR (FCR-N)	Integrated, Contractual or Central settlement	The Transfer of Energy (ToE) price is currently fixed at the imbalance price but this is currently under consideration.
FCR (FCR-D)	Uncorrected	
aFRR	N.A.	Not yet open for independent aggregation. Might adopt the model that is now piloted for mFRR
mFRR	Integrated, Contractual Central settlement	Not yet open for independent aggregation but it's being piloted. The ToE price level is the Day-Ahead market price.
Wholesale	Integrated or Contractual	The Aggregator requires an agreement with power exchange, as well as an agreement with an open electricity provider, which also covers balance responsibility[18] to participate in the DA and ID markets.

Table 3: Aggregation Implementation Models implemented in Finland

4.5 Value stacking

Portfolio bidding is allowed in all reserve products and multiple flexibility markets but the same capacity cannot be sold multiple times.

Dynamic pooling is allowed in balancing services. The share of capacity coming from different BRPs is reported in the bidding phase by the BSP.

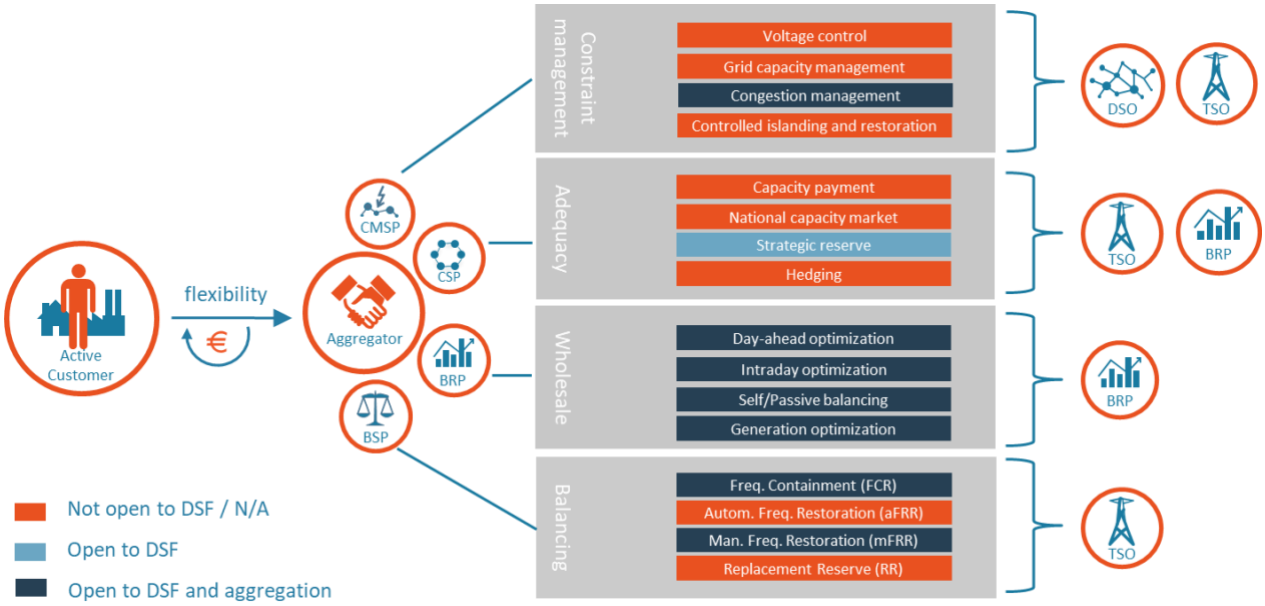

Figure 6: Overview of flexibility services in Finland

[18] https://www.fingrid.fi/en/electricity-market/market-integration/the-future-of-the-electricity-markets/demand-side-management/

5 France

5.1 Implicit flexibility services

Network tariffs

The transmission tariff for high voltage, as fixed in the TURPE 5,[19] has an energy and power component (excluding HV-B 3). The cost for energy and capacity has a static time-of-use (ToU) component, with five different time periods (depending on the season and time of the day) and three different tariff options, depending on the consumption type.
For medium voltage, there are two different tariffs, depending on consumption profile, with the ToU component based on five different time periods. There is also a choice of static ToU and mobile tariffs (with the peak hours communicated day-ahead).
For low voltage there is a static ToU tariff based on four different time periods.
These arrangements partly allow for grid tariff optimisation, especially for medium voltage where there is a dynamic component.

Supply tariffs

In France, households can choose between regulated or non-regulated tariffs. There are three available regulated tariffs: base, peak/off-peak and dynamic. The latter is called 'Tempo option' and works with six different tariffs, depending on the day (blue, white and red) and peak and off-peak hours. However, the peak/off-peak tariff (*Tarif Bleu*) is the most popular among residential customers.[20] Dynamic supply tariffs are more common among large industrial customers. In 2018, the capacity made available through these tariffs was estimated to be around 700 MW.[21]

5.2 Roles and responsibilities

The role of Aggregator (called *operateur d'effacement* in France)is formalised. The Balancing Service Provider role is divided into two separate roles (*responsable de reserve,* for FCR and aFRR, and *acteur d'adjustement* for mFRR and RR).
There is a role for Capacity Service Providers (called *responsable de périmetre de certification)*.

5.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) (*réglage primaire*), is open to demand-side participation, aggregation and independent aggregation.
- Automatic frequency restoration reserve (aFRR) (*réglage secondaire*) is mandatory for generators and open to aggregation (for generation). Generators can source through a secondary market aggregated load reduction to fulfil their capacity obligation but this market is never used in practice. The process is expected to change at the end of 2021 as a result of the PICASSO platform.[22]
- Replacement Reserve and Manual frequency restoration reserve is divided into two types - *Réserve Rapide* and *Réserve Complementaire* - with both open to demand-side response and (independent) aggregation participation. mFRR and RR are called upon through the balancing mechanism (*mécanisme d'ajustement*).

There is a special tender dedicated to facilitating DSF participation in these services, referred to as *Appel d'Offres*. This mechanism offers financial compensation for making capacity available. The capacity is deployed through NEBEF or the capacity mechanism.[23]

Adequacy services

The capacity mechanism (*mécanisme de capacité*) is intended to safeguard the security of electricity supply in France during peak winter periods. It is based on an obligation, with obligated parties required to cover consumption during peak periods. This can be done by means of certificates based on generation and demand response capacities. The arrangement allows (independent)

[19] https://www.enedis.fr/sites/default/files/TURPE_5bis_plaquette_tarifaire_aout_2019.pdf
[20] https://en.selectra.info/energy-france/suppliers/edf/tarif-bleu
[21] https://bilan-electrique-2018.rte-france.com/wp-content/uploads/2019/02/BE-PDF-2018v3.pdf
[22] https://www.entsoe.eu/network_codes/eb/picasso/#:~:text=The%20Platform%20for%20the%20International,energy%20from%20frequency%20restoration%20reserves
[23] https://www.services-rte.com/fr/decouvrez-nos-offres-de-services/repondre-a-lappel-doffres-reserv.html

Aggregators to trade capacity certificates with obligated parties. This capacity can be activated through the balancing mechanism or NEBEF mechanism.

Constraint management services

Constraint management services for high voltage level are open to aggregation, however there is little to no participation due to the low revenues associated with it.

DSF constraint management services at distribution level are not yet business as usual although there have been several trials. Enedis (DSO covering 95% of French connections) has published a roadmap for using flexibility for grid capacity management via market-based mechanisms.[24]

Wholesale

Aggregators can trade blocks of load reduction in the day-ahead and intra-day markets. The Block Exchange Notification of Demand Response mechanism, known as the *NEBEF* mechanism,[25] was introduced in France in 2015 to regulate (independent) aggregation for wholesale and mFRR/RR.

5.4 Aggregator implementation models

Services	Model	Notes
Wholesale, FCR, mFRR and RR[26]	Corrected	Applicable to remote ('telereleve') sites connected to the TSO grid or remote sites connected to the DSO grid with a CARD (Contrat d'Accès aux Réseaux publics de Distribution) > 36 kVA
	Central Settlement	Applicable to DSO connected sites with the exception described above.
	Contractual	If Aggregator and BRP_{SUP} have a contractual agreement
aFRR	Depends on the activation process	When load reduction is traded through the secondary market, the same model as for the other balancing services applies.
Capacity market	Depends on the activation process	A model is only applicable for energy utilisation. When the capacity is activated it is done through the balancing mechanism or through wholesale. The rules for those services will apply then.

Table 4: Aggregation Implementation Models implemented in France

5.5 Value stacking

All products and markets can be offered at pool level, and dynamic pooling is possible in wholesale and capacity markets and partially for balancing. For telemetered entities, the Aggregator also needs to provide baselines for non-activated assets for use in RTE audits. Aggregators can also provide flexibility pools from profiled sites with pro rata activation of assets. The limitation, however, is that the Aggregator is responsible for the full pool of assets even if the activation was limited to a subset of assets.

[24] https://www.enedis.fr/sites/default/files/Flexibilities_-_Energy_transition_and_performance_of_distribution.pdf
[25] https://www.services-rte.com/en/learn-more-about-our-services/participate-nebef-mechanism
[26] The Aggregator does not hold balance responsibility for the activation of mFRR and RR, although there is penalty for under delivery.

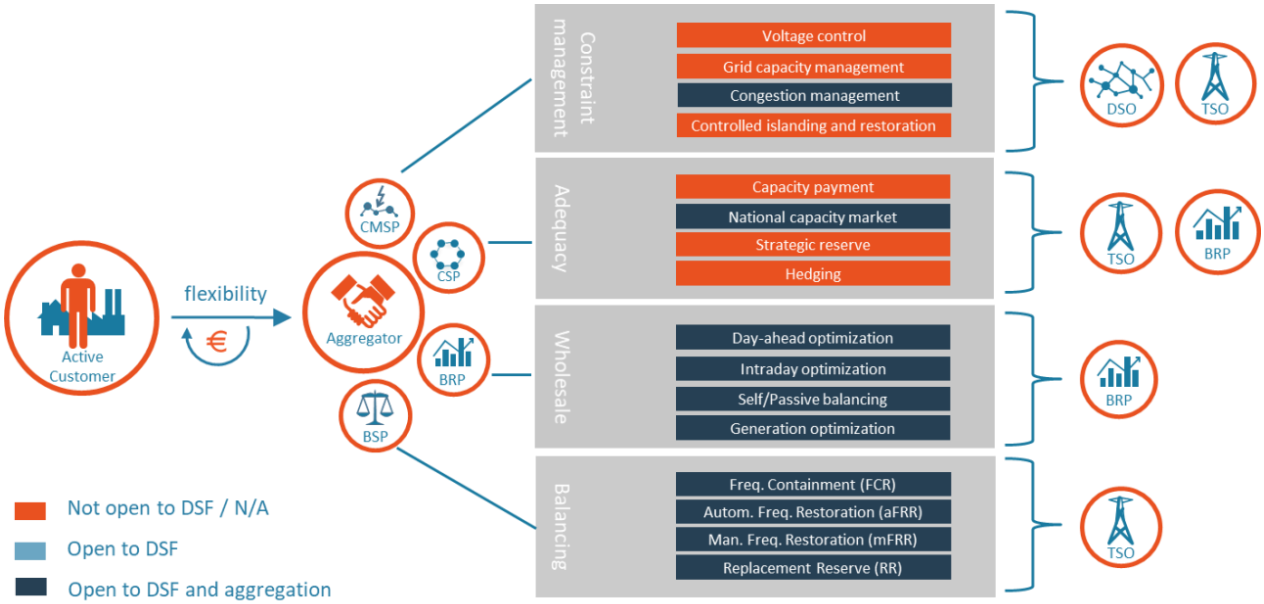

Figure 7: Overview of flexibility services in France.

6 Germany

6.1 Implicit flexibility services

Network tariffs

Each one of the four TSOs in Germany charges its own company-specific tariff to customers.[27] Transmission charges are predominantly based on volumetric and maximum capacity but only connections above 100 000 kWh pay the capacity charge.[28] This arrangement partly incentivizes consumers to manage their peak capacity.

Distribution charges are mostly volumetric and there appears to be a lack of transparency about how they are calculated.[29] The energy charge is generally flat. There are peak/off-peak tariff options but they are not commonly used. This arrangement leaves little to no option for distribution-connected consumers to optimise grid tariffs.

Supply tariffs

While dynamic pricing is possible in Germany, the current lack of smart metering infrastructure means these tariffs are barely used.

6.2 Roles and responsibilities

In Germany, the Aggregator and Balancing Service Provider (BSP) roles have been formalised. There is no specific role assigned for either Capacity Service Providers or Constraint Management Service Providers.

6.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (known as *Primary Control Reserve*) is open to DSF and (independent) aggregation.
- Automatic frequency restoration reserve (known as *Secondary Control Reserve*) is open to DSF and (independent) aggregation.
- Manual frequency restoration reserve is split in two services, Minute Reserve and Interruptible Loads (*AbLaV*). While Minute Reserve is open to DSF and independent aggregation, AbLaV allows load participation but not aggregation. It is not clear whether the AbLaV product will continue after 2022.

Adequacy services

In Germany, there is a strategic reserve (*Kapazitätsreserve)* which is activated if the electricity demand cannot be met through market-based mechanisms. The first auction, for 2 GW[30], took place in October 2019 and delivery began in October 2020. Although the tender is open to all types of domestic capacity providers (generating plants, storage facilities and demand response operators), technical requirements were impeding DSF participation.[31]

In 2018, the EU ruled that industrial load must be allowed to participate in the strategic reserve and all technologies must be treated equally. In response, Germany amended the rules to allow for aggregation of distributed loads, lowering the minimum bid size and number of tests, but has stated that only inflexible loads can participate in the reserve which means they cannot be active in other balancing services.

Constraint management services

[27] As of 2023, regional differences in network tariffs on TSO level will be abolished based on the German network modernisation law (Netzentgeltmodernisierungsgesetz) (NEMoG). The transition path is 20% harmonization in 2019, 40% in 2020, 60% in 2021, 80% in 2022 and 100% harmonization from 2023.

[28] https://smarten.eu/wp-content/uploads/2019/12/the_smarten_map_2019.pdf

[29] https://www.agora-energiewende.de/veroeffentlichungen/netzentgelte-2018-problematische-umverteilung-zulasten-von-geringverbrauchern/

[30] Only gas-fired power plants participated in this auction.

[31] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=uriserv:OJ.L_.2018.153.01.0143.01.ENG

Constraint management services, at both transmission and distribution level, are not open to (independent) aggregation. To manage congestion, system operators use a cost-based mechanism to directly control generation with a minimum size of 10 MW. [32]

The new Redispatch 2.0, planned for implementation in October 2021, will allow system operators to control generation and storage units with a minimum size of 100 kW.

From 2021, in accordance with EU requirements, there will be a new market for *non-frequency ancillary services (nicht-frequenzgebundene Systemdienstleistungen - NF SDL)*. The Federal Energy Ministry BMWi recently published draft regulation for the new product and for technology-neutral and market-based auctions. This legislation may mainly apply for reactive power and black start ability. Details will be formulated by the regulator BNetzA or four TSOs later.

Wholesale
Wholesale optimization can only be offered via the Supplier's BRP and is therefore not yet open to independent aggregation.

6.4 Aggregator implementation models

Services	Model	Notes
FCR, aFRR, mFRR	Integrated, Contractual, and Corrected	Usually, there is a contract between Aggregator and Supplier's BRP. If not, there is a framework to correct the Supplier's balance position and to compensate for the energy sourced through the Active Customer's contract. The price of the ToE matches that in the Active Customers' retail contract.
Wholesale	Integrated	

Table 5 Aggregation Implementation Models implemented in Germany

6.5 Value stacking

Pooling is allowed but prequalification is required at asset level.
Value stacking of balancing products is possible even where multiple Aggregators delivering balancing products are active on the same unit. The *Zuteilungsregel*[33] explains how to quantify the delivered flexibility activation for each balancing product when value stacking.
Dynamic pooling is not possible as Aggregators need to notify the assets delivering a service one week in advance.

[32] https://www.bdew.de/energie/redispatch-20/
[33] www.regelleistung.net%2Fext%2Fdownload%2FKonsultation_Regelleistungsistwerte&usg=AOvVaw3KNaMkJf4BwECk_j93KJCB

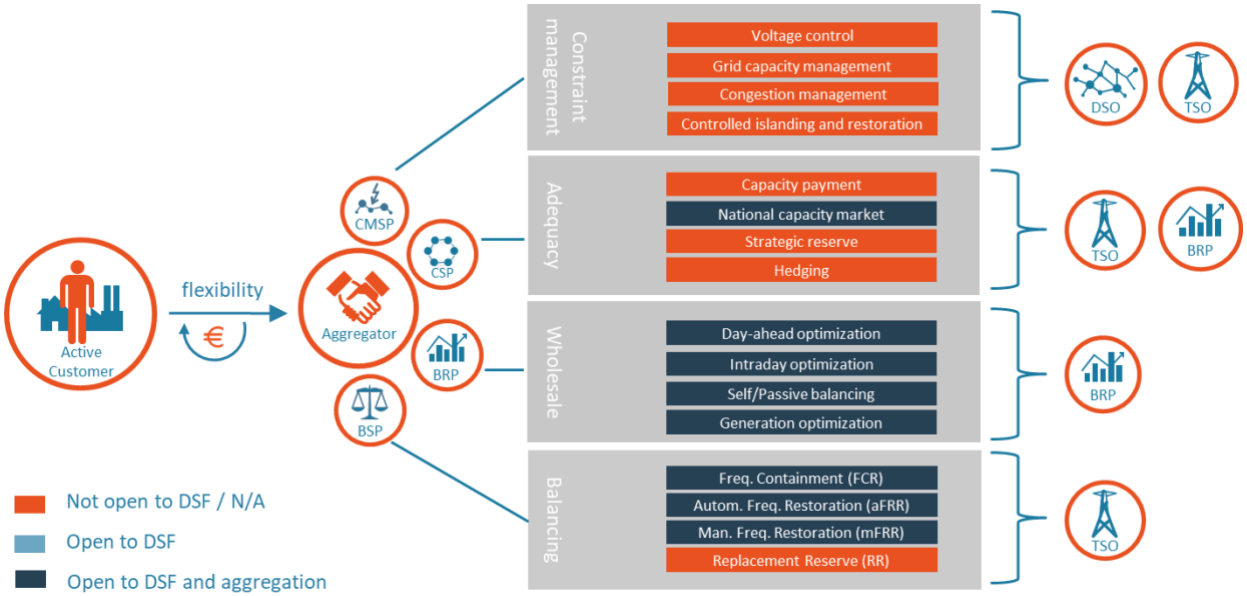

Figure 8: Overview of flexibility services in Germany.

7 Great Britain

7.1 Implicit flexibility services

Network tariffs

National Grid Electricity System Operator (NG ESO) charges Transmission Network use of System (TNUoS) charges to customers with half hourly metering. The tariff is based on Triad periods,[34] making the charge dependent on consumption during the highest demand periods. These periods are not published in advance and grid users must forecast and manage their load to avoid them. This mechanism incentivizes Active Customers to optimise their load over long periods.

Distribution Use of System (DUoS)[35] charges vary by region as well as by time of day, based on a time banding mechanism designed to encourage customers to spread their network usage across the day and avoid network usage during times of peak demand.

Supply tariffs

Time-of-Use (ToU) and dynamic pricing tariffs are available to all large customers (industrial and commercial) with half hourly measurements. Although there are suppliers offering ToU and dynamic tariffs to domestic customers, these are not available to all customers as smart meters are not yet fully rolled-out in Great Britain.

7.2 Roles and responsibilities

The role of Aggregator is recognized by regulation as an independent organisation or a market actor combining roles such as Active Customer, Supplier or generator. Aggregators performing independent aggregation are referred to as *Virtual Lead Parties* (VLPs) when participating in the Balancing Mechanism or the Replacement Reserve market introduced by Project TERRE.
Balancing Service Provider (BSP) is a recognized role in accordance with the European Electricity Balancing Guideline but the term is not commonly used by market participants.
Capacity Provider is the designated role for parties providing capacity in the Capacity Market.
There is not yet a role for provision of constraint management services.

7.3 Explicit flexibility services

Balancing services

The procurement of frequency and reserve services in Great Britain (GB) is changing[36] to comply with Electricity Regulation within the Clean Energy Package. This section describes the current services and does not focus on future changes.

- Frequency containment reserve (FCR): In GB this equates to two services: Firm Frequency Response and Dynamic Containment. The former is open to DSF participation and also (where technical requirements are fulfilled) to independent aggregation. The latter is a new product 'soft launched' by NG ESO in 2020 which only allows aggregation at Grid Supply Point group but NG ESO intends to extend this in the future.
- Automatic frequency restoration reserve (aFRR): The closest equivalent to this was the Fast Reserve (FR) service. The service was open to DSF and independent aggregation but the minimum required power of 25MW created a barrier for Aggregators. Fast Reserve has been discontinued in 2020 due to non-compliance with the CEP, and NG ESO only intends to use optional fast reserve contracts.[37]
- Manual frequency restoration reserve (mFRR): Short Term Operating Reserve (STOR) used to be procured by NG ESO in three annual tenders but this will change to day-ahead procurement from 2020. It is open to DSF and independent aggregation. Most of the STOR utilised capacity comes from DSF.

[34] Triad refers to the three half-hour settlement periods with the highest system demand from November to February, separate by at least ten clear days.
[35] https://www.dcusa.co.uk/DCUSA%20Document%20Public%20Version/Schedule%2016%20v10.2.pdf
[36] https://www.nationalgrideso.com/document/157791/download
[37] https://www.nationalgrideso.com/document/174526/download

- Balancing Mechanism: This is NG ESO's tool for balancing the system close to real time. It is based on a bid-offer mechanism after gate closure. Traditionally, this mechanism has been closed to independent Aggregators but this has recently changed, with the P344 Balancing and Settlement Code modification[38] which allows them to participate as Virtual Lead Parties.

For most of the above-mentioned services, any technology or technologies able to fulfil a service's technical requirements can offer it. This includes generators connected to the transmission and distribution networks, storage providers and aggregated demand side response.

Adequacy services

In GB, NG ESO organizes a Capacity Market to ensure long-term supply and generation capacity. This mechanism is open to traditional generation, DSF and independent aggregation. (Aggregated) units connected to the transmission or distribution network can participate in Capacity Market Auctions. It is possible to trade capacity obligations via 'Secondary Trading' which allows capacity providers to cover unavailability of their contracted capacity.

Depending on the nature of the technology providing capacity, de-rating factors are applied to the asset capacity to determine the contracted, and therefore the remunerated, capacity. The factor applied to demand response is only of 86.1% which is relatively low given that nuclear capacity has an 80% de-rating factor.[39] For example, if an Aggregator offers 1MW of demand response capacity, only 86.1% of that capacity, i.e. 861kW, will be remunerated.

Constraint management services

Constraint management at transmission level is managed, amongst other methods, by Bid-Offers through the Balancing Mechanism. As mentioned above, the Balancing Mechanism is now open for participation to distributed DSF and independent aggregation.

At distribution level, in addition to multiple innovation projects, GB DSOs have been tendering for flexibility through the match-making flexibility platform, Piclo Flex.[40] The Electricity Network Association (ENA) is attempting to standardise DSO constraint management products as part of the Open Networks (ON) project.[41] Current DSO flexibility classification identifies four main services: Secure, Sustain, Dynamic and Restore.

Wholesale

Currently, DSF and aggregation can only take place where there is agreement with the Supplier/BRP, therefore independent aggregation is not allowed.

[38] https://www.elexon.co.uk/mod-proposal/p344/
[39] https://www.emrdeliverybody.com/Capacity%20Markets%20Document%20Library/Auction%20Guidelines%202020_T-1_T-3_T-4.pdf
[40] https://picloflex.com/
[41] https://www.energynetworks.org/assets/files/ON-WS1-P2%20DSO%20Service%20Requirements%20-%20Definitions%20-%20PUBLISHED.pdf

7.4 Aggregator implementation models

Services	Model	Notes
FCR (FFR) **aFRR (FR), mFRR (STOR) and BM**	Uncorrected Broker, Integrated or 'BSP-IA'	The broker and integrated model are always an option. Where the Aggregator and Supplier do not have a contract, the 'BSP-IA' arrangement applies (see section 1.5.1). The Balancing and Settlement Code Company (or ISR in USEF terminology), ELEXON, corrects the balance position of the BRPs affected by flexibility activation from Aggregators (BSPs or VLPs) to avoid them causing imbalance charges.[42] In addition, Aggregators (BSPs or VLPs) are only responsible for under-delivery but not for over-delivery. Regarding transfer of energy: - If the Active Customer 'opts-in', relevant data will be shared with their Supplier for billing purposes. In this case, the ToE will be done through the Active Customer. This could be mapped as a type of corrected model. - If the Active Customer doesn't opt-in, there is not a standard procedure to arrange ToE, therefore it could be considered a *free riding* model.
Capacity Market	Depends on the activation	The capacity market does not offer activation payment. When the energy is activated it can be done through another 'relevant Balancing Service' or through wholesale to get a remuneration. Therefore, the AIM will correspond to that of the selected service.
Day-ahead and intraday optimization	Contractual or Integrated	

Table 6: Aggregation Implementation Models implemented in Great Britain

7.5 Value stacking

In the GB market, stacking of services is possible and depends on the service and type of contract and/or procurement the provider has committed to. NG ESO has published some high-level principles for services and revenue stacking and initial options for flexibility value stacking in the ESO Balancing Services. These allow providers to offer multiple services, to multiple entities, and allow for the same assets to offer two services at the same time if they are not conflicting. Stacking is also compatible with Capacity Market rules. The Energy Networks Association (ENA) has published the current overview of permitted revenue stacking per service[43] and this includes balancing, capacity and DSO constraint management services (this is an area under development which is being discussed as part of the ENA Open Networks project).[44]

From the ENA publication we conclude that while products are readily stackable 'in time, they are less stackable for 'double serving.' The services that generally allow double serving are the capacity mechanism, RR and the BM but the assets offered for each service are fixed and cannot be modified in real time so 'dynamic pooling' is not possible.

[42] https://www.elexon.co.uk/mod-proposal/p354/
[43] https://www.energynetworks.org/assets/images/Resource%20library/ON20-WS1A-P5%20DSO%20Revenue%20Stacking-PUBLISHED%20300720.pdf
[44] Under Workstream 1A Product 4: DSO Services – Commercial Arrangements

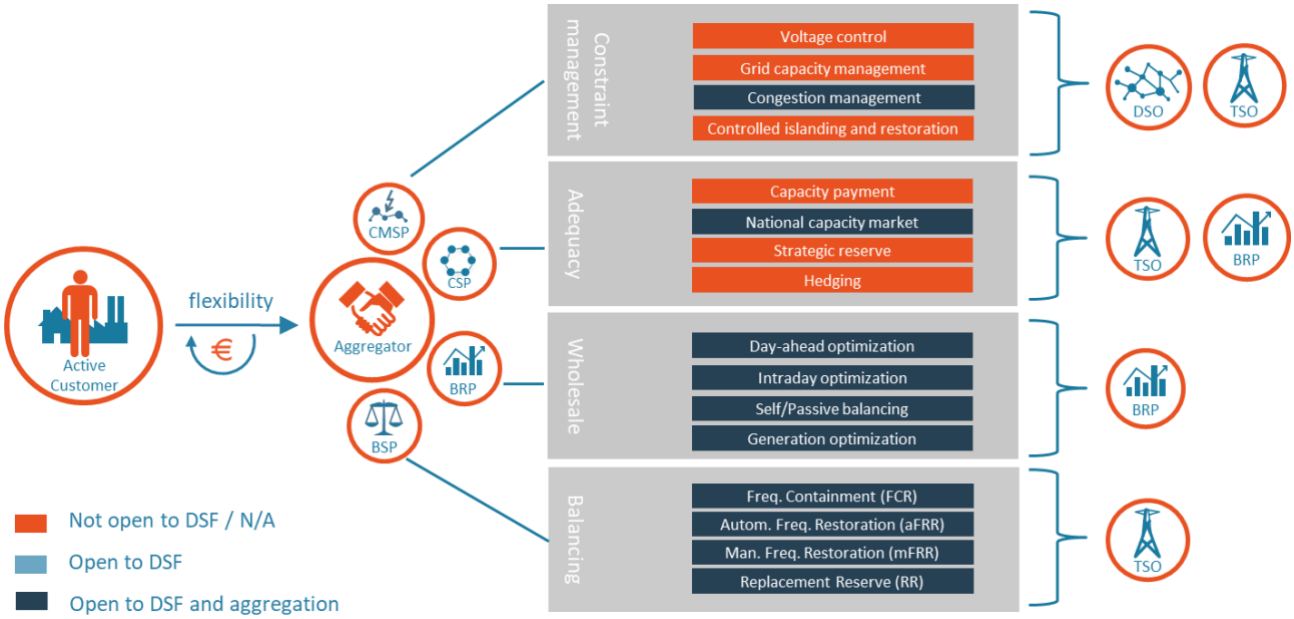

Figure 9: Overview of flexibility services in Great Britain.

8 Netherlands

8.1 Implicit flexibility services

Network tariffs

The transmission tariff is a capacity-based charge that reflects both the connection size and the maximum capacity recorded per month or per week. With this arrangement, transmission-connected Active Customers can optimise their peak consumption to reduce their charges.

The distribution tariff is a flat charge based on the Active Customer's connection size and applies to customers with a connection <3x80 A. While this arrangement does not incentivise Active Customers to shift their consumption in time, DSOs also offer maximum capacity tariffs (similar to the TSO tariff) to large industrial Active Customers.[45]

Supply tariffs

Active Customers may have peak /off-peak or dynamic pricing based on smart-meter allocation. In the residential sector, this is not common practice, with few suppliers offering dynamic pricing tariffs. It is most common in the C&I segment; for example, greenhouses are often exposed to real-time pricing through their supply contract and it is common for them to contract ESCos to perform the optimisation in relation to dynamic pricing. It should be noted that, where this happens, the Aggregator performs the Energy Service Company (ESCo) role.

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8.2 Roles and responsibilities

In the Netherlands, the Aggregator role has not yet been defined in legislation, but it is proposed in the Energy Law proposal currently under consultation.[46] The Balancing Service Provider (BSP) role has been formalised. There is a proposition to implement the Constraint Management Service Provider (CSP) (*Congestie Service Provider*) role in the grid code to designate the party providing grid capacity management services to the DSOs.

8.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) is open to DSF and aggregation. Distributed resources can also participate in the service.
- Automatic frequency restoration reserve (aFRR) can be procured through availability contracts and through free bids. Bids from contracted and non-contracted parties are then placed in a *bidladder* and are selected from lower to higher price. The aFRR bidladder is open to DSF and aggregation via the BSP. Distributed resources can also participate in this service via *pooling,* i.e. aggregation.[47]
- Manual frequency restoration reserve (mFRR), directly activated mFRR (mFRRda), previously known as *Noodvermogen*, is open to DSF and aggregation by *pooling* via the BSP. Distributed resources can also participate in this service by *pooling* [48].

Adequacy services

There are no adequacy services in the Netherlands yet, and it is not foreseen before 2025.

Constraint management services

TSO and DSO congestion management are open to DSF and aggregation participation. TenneT, the TSO, and DSOs have worked together in the creation of the GOPACS platform. This platform facilitates the coordination of the TSO and DSOs in the

[45] For example: https://www.stedin.net/zakelijk/betalingen-en-facturen/tarieven
[46] https://www.internetconsultatie.nl/energiewet
[47] https://www.tennet.eu/fileadmin/user_upload/SO_NL/Productinformatie_aFRR.pdf
[48] https://www.tennet.eu/fileadmin/user_upload/SO_NL/Productinformatie_mFRRda_incident_reserve.pdf

procurement of flexibility to solve network constraints. In addition to this, several DSOs have implemented USEF to manage local congestion problems.

Wholesale
DSF can be traded day-ahead, intraday and to perform self-balancing or passive balancing but this can only be done via the Supplier's BRP and so is not yet open to independent aggregation.

8.4 Aggregator implementation models

Services	Model	Notes
Wholesale (DA/ID)	Integrated or Contractual	Only trades by BRP, Aggregator may be contracted by BRP to control their flexibility.
Self/passive-balancing	Integrated or Contractual	Passive balancing is rewarded via imbalance settlement mechanism.
FCR	Uncorrected	
aFRR	Integrated, Broker, Contractual or "BSP-IA" arrangement	When the BSP/Aggregator does not have a contractual arrangement with the BRP_{sup}, TenneT applies the 'BSP-IA' model, see section 1.5.1. TenneT corrects the BRP perimeter[49] affected by the BSP by the activated volume.[50] However, ToE is not arranged by regulation, it is not yet fully clear how the retail side of this model will be implemented. Assuming the Supplier would require a form of remuneration (the BSP-IA model only removes the energy from the BRP_{sup}'s perimeter without remunerating the sourcing of this energy – this could be considered as free riding), there are is one option: • The Supplier seeks compensation from the customer. Since the customer typically would know the activated volume, the customer can remunerate the Supplier. This arrangement would correspond to the Corrected model.
mFRRda	Integrated or Broker	BRP perimeter correction on the called volume.[51] The Compensation of open supply position has to be agreed upon between the Aggregator (BSP) and customer as well as customer and Supplier(BRP). The Aggregator is remunerated for the delivered energy[52].
DSO congestion management	Uncorrected	Applicable for flexibility deployed under the USEF pilots.
	Integrated or Contractual	Applicable for flexibility deployed under the GOPACS platform.

Table 7: Aggregation Implementation Models implemented in the Netherlands

8.5 Value stacking

For all balancing products, pooling is allowed:

- FCR: Requires Symmetrical product. If the product is delivered via a portfolio of generation and load, the BSP needs to balance this portfolio in such a way that a symmetrical product can be delivered.

[49] Correction for BRP(s) of connection points that deliver the aFRR.
[50] https://www.tennet.eu/fileadmin/user_upload/SO_NL/Product_information_aFRR.pdf
[51] https://www.tennet.eu/fileadmin/user_upload/SO_NL/Productinformation_mFRRda_incident_reserve.pdf
[52] This is a slight variation on the USEF Broker model where the BRP_{SUP} receives the remuneration.

- FCR: When offering from a pool, allocation information for each contributing Reserve Providing Unit and/or Reserve Providing Group has to be provided via ENTSO-E message (Planned Resource Schedule).
- FCR, aFRR, mFRR requires prequalification of all Reserve Providing Units and/or Reserve Providing Groups.

Dynamic pooling for mFRR and aFRR is allowed; the Aggregator must notify the TSO about the units used for activation within 5 minutes of the activation.

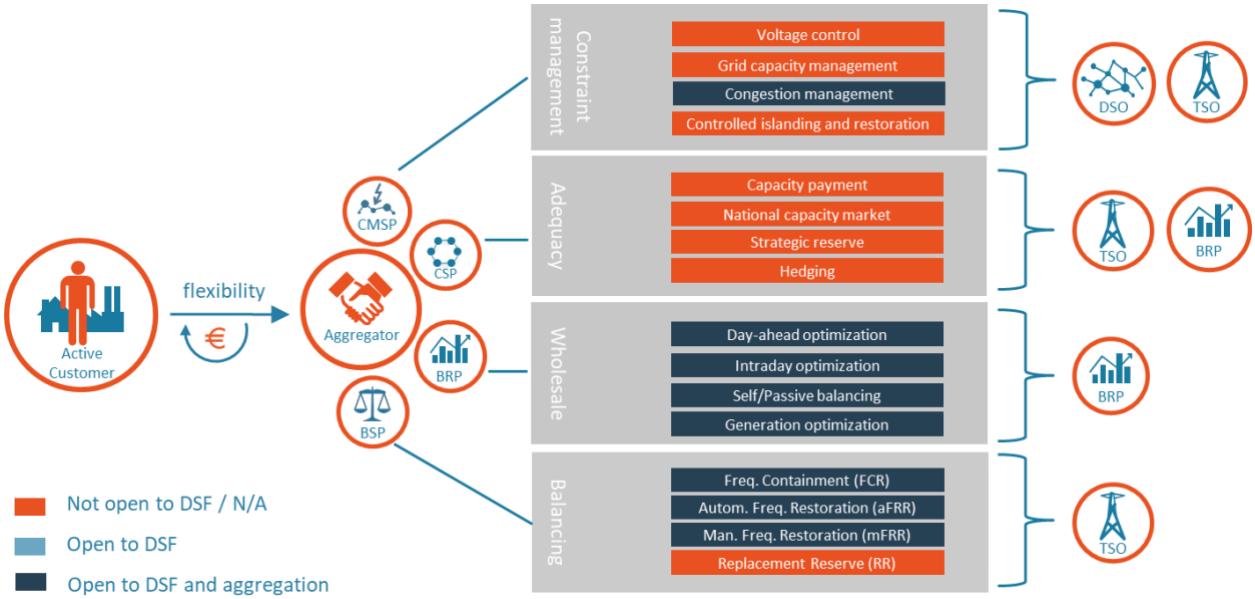

Figure 10: Overview of flexibility services in the Netherlands.

9 Spain

9.1 Implicit flexibility services

Network tariffs

The transmission and distribution tariffs in Spain are the same for the whole territory, i.e. there are no locational dependencies, but seasonal calendars vary from one region to another[53].

There are both capacity and energy charges which may either be flat or based on the time of the day, or year, depending on the Active Customer's voltage range.

For low voltage connected Active Customers,[54] the capacity term is fixed and based on the connection size. For the energy component, the Active Customer can choose between a flat or hourly rate (based on two or three periods).[55]

For medium voltage and high voltage connections, both the capacity and the energy charge depend on the hourly rate (based on three or six periods).

A redesign of network tariffs is planned for 2021. In July 2019, the Spanish regulator launched a public consultation for the new tariff methodology which gave a lot of weight to contracted capacity, although tariffs do also have a time of use component.

Supply tariffs

The completed smart-meter roll-out means there are dynamic pricing tariffs available for small and large Active Customers. In addition, Active Customers with a connection lower than 10kW also have the option to choose a regulated dynamic tariff based on day-ahead prices and other components. The resulting price is known as PVPC (*Precio Voluntario al Pequeño Consumidor*).[56]

These arrangements allow Active Customers to adjust their consumption to lower their energy bills.

9.2 Roles and responsibilities

The Aggregator role was defined in Spanish legislation in June 2020. Regulatory changes to allow for independent Aggregators are expected in 2021.

The Balancing Service Provider (BSP) role has been defined by legislation; however, currently BSP is equal to the BRP but this will change once the independent Aggregator starts participating in balancing markets.

There is no defined role for parties offering Constraint Management services.

9.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) (called *Regulación Primaria in Spain)* is a mandatory service and is not remunerated.
- Automatic frequency restoration reserve (aFRR) (*Regulación Secundar*ia) has just opened to make storage, DSF and aggregation participation possible. Aggregated resources[57] connected to the distribution grid will also be able to participate in the auctions.[58] For the time being, aggregation is delivered by the energy Supplier but changes in 2021 are expected to include an independent Aggregator for 2022.
- Manual frequency restoration reserve (mFRR) (called *Regulación Terciaria in Spain)* has just made it possible for storage, DSF and aggregation to participate. Aggregated resources connected to the distribution grid will also be able to

[53] 1 calendar for the mainland region and 3 calendars for non-mainland regions.
[54] With a connection lower than 15kW
[55] https://www.idae.es/sites/default/files/estudios_informes_y_estadisticas/tarifas_reguladas_marzo_2020.pdf
[56] https://www.ree.es/es/actividades/operacion-del-sistema-electrico/precio-voluntario-pequeno-consumidor-pvpc
[57] The aggregated resources need to be of the same nature, i.e. either load or generation, a combination is not allowed.
[58] https://api.esios.ree.es/documents/574/download?locale=es

participate in auctions. In addition, the interruptible loads service (*servicio de interrumpibilidad*) traditionally allowed non-aggregated load participation but this service was discontinued in August 2020.

Adequacy services
There are no adequacy services in Spain yet.

Constraint management services
High voltage constraint management is handled by REE, the Spanish TSO. There is a *technical restriction market* (*mercado de restricciones técnicas*) to allow REE to take re-dispatch measures if required but market access is limited and excludes the participation of DSF and aggregation. During 2021, we expect changes which will allow storage, DSF and aggregation to provide these services.

There is no immediate need for medium and low voltage constraint management but this is expected to change in the future. Amongst other innovation projects around this topic, the IREMEL project[59] aims to demonstrate a local flexibility market. Ultimately, in this type of market, DSOs would request congestion management services from Aggregators.

Wholesale
At present, DSF and aggregation are only possible within the BRP portfolio.

9.4 Aggregator implementation models

The role of independent Aggregator has been recently approved in Spain but further regulation needs to be defined to enable its market participation. Until then, aggregated DSF is only possible via the energy Supplier.

Services	Model	Notes
Wholesale	Integrated	
aFRR, mFRR	Integrated/Broker	In the Broker model, the aggregator (BSP) would delegate the balance responsibility to the $BRP_{SUP.}$

Table 8: Aggregation Implementation Models implemented in Spain

9.5 Value stacking

The option to offer balancing services with a pool of aggregated assets has been recently approved. However, combining assets of different nature (i.e. demand and load) is not allowed yet.
The opening of balancing services is in an early stage so it is not yet clear whether value stacking will be feasible.

[59] https://www.omie.es/es/proyecto-iremel

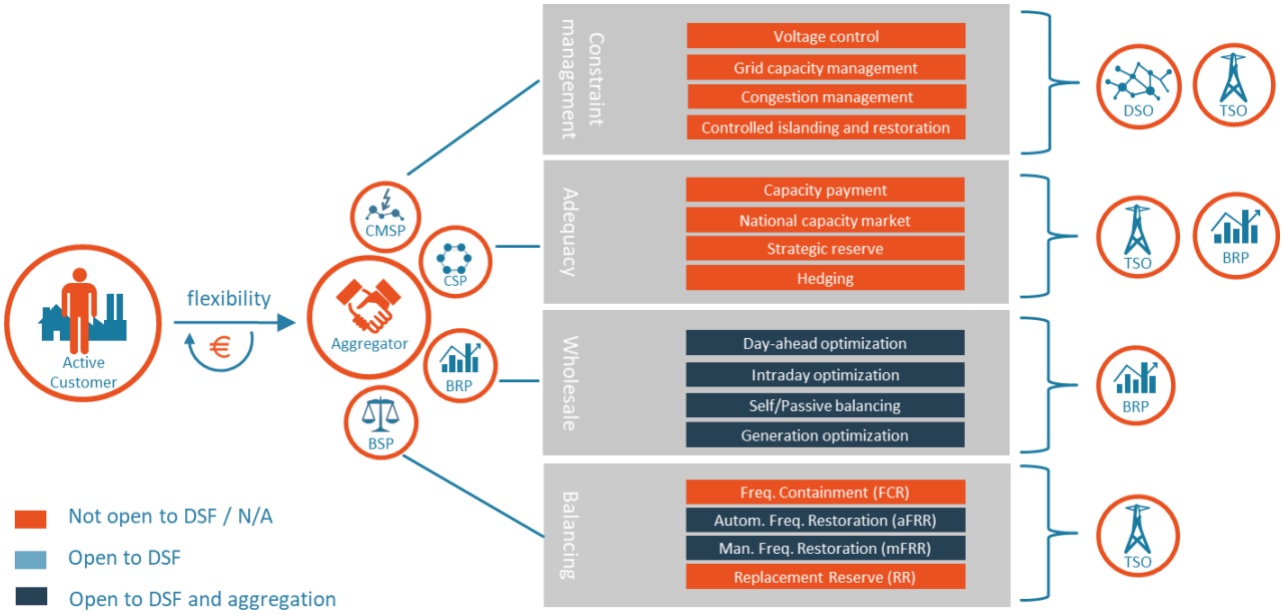

Figure 11: Overview of flexibility services in Spain

10 Switzerland

10.1 Implicit flexibility services

The Swiss transmission tariff has flat volumetric and capacity components for transmission-connected Active Customers.[60]
In Switzerland, the supply and distribution are bundled, i.e. Active Customers do not have the option to choose a supplier, but this will change in future with the liberalisation of the electricity market.[61]
The combination of distribution and supply charges is highly volumetric and dependent on location.[62] There are flat and peak/off-peak tariff options, depending on the Active Customer type.
This situation does not provide much scope for Active Customers to optimize their consumption.

10.2 Roles and responsibilities

The Aggregator role is not yet defined in Swiss legislation. Currently, Aggregators act as *Ancillary Service Providers* or *virtual generation units*. The role of Balancing Service Provider(BSP) is performed by the *Ancillary Service Provider*.

10.3 Explicit flexibility services

Balancing services

- Frequency containment reserve (FCR) (*Primärregelleistung*) is open to DSF and independent aggregation. Distributed resources can also participate in this service.
- Automatic frequency restoration reserve (aFRR) (*Sekundärregelleistung*) is open to DSF and independent aggregation. Distributed resources can also participate in this service.
- Manual frequency restoration reserve (mFRR) and Replacement Reserves (RR) (*Tertiärregelleistung*) are open to DSF and independent aggregation. Distributed resources can also participate in this service.

Adequacy services

There are not yet adequacy services in Switzerland.

Constraint management services

Constraint management at transmission level is handled by Swissgrid via grid reconfiguration and non-market-based redispatch. Where redispatch is used, Swissgrid intervenes in the power plant deployment and directs some of the generating units to increase or decrease their production. This arrangement does not allow for the participation of DSF or aggregation.

At distribution level, some areas in Switzerland are expected to suffer future congestion due to renewables generation and so there are several local flexibility markets projects and pilots underway, e.g. the Romande Energie smart grid project.[63]

Wholesale

Aggregated DSF can be traded day-ahead via the Supplier's BRP but this service is not yet open to independent aggregation.

10.4 Aggregator implementation models

Independent Aggregators can serve balancing markets via a regulated framework. Wholesale market participation by independent Aggregators is under consideration.

Services	Model	Notes
Wholesale	Integrated	

[60] https://www.swissgrid.ch/en/home/customers/topics/tariffs.html#tariffs-and-remunreation
[61] https://www.swissinfo.ch/eng/liberalisation-_government-sticks-to-plans-to-open-electricity-market-/45261176
[62] https://www.strompreis.elcom.admin.ch/Map/ShowSwissMap.aspx
[63] https://www.strommarkttreffen.org/2019-04-10_Spicker_Local_Flexibility_markets-new_role_for_TSOs_and_DSOs.pdf

FCR **aFRR** **mFRR**	Integrated, Contractual or Central Settlement	If the Aggregator and the Supplier have an agreement, the contractual model or integrated model applies. If not, the central settlement model applies. For the latter, the transfer of energy price is the day-ahead spot price (swissix exchange stock price for applicable 15-min period).

Table 9: Aggregation Implementation Models implemented in Switzerland

10.5 Value stacking

Pooling is allowed in balancing markets. The pool concept was introduced in Switzerland in 2013. It enables prequalification and participation in the balancing market by consolidating small generating units and flexible loads that would not meet the requirements individually.

Dynamic pooling is allowed since the Aggregator assigns the activated assets ex-post. This requires a baseline per asset. For small assets (in the residential sector in particular), it is possible to group multiple assets into a single asset (*EZE - Erzeugungseinheit*) with a single baseline. Where this occurs, the Aggregator is also responsible for assets that were not activated.

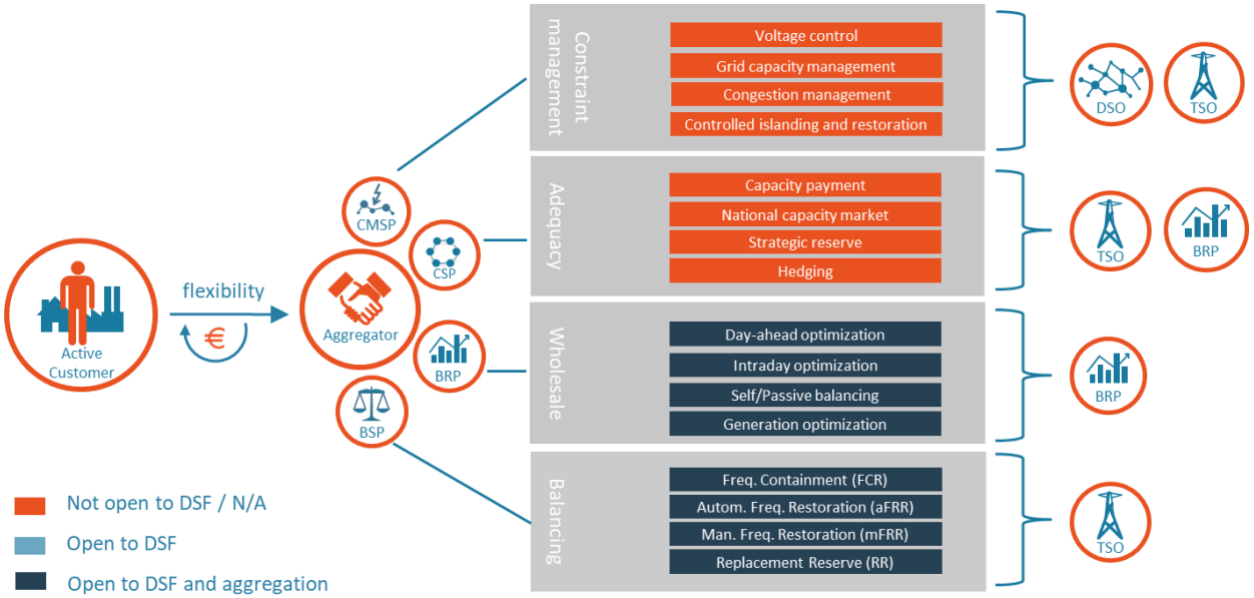

Figure 12: Overview of flexibility services in Switzerland

11 Overview

- In general, network tariffs are peak/off-peak tariffs based on energy volume.
- Very few tariffs offer dynamic pricing or advanced ToU, especially to the residential segment.
- Most countries have implemented the Aggregator and Balancing Service Provider roles. Few countries have implemented the Capacity Service Provider (Great Britain, Belgium, and France) and Constraint Management Service Provider roles (potentially the Netherlands).
- All countries are starting to open up balancing services to DSF and aggregation. However, the participation of distributed resources in those services is still not allowed in some countries.
- Day-ahead and intraday trading are mainly possible via the integrated model or, in some cases, are contractual. Only France allows (independent) aggregation to trade in the wholesale market, via the NEBEF mechanism., but soon Belgium will follow.
- Four countries have capacity services in place – France, Germany, Great Britain and Finland - and (theoretically) allow DSF participation.
- Constraint management services for the TSO are not generally open to DSF.
- Constraint management services for the DSO are still at trial stage in most countries. In Great Britain and the Netherlands, these services are more developed and allow the participation of DSF and aggregation.
- The overview below shows a lack of standardisation across Aggregator role implementation and, in most countries, the need for some sort of contractual relationship with the Supplier.

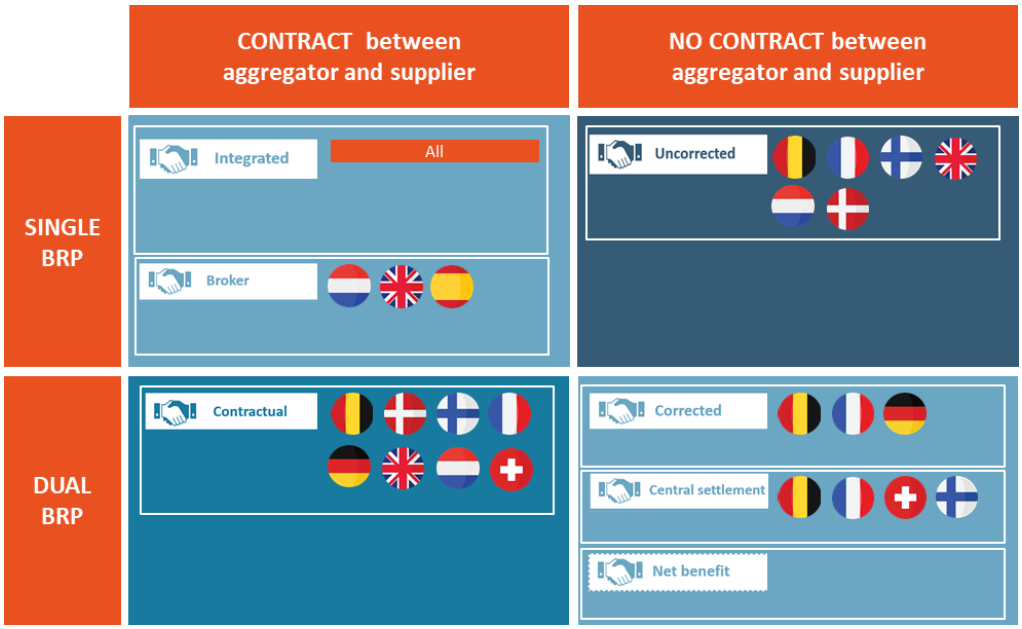

Figure 13: Overview aggregator implementation models per country

Abbreviations

AGR	Aggregator
BRP	Balance Responsible Party
BSP	Balancing Service Provider
BSP-IA	Balancing Service Provider – Independent Aggregator model
CEP	Clean Energy Package
CMSP	Constraint Management Service Provider
CSP	Capacity Service Provider
DA	Day-ahead
DF	Distributed flexibility
DSF	Demand-side flexibility
DR	Demand Response
DSO	Distribution System Operator
FRP	Flexibility Requesting Party
FVC	Flexibility Value Chain
IA	Independent Aggregator
ID	Intraday
ISP	Imbalance Settlement Period
ISR	Imbalance Settlement Responsible
RTP	Real Time Pricing
ToE	Transfer of Energy
ToU	Time of Use
TSO	Transmission System Operator
USEF	Universal Smart Energy Framework