





USEF & Jedlix 📕 Case study: practical deployment of electric vehicle flexibility

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# Table of Contents

Table of Contents						
1	1 Introduction					
2	EV s	mart charging landscape	5			
	2.1	The Flexibility Value Chain	5			
	2.2	Aggregation Implementation Models	7			
3	Мар	ping of EV flexibility services on the Flexibility Value Chain and				
	Aggregation Implementation Models					
	3.1	Local Optimization Services	9			
	3.2	Constraint Management Services	10			
	3.3	Adequacy Services	11			
	3.4	Wholesale Services	13			
	3.5	Balancing Services	14			
4	Discussion of current EV deployments					
	4.1	Summary of current deployments of Jedlix	16			
	4.2	Reflection on the EV landscape and AIMs applied	16			
	4.3	Reflection on the use of measurement data and baseline methodologies	17			
	4.4	Concluding remarks	18			
Bibliography						

# 1 Introduction

Electric mobility is bringing revolutionary change to the current energy market. The adoption of Electric Vehicles (EVs) is growing rapidly, with the associated charging infrastructure continuously rolled out. As the uptake of EVs increases, so does the electricity grid load and, therefore, the potential need for grid reinforcement. Utilizing the flexibility available in EV charging processes could help to limit, or avoid, some of the reinforcement requirements and therefore costs. EVs are considered to offer a comparatively large amount of flexibility and this could be used to provide multiple flexibility services; for example, constraint management. It is therefore unsurprising that Demand-Side Flexibility (DSF) is increasingly being applied to control charging processes as the EV industry grows.

This paper discusses current utilization of EV flexibility based on the practical deployments of Jedlix, an Aggregator focused specifically on EV flexibility. Jedlix is a Dutch company that is already established in the Netherlands as a smart charging industry frontrunner and its EU expansion is ongoing.

The application methods applied to smart charging to unlock flexibility are diverse<sup>1</sup> and depend on: the different parties involved, charging locations, control methods applied, and type of flexibility services targeted. The flexibility opportunities offered by the EV smart charging landscape as a whole can therefore be considered to be extensive. In the second chapter of this paper, we provide insight about the different ways flexibility can be deployed based on USEF's Flexibility Value Chain, which describes in detail the multiple services an Energy Service Company (ESCo) or Aggregator can offer.

In addition to USEF's Flexibility Value Chain, Chapter 2 introduces a range of Aggregation Implementation Models (AIMs) which can be applied in practice. The AIMs categorize the relationship between the Aggregator and the Supplier (and its Balance Responsible Party (BRP)), which is responsible for the supply of energy to the Prosumer. Relationships can differ; for example, the Aggregator and the Supplier may have a contractual arrangement; or the Aggregator may operate independently. In the latter scenario, regulatory arrangements can be applied to compensate the Supplier (and its BRP) for any deviations from the 'normal' energy consumption pattern resulting from DSF activation.

Chapter 3 focuses on the smart charging applications applied in practice. Insight is provided about *which* flexibility services are currently offered and *what* the relationship typically is between the Aggregator and affected Supplier for each of these services. To this end, the current Jedlix deployments are categorized based on USEF's Flexibility Value Chain and Aggregation Implementation Models.

To further shape the Aggregator role, and integrate flexibility into all markets and products, requires solutions which address multiple complexities<sup>2</sup>. As well as summarizing the main findings, the final chapter of this paper considers some of these complexities to further stimulate the current and future EV flexibility deployment across all EU markets and products.

<sup>&</sup>lt;sup>1</sup> The focus in this paper is on grid-to-vehicle, vehicle-to-grid applications are out-of-scope (as these are not yet applied on a large scale).

<sup>&</sup>lt;sup>2</sup> Seven of these complexities were identified in the USEF Workstream on Aggregation Implementation Models [3].

# 2 EV smart charging landscape

This chapter describes the EV smart charging landscape by addressing the individual roles of the parties involved in unlocking EV flexibility and mapping them on to the USEF Flexibility Value Chain (FVC). The FVC provides a complete overview of the needs of Flexibility Requesting Parties and the associated markets and products in which Demand-Side Flexibility (DSF) could potentially create value. The different Aggregation Implementation Models (AIMs) distinguished by USEF are then described to illustrate the possible differences in the relationship between the Aggregator (AGR) and the Supplier (and its BRP) responsible for supplying energy to the Prosumer. Both the FVC and AIMs are used in the subsequent chapter for the effective categorization of EV flexibility deployments, thereby providing insight about current practices.

## 2.1 The Flexibility Value Chain

## 2.1.1 Flexibility services and Flexibility Requesting Parties

Flexibility can provide value to different parties [1]:

- The *Prosumer* can use flexibility for in-home optimization, e.g. optimizing against variable energy and/or grid tariffs, or increasing self-consumption of own generation.
- The Supplier and its Balance Responsible Party (BRP) aim to reduce sourcing costs, maximize revenue of generation and avoid imbalance charges. Flexibility can help a Supplier/BRP optimize its portfolio.
- The *Distribution System Operator (DSO)* is responsible for the installation and maintenance of distribution grids. A DSO can use flexibility, e.g. to defer or avoid grid reinforcement costs.
- The *Transmission System Operator (TSO)* is responsible for the installation and maintenance of the transmission grid and for system stability. It may also, depending on national regulation, have responsibility for ensuring generation adequacy. The TSO can use flexibility for any of these purposes.

The Supplier/BRP, DSO and TSO are considered Flex Requesting Parties (FRPs). In an in-home optimization scenario, the Prosumer can use its flexibility to profit from incentives offered by the Supplier and/or the DSO. In Figure 2-1, the abovementioned parties can be found on the right-hand side, linked to the services relevant to them. Services are classified within five categories:

- 1. Local Optimization Services
- 2. Constraint Management Services
- 3. Adequacy Services
- 4. Wholesale Services
- 5. Balancing Services

More information on each of the services and categories can be found in the USEF Flexibility Value Chain white paper [1].

## 2.1.2 Control by

The local optimization services in category (1) are offered by the ESCo role, to enable Prosumers to profit from price fluctuations. In this scenario, the Supplier/DSO uses *implicit DSF* for flexibility requests. The services in categories (2)-(5) are offered directly to FRPs (*explicit DSF*) and so it is the AGR role that unlocks and maximizes the value of flexibility. To this end, the AGR establishes a contract with the Prosumer which sets out terms and conditions related to the use of his flexibility. As it is either the role of the AGR (explicit DSF) or the ESCo (implicit DSF) to control the load (or generation) to exploit the value of flexibility, both parties are listed in the 'control by' box in Figure 2-1.

#### 2.1.3 Roles of the other parties involved

As already discussed, unlocking the value of EV flexibility in the smart charging process requires ESCo or AGR involvement. The party taking the role may be a new (independent) market party or a party already active in the energy sector or EV charging process. The (smart) charging process typically involves several parties, e.g. the charging area or building owner, the car manufacturer, Charging Point Operator (CPO) or E-Mobility Service Provider (EMSP), and these are listed on the left-hand side of Figure 2-1. The CPO operates and maintains the charging infrastructure while the EMSP services direct customers, i.e. EV drivers, and so handles all communications and settlement with them. Depending on the charging situation, and the way control is applied, the roles of the 'other involved parties' may be mapped onto the USEF Flexibility Value Chain. For example, a party could be in the Prosumer role and potentially able to benefit from implicit DSF, or in the AGR role, unlocking and maximizing the value of flexibility. The rest of this paper discusses the roles of the different parties and scenarios in more detail.



Figure 2-1: This figure illustrates the EV smart charging landscape. The Prosumer and the FRPs can be found on the right-hand side, linked to relevant categories of flexibility services. The roles of the ESCo and AGR can be found in the 'control by' box, as parties responsible for optimizing the flexible load for the respective implicit and explicit DSF. The charging process can be controlled in multiple ways, as indicated in the 'control via' box. The market parties typically involved in (smart) charging processes and able to adopt various roles to unlock EV flexibility are listed on the left-hand side.

#### 2.1.4 The Prosumer role in different charging situations

The list below describes the three most common EV charging situations and indicates which party typically holds the contract with the Supplier and, hence, is in the role of the Prosumer:

- Charging @ home: for home charging, the Prosumer is typically a residential end-user and the driver of the EV, able to profit from flexibility by, e.g. choosing a variable or time-of-use supply tariff.
- Charging @ charging areas or (office or public) buildings: for charging at charging areas, office or public buildings, it is typically the charging area or building owner that adopts the role of Prosumer and can directly benefit from implicit DSF by, e.g. applying kW<sub>max</sub> control to reduce the maximum load and thereby reduce connection capacity costs.

Charging @ public points (curb side parking): for charging in public areas, it is typically the CPO who holds the contract with the Supplier<sup>3,4</sup> and, therefore, adopts the role of Prosumer. When the roles of CPO and EMSP are combined, the CPO buys and consumes the energy itself (and settles with the EV driver accordingly). For roaming (CPO ≠ EMSP), the CPO settles with the EMSP, who will then settle with the EV driver accordingly.

### 2.1.5 Control via

The three different approaches to controlling EV charging processes are detailed below and also illustrated in the 'control via' box in Figure 2-1.

- The charging process can be controlled via the charging point, with control signals coming from the CPO. The CPO could be involved as the messenger, passing through the control signal coming from an ESCo or AGR, or could take the role of ESCo or AGR himself.
- II. The charging process can be controlled via the car itself, with control signals coming from the car manufacturer. The car manufacturer could be involved as the messenger, passing through the control signal coming from an ESCo or AGR, or could take on the role of ESCo or AGR himself.
- III. The charging process can be controlled by a Home- or Building Energy Management System (HEMS or BEMS), which typically sends signals to the charging point. The HEMS or BEMS is typically serviced by an ESCo or AGR.

The communication standards and protocols used by the different parties involved in the smart charging process depend on the way control is applied. More information on EV related protocols can be found in the EV Related Protocol Study of ElaadNL [2].

### 2.2 Aggregation Implementation Models

For explicit DSF, the AGR offers flexibility services to the FRPs. As previously discussed, different parties can adopt the AGR role (e.g. the CPO, EMSP or another (independent) market party) and the way control is applied can differ per situation. Additionally, smart charging deployments can be distinguished by differences in the relationship between the AGR and the Supplier (and its BRP) responsible for the energy supply to the Prosumer. For example, both parties could have a contractual agreement or the AGR could operate independently. In the latter situation *Transfer of Energy* (ToE) could be applied to compensate the Supplier for the effects of DSF activation, thereby neutralizing: *(i) the energy position of the Supplier;* and *(ii) the balancing position of its BRP*, from the impact of DSF activation by the AGR. If, and how, ToE is arranged differs per AIM. The different AIMs classified in the USEF Aggregator Workstream [3] are shown in Figure 2-2, and briefly introduced in the list below.



Figure 2-2: Seven Aggregation Implementation Models classified in the USEF Aggregator Workstream [3].

<sup>&</sup>lt;sup>3</sup> To enable the EMSP to hold a contract with the Supplier, contracts with multiple Suppliers or Supplier switches (multiple per day) on a single connection must be allowed. The first is allowed in the Netherlands ('meerdere leveranciers op één aansluiting (MLOEA)'), although it does require additional meter equipment, while the second is under consideration. It could therefore be possible in the future that the EMSP holds both the contract with the Supplier and takes on the role of Prosumer.

<sup>&</sup>lt;sup>4</sup> There are exceptions to this situation. In the Netherlands, there are examples of another party holding the contract with the Supplier, e.g. the municipality (as owner of the charging point) holding the contract with the Supplier.

- In the *integrated* model, the AGR and Supplier/BRP roles are combined as a single market party. In the *broker* model, the AGR is a separate market party from the Supplier/BRP but both parties have a contractual relationship in which they agree their roles and responsibilities. Note that in the *integrated* model, the AGR can only serve Prosumers that are connected to the specific Supplier/BRP while, in the broker model, the AGR can interact with multiple Suppliers/BRPs to serve a broader range of Prosumers.
- In the uncorrected model, the AGR and Supplier have no contractual relationship. The AGR does not have its own BRP and so Transfer of Energy is not applied, as a result activation of DSF will result in imbalance for BRP<sub>sup</sub>.
- In the *contractual* model, the AGR and Supplier assign their own BRP and have a contractual relationship which defines the responsibilities of BRPs, AGR and Supplier, including all interactions and settlement between parties. Transfer of Energy is typically arranged via ex-post nominations between BRP<sub>sup</sub> and BRP<sub>agr</sub>.
- In the *corrected* and *central settlement* model, the AGR and Supplier have no contractual relationship and both parties have their own BRP. In the *corrected* model, ToE is applied through administrative correction of the Prosumer's meter (affecting BRP<sub>sup</sub>) and perimeter correction for BRP<sub>agr</sub>. In the *central settlement* model, ToE is arranged via perimeter corrections of both the BRP<sub>sup</sub> and BRP<sub>agr</sub>. The same is true for the *net-benefit* model, however both models (*central settlement* and the *net-benefit*) differ in their ToE-price-methodology. Corrections are performed by a central authority, typically the Allocation Responsible Party (ARP).

The next chapter provides insight about which AIMs are applied in practice to unlock EV flexibility. The models will be linked to the different types of services (see Figure 2-1) offered by the AGR.

# 3 Mapping of EV flexibility services on the Flexibility Value Chain and Aggregation Implementation Models

This chapter describes current deployments of EV flexibility. Insight is provided about *which* type of flexibility services are offered and *what* the relationship is between the Aggregator (AGR) and the Supplier/BRP of the Prosumer. To this end, the current deployments of Jedlix, an AGR and one of the EV smart charging industry leaders, are categorized based on the Flexibility Value Chain and Aggregation Implementation Models introduced in the previous chapter.

## 3.1 Local Optimization Services

Current deployments of implicit DSF focus on profiting from time varying energy or grid tariffs, or limiting the capacity costs (through kW<sub>max</sub> control). The use of EV flexibility to increase self-balancing is limited because, in many EU countries, current regulations allow for net-metering in the residential segment.

The role of the ESCo, who offers the local optimization service, can be adopted by an (independent) market party although it is often performed by car manufacturers, CPOs or EMSPs, with control typically applied via the respective car or charging point. If another (independent) market party performs the role of ESCo, control can still be applied via the car or the charging point<sup>5</sup> but control signals may also be sent via a BEMS or HEMS.

Where kW<sub>max</sub> control is offered as a service by an ESCo, the use of a BEMS or HEMS is common. The BEMS/HEMS is typically connected to a smart meter and capable of retrieving real-time measurements from all connected loads. This measurement data serves as input to define the control signal for smart charging and other flexible assets available, e.g. a home battery.

Jedlix also offers implicit DSF services, for *charging @ home*. In this situation, implicit DSF and explicit DSF are combined so Jedlix adopts the roles of both ESCo and AGR. Where Prosumers have a time-varying tariff, these are considered in the optimization of the charging processes (ToU optimization). The flexibility is also optimized to offer services to the electricity (balancing) market (explicit DSF) and this is explained in subsequent sections.

The charging process can be controlled by Jedlix in two different ways, depending on the charging point (operator) and the type of car. Jedlix collaborates with multiple CPOs who allow Jedlix to control charging processes via the charging point, with the CPO involved as messenger. Jedlix also collaborates with car manufacturers in order to retrieve information about the car (e.g. state-of-charge of the battery) which can then be used during the optimization process and/or to control the charging process via the car. Jedlix's practical deployments are illustrated in Figure 3-1.

<sup>&</sup>lt;sup>5</sup> With the car manufacturer or CPO involved as messenger.



Figure 3-1: Illustration of the EV smart charging landscape. The local optimization services typically applied in practice by Jedlix are highlighted, as are the parties that are typically involved in offering the service(s).

#### 3.2 Constraint Management Services

Current deployments which include DSO constraint management services mainly focus on congestion management and are on a small (pilot) scale. To serve the DSO, Jedlix is involved in several projects in which the USEF framework [4] is used to enable a direct trade between the AGR and DSO<sup>6</sup>. In these projects, Jedlix informs the DSO about the expected controllable<sup>7</sup> EV load in the congestion area. This is done by sending a day-ahead D-prognosis to the DSO [4]. Where there is high risk of congestion, it can be mitigated by both parties trading flexibility. If flexibility is traded, the D-prognosis is adjusted according to the trade and serves as a baseline for the validation of product delivery.

To realize the flexibility trade, Jedlix controls the charging process by sending control signals to the CPOs involved. The projects include public charging points and a group of charging points in a public parking garage. Where an EV is connected to a charging point, the CPO validates whether the EV-driver has a contract with Jedlix<sup>8</sup>. If this is the case, Jedlix is informed and will receive (close to real-time) data from the CPO which includes data from the submeter (5 min. resolution) within the charging point. The aggregated submeter data (of all controllable EV load in the congestion area) is used by the DSO to validate Jedlix's product delivery, by comparing the aggregated load to the baseline, i.e. the D-prognosis.

Generally, each public charging point has its own main meter and meter identifier (EAN code), as well as a submeter per socket (most points have two sockets). Submeter (not main meter) data is typically used for product delivery validation for two reasons: i) the main meter is not always a smart meter. The initial design of public charging points in the Netherlands does not yet include a smart meter<sup>9</sup>; ii) the submeter data considers car-specific data. If main meter data is used, Jedlix's D-prognosis would need to consider the load of all EVs (including the uncontrollable ones) connected to the charging point which could lead

<sup>&</sup>lt;sup>6</sup> Amongst others in the Interflex and Smart Solar Charging (Lombok Utrecht) project EV flexibility has been used to solve congestion problems. <sup>7</sup> Controllable by Jedlix.

<sup>&</sup>lt;sup>8</sup> Based on the EMSP-card number (see: OCPI protocol [2]).

<sup>&</sup>lt;sup>9</sup> Some of the charging points involved in the constraint management services projects conducted by Jedlix are of this type.

to undesirable baseline deviations. Note that, although the aggregated submeter data is used by the DSO for product delivery validation, the DSO could use the smart meter (if available) to perform additional controls to assess the quality of the measurements and baseline<sup>10</sup>.

In the above mentioned projects, the affected Supplier/BRP is not involved, and there is no correction for it, so the *uncorrected model* is applied for congestion management. Figure 3-2 gives an overview of the constraint management services applied in practice and the parties involved in offering the services.



Figure 3-2: Illustration of the EV smart charging landscape. The constraint management services applied in practice by Jedlix are highlighted, as are the parties involved in offering the service(s).

#### 3.3 Adequacy Services

Capacity mechanisms differ throughout the EU. For example, in France, there is a national capacity market which is open for aggregation and DSF while, in Finland, flexibility can be used to offer strategic reserves [5]. To exploit the value of EV flexibility for adequacy services, Jedlix is developing a solution for the French national capacity market. By cooperating with a Capacity Service Provider (CSP), Jedlix is able to add its flexibility to the CSP's portfolio, allowing it to enter the market without reaching the minimum capacity required for market participation. Before entering the market, the CSP's portfolio must be certified (i.e. a prequalification of assets) and, to this end, RTE (the French TSO) performs audits and can perform additional controls during active market participation [6].

Jedlix will only use smart *charging @ home* for adequacy services in France. It is collaborating with multiple car manufactures to achieve this as control is applied via the car, with the car manufacturers involved as messenger. Control for *charging @ public areas* is not (yet) in scope due to the more fragmented landscape<sup>11</sup> in France, where there are many different small parties involved (charge point owners, CPOs and EMSPs) and many exceptions to the party adopting the role of Prosumer (and holding the contract with the Supplier).

<sup>&</sup>lt;sup>10</sup> According to USEF the DSO could send a request for smart meter data to the Meter Data Company (MDC) in the settlement phase.

<sup>&</sup>lt;sup>11</sup> Compared to e.g. the situation in the Netherlands.

The RTE capacity mechanism is based on capacity certificates which dictate that CSPs place bids on the wholesale or balancing markets on dedicated days (i.e. days with peak periods [6]). Product delivery of explicit DSF is validated using the NEBEF mechanism which has been in place since 2015 and enables independent aggregation [7]. The NEBEF mechanism allows for multiple methods of DSF validation and Transfer of Energy. The selected methods are typically tailored to the specific situation and, therefore, are dependent on the entity<sup>12</sup> and/or type of flexible assets involved.

It is expected that the process for Jedlix will require that it provides RTE with a list of meter identifiers for participating households. Smart meter data from the households will be used (and provided by the DSOs to the TSO) to validate product delivery. The baseline method applied is expected to be 'double reference rectangle', where meter data from before and after the activation period is used to validate whether the product was actually delivered [7]<sup>13</sup>. RTE will be responsible for correcting the position of the affected Suppliers/BRPs. The model used by RTE for the Transfer of Energy (ToE) in this situation is the *central settlement model*<sup>14</sup>. As it involves 'profiled sites', i.e. residential Prosumers with a smart meter, RTE will calculate the price used for the ToE based on the energy supply costs of the residential connections involved, with tariffs defined by the regulator.

In Figure 3-3 an overview is provided of the adequacy services to be applied in practice by Jedlix and the parties involved in offering the services.



Figure 3-3: Illustration of the EV smart charging landscape. The adequacy services to be applied in practice by Jedlix are highlighted, as are the parties involved in offering the service(s).

<sup>13</sup> Note that the meter data in this situation also includes the non-controllable load of each household, this could lead to unexpected deviations with respect to the baseline. Depending on the situation and the direction of these deviations, the effects could be positive (e.g. if the AGR comes short and the deviation is in the right direction) or negative (e.g. if the deviation is in the opposite direction).

<sup>&</sup>lt;sup>12</sup> An entity can consists of connections to different DSOs or to RTE, with different Supplier/BRPs involved, and with different financial settlement models [7].

<sup>&</sup>lt;sup>14</sup> This model is referred to as the *regulated model* by NEBEF [7]. The regulated model is typically applied when the Prosumers involved are connected to the distribution grid.

### 3.4 Wholesale Services

Currently, Jedlix is using EV flexibility for day-ahead optimization and passive-balancing in different EU countries. These services are highlighted in Figure 3-4.

In the Netherlands, as in most EU countries, there is not (yet) a regulatory framework to accommodate the Transfer of Energy. Unlocking the value of EV flexibility for wholesale services therefore requires that an AGR, like Jedlix, has a contract with the affected Supplier and its BRP. As a result, the AIM model is the *broker model*.

Jedlix has contracts with multiple Suppliers/BRPs in order to serve a broader range of Prosumers. The contractual agreement sets out the terms and conditions for the price, baseline methodology and data exchange. The baseline methodology in this situation is based upon the typical characteristics of an EV charging session and the load profile of an uncontrolled charging session is approximated. The effect of DSF activation is ultimately validated by comparing this baseline to the measurement data - which is based on a 5 min. resolution.

Smart charging is applied to both *charging @ public areas* and *charging @ home* situations. Depending on how control is applied, the measurements used for product validation are provided by either the charging point (via the involved CPO) or from the car (via the involved car manufacturer). Note that control is only applied where Jedlix has a contract with the Prosumer's Supplier/BRP. For *charging @ home*, this is the residential household's Supplier/BRP and, for *charging @ public areas*, this is typically the CPO's Supplier/BRP. The service agreement Jedlix has with the EV driver is independent of its contract with the different Suppliers/BRPs<sup>15</sup>.

In addition to the Netherlands, Jedlix is also active on the wholesale market in France, through cooperation with multiple BRPs. The cooperation is based on the type of contractual agreement described above and so the *broker model* is applied. Due to the more fragmented landscape in France, control is only applied to *charging @ home* situations (with multiple car manufacturers involved).

Note that France is the only country in the EU that enables independent aggregation on wholesale markets. Although not (yet) applied by Jedlix, the NEBEF mechanism makes it possible for Jedlix, and its BRP, to use the EV flexibility from multiple prosumers, regardless of their Supplier/BRP. If independent aggregation is applied, the sourcing of energy through Transfer of Energy is facilitated by RTE using the same baseline methodology and AIM described in section 3.3 - where the quantification of DSF volumes is based on smart meter measurements both before and after the activation period, and the *central settlement model* is used for remuneration of the affected Suppliers/BRPs.

<sup>&</sup>lt;sup>15</sup> In some situations, the EV driver has a contract with the car manufacturer to apply smart charging. In this situation, the car manufacturer assigns Jedlix to optimize the charging processes and maximize the value of the flexibility.

#### USEF & Jedlix E Case study: practical deployment of electric vehicle flexibility



Figure 3-4: Illustration of the EV smart charging landscape. The wholesale services typically applied in practice by Jedlix are highlighted, as are the parties involved in offering the service(s).

#### 3.5 Balancing Services

Balancing markets throughout the EU are increasingly opening up for aggregated decentralised assets, like EVs [8]. In the Netherlands, Jedlix is using EV flexibility for balancing services based on two different AIM models.

In the first scenario, Jedlix is cooperating with a BRP, who also performs the role of Balancing Service Provider (BSP), in the *broker model*. The EVs flexibility is added to the BSP/BRP portfolio and used to place voluntary bids in TenneT's (Dutch TSO) aFRR market. Note that flexibility is limited to charging situations where the Prosumer holds a contract with the specific Supplier/BRP offering the service to the market.

To validate product delivery, the BSP is required to provide TenneT with measurement data and a nominated baseline (i.e. a forecast of the expected load/generation for the upcoming minute) every 4 seconds. The baseline is based on the BRP 'e-program' and any planned deviations. The e-program is the day-ahead nomination that results from wholesale market operations. In practice, only 5 min. measurements are available (coming either from submeter in the charging pole or car) so Jedlix uses a predefined algorithm to translate measurements to a 4 second signal, an approach which has been validated by TenneT. Ex-post, the 5 min. measurements are also communicated to TenneT and used to quantify the delivered aFRR volumes. Note that TenneT can also use smart meter data from the related charging points and households<sup>16</sup> (if available) to perform additional controls to assess the quality of the measurements and baseline.

In the second scenario, Jedlix is cooperating with a BSP to implement a BRP independent aFRR balancing service as part TenneT's pilot project. Day-ahead, a list of meter identifiers (i.e. the pool configuration of charging points and households) is provided to TenneT which uses it to inform the affected Suppliers/BRPs. In this situation, the nominated baseline is provided by Jedlix and established based on the expected (uncontrolled) load profiles of the EVs, one minute in advance. Product validation is based on the same measurements and algorithms for the 4 seconds signals described above. Jedlix and the BSP are remunerated based on the quantified volumes; these are also used to correct the perimeter of the affected BRPs, thereby

<sup>&</sup>lt;sup>16</sup> To be able to compare these measurements to the submeter measurements, they need be corrected for the uncontrollable load.

correcting their balancing position. TenneT does not facilitate Transfer of Energy (ToE) but it is possible for the Supplier to arrange ToE itself, via the Prosumer. The AIM model in this situation mostly resembles the *corrected model*. Another option is that ToE is arranged bilaterally, via the BSP and affected Supplier. Where this happens, the AGR/BSP will likely have a contract with the affected BRP<sub>sup</sub>. The AIM model in this situation mostly resembles the *contractual model*<sup>17</sup>. When ToE is not arranged, the situation could be referred to as a 'freeride-model', where the AGR does not source energy but is remunerated for the energy sold to TenneT.

The balancing services typically applied in practice by Jedlix, and the parties involved in offering them, are highlighted Figure 3-5.



Figure 3-5: Illustration of the EV smart charging landscape. The balancing services typically applied in practice by Jedlix are highlighted, as are the parties involved in offering the service(s).

<sup>&</sup>lt;sup>17</sup> This situation, in which the AGR compensates the affected BRPs based on bilateral agreements, is currently also practiced in the TenneT's mFRR market.

# 4 Discussion of current EV deployments

The previous chapters described the EV smart charging landscape and focused on the flexibility services and Aggregation Implementation Models (AIMs) currently applied by Jedlix in practice. This final chapter summarizes the main findings and discusses some of the complexities encountered in relation to: the number of parties involved in smart charging processes, the opportunities for independent aggregation, the baseline methodologies applied, and measurement data used. Multiple considerations are made about how to further stimulate unlocking of EV flexibility across all EU markets and products.

#### 4.1 Summary of current deployments of Jedlix

The EV smart charging landscape is considered to be extensive. Due to the number of parties typically involved, different types of control that can be applied and various types of flexibility services that can be offered. Chapter 2 of this paper discussed the landscape in detail, and Chapter 3 described current Jedlix deployments and categorized them based on USEF's Flexibility Value Chain and Aggregation Implementation Models. The flexibility services currently offered by Jedlix in the Netherlands and France are summarized in Table 4-1 below. Note that, where the Prosumer is exposed to variable tariffs, Jedlix can offer a combination of these services with implicit DSF (ToU optimization services).

Flexibility Service	Country	Control via	AIM	Baseline methodology
Constraint management	NL	Charging point	Uncorrected	D-prognosis (USEF)
Adequacy services	FR	Car	Central	Double reference rectangle (RTE / NEBEF)
Wholesale services	NL	Charging point, car	Broker	Based on charge session characteristics (bilateral)
	FR	Car	Broker	Based on charge session characteristics (bilateral)
Balancing services	NL	Charging point, car	Broker	Nominated baseline and measurements every 4 sec. (TenneT)
		Charging point, car	Different models*	Nominated baseline and measurements every 4 sec. (TenneT)

Table 4-1: Summary of flexibility services currently offered, or prepared to be offered, by Jedlix in the Netherlands and France.

\* Depending on if and how ToE is arranged. In practice applied models can be the broker, contractual or free-ride model.

## 4.2 Reflection on the EV landscape and AIMs applied

In the Netherlands, Jedlix is currently offering constraint management, wholesale and balancing services. With the communication standards and protocols in place, it is possible for Jedlix to collaborate with CPOs and control charging processes via charging points located in both public areas and homes. Jedlix also collaborates with car manufacturers to control the charging process via the car.

The Aggregation Implementation Model (AIM) applied for congestion management is the *uncorrected model* which has no Supplier/BRP involvement. To deliver both wholesale and balancing services, Jedlix is cooperating with multiple Suppliers/BRPs in the *broker model*, with flexibility used only in situations where the Prosumer (typically the CPO or residential end-user) holds a contract with the affected Supplier/BRP. As there is not (yet) a regulatory framework in place that accommodates Transfer of Energy in the Netherlands, it is only possible to offer wholesale services via the *integrated* or *broker model*. TenneT's (Dutch TSO) ongoing aFRR pilot may open up methods of independent aggregation for the delivery of balancing services. Jedlix is participating in this pilot, in cooperation with a BSP, to explore these possibilities.

In France, Jedlix offers wholesale services and is preparing to offer adequacy services. The (smart) *charging @public areas* landscape is more fragmented in France than the Netherlands and involves many different small parties, and many exceptions to the party adopting the Prosumer role (and holding the contract with the Supplier). As a result, Jedlix only controls charging processes via the car for *charging @ home* where the residential end-user holds the contract with the Supplier.

To offer adequacy services, Jedlix cooperates with a Capacity Service Provider (CSP) for independent aggregation of all Prosumer flexibility (regardless of the Supplier/BRP involved), with Transfer of Energy arranged by RTE (French TSO) based on the *central settlement model*. Independent aggregation for wholesale services is also possible in France although not (yet) used by Jedlix as it only offers wholesale services in cooperation with multiple Suppliers/BRPs in the *broker model*.

It can be concluded from the above situations that a more fragmented EV landscape can form barriers to the use of EV flexibility. In France, the use of EV flexibility by Jedlix is limited to *charging @ home* and control via the car<sup>18</sup> while, in the Netherlands, it also applies to *smart charging @ public areas*. Use of EV flexibility can also be limited as a result of the AIM applied. If independent aggregation is possible, the flexibility of all Prosumers can be used (regardless of the affected Supplier/BRP). Independent aggregation is currently used by Jedlix to offer aFRR services to TenneT in a pilot setting. In France, the different markets are fully open for independent aggregation and the NEBEF mechanism prescribes how Transfer of Energy is to be arranged. For wholesale services, Jedlix is not (yet) exploiting independent aggregation in France. It is cooperating with Suppliers/BRPs in the *broker model*, as this provides an opportunity to enter the market with an EV portfolio of that does not necessarily reach the minimum capacity required for market participation. It is expected that use of independent aggregation to unlock the value of EV flexibility will increase as EV adoption grows.

## 4.3 Reflection on the use of measurement data and baseline methodologies

To validate product delivery, measurement data is compared to the baseline. The measurement data used, and baseline methodology applied, differs per flexibility service type. Measurements from the submeter (in the charging point) are used<sup>19</sup> to validate delivery of constraint management services. The baseline methodology used by Jedlix for constraint management services is based on the expected day-ahead uncontrolled load profile (D-prognosis). As the number of simultaneous charging sessions in a specific congestion area is typically limited to tens, the expected load and flexibility is hard to predict, so the baseline becomes stochastic, which leads to undesirable deviations between the baseline and measurement data. As a result, it can be concluded that a D-prognosis established day-ahead is not a suitable baseline to quantify EV flexibility. To improve accuracy, other methods could be considered; e.g. the methods currently used by Jedlix to validate the delivery of wholesale, adequacy or balancing services. The baseline methodology for wholesale services uses charging session characteristics to approximate the load of the uncontrolled charging session. The baseline for adequacy services in France uses smart meter data before and after the activation period. The baseline for balancing services in the Netherlands uses a nominated baseline combined with a predefined algorithm<sup>20</sup>, to translate the available submeter data (5 min. resolution) into a 4 second signal. When considering other methodologies for the validation of constraint management services, they should be evaluated against different criteria; e.g. the opportunity to prevent gaming. Furthermore, a methodology should ascertain the desired timeline for requesting and/or activating flexibility. For example, DSOs might want to secure the use of the available flexibility earlier in time, so mechanisms such as drop-to could also be considered for congestion management. In this situation, the Aggregator is remunerated for the availability and required activations to keep the (aggregated) load or generation below or above an agreed limit [1]. The recently published USEF Flexibility Trading Protocol (UFTP) [9] accommodates the use of different baseline methodologies, in addition to the D-prognosis, for validation of constraint management services.

Based on the above, it can be concluded that the data available is sufficient for baseline methodologies currently applied in practice. Solutions are workable for all parties and do not require additional meter equipment but this would not be possible without the close collaboration of AGRs and Flex Requesting Parties. For example, Jedlix works closely with TSO's across Europe to streamline and harmonize these procedures and, as a result, limits or avoids costs for additional meter equipment because there is no need for a *split supply model* which requires an additional smart meter to distinguish between controllable and uncontrollable load. The *split supply model* is being discussed in some EU countries to stimulate (independent) Aggregators.

<sup>&</sup>lt;sup>18</sup> In France, many charging points installed at home are not (yet) connected to the back-office of a CPO.

<sup>&</sup>lt;sup>19</sup> In addition to the submeter data, the DSOs could use the smart meter data (if available) to perform additional controls to assess the quality of the measurements.

<sup>&</sup>lt;sup>20</sup> This algorithm has been validated by TenneT in practice.

## 4.4 Concluding remarks

The number of EVs is rapidly increasing and charging infrastructure is continuously being rolled out. As the volume of EVs increases, so does the need for DSF (e.g. for constraint management) and so the portfolios of AGRs focused on exploiting EV flexibility, such as Jedlix, are also growing rapidly. The types of markets and products targeted by Jedlix are also increasing. To open up markets and products for DSF, regulations and market mechanisms are transitioning. This paper has described how Jedlix is participating in pilot projects to further stimulate the use of EV flexibility to e.g. solve congestion in distribution grids or ensure system balance. While some market barriers have already been solved, others still require attention; in particular: the fragmented EV landscape, opportunities for independent aggregation, and the baseline methodology for congestion management. We hope that the situations described and considerations made in this paper can act as a guideline to further develop and harmonize flexibility services across the EU.

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