IMPACT ASSESSMENT OF DIFFERENT MODELS OF INDEPENDENT AGGREGATOR FINANCIAL RESPONSIBILITY AND COMPENSATION IN SWEDEN

Energimarknadsinspektionen

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EXECUTIVE SUMMARY

Sweden must transpose and implement a regulatory framework for independent aggregation, a new concept introduced in the latest version of the European Electricity Directive (2019/944) in the Clean Energy Package for Europeans (CEP) [1], which stipulates that all Member States should enable the role of independent aggregator (hereafter 'IA'), i.e. a *market participant engaged in aggregation who is not affiliated to the customer's supplier.*

The Energimarknadsinspektionen, i.e. the Swedish Energy Markets Inspectorate (hereafter 'Ei'), has started a project with the purpose of presenting the proposals and amendments needed in Swedish law to implement a model for independent aggregation in Sweden, according to NordREG's recommendations [2]. DNV GL was commissioned by Ei to support this activity.

This document describes and qualitatively assesses the impact of different models to allow for independent aggregation, and provides recommendations on which models DNV GL deems suitable for implementation in Swedish regulation.

After a first selection, the study presents the impact analysis on the following models: split-responsibility model, central settlement model and two variants of the corrected model. Based on a thorough qualitative analysis, the following recommendations are provided:

1. Implementing the split-responsibility model. This model has several benefits, as it can be generically applied, and can serve other purposes as well (e.g. efficiency improvement of the implementation of article 4 of the EC's Electricity Directive (2019/944)). The costs for implementation are relatively low, since it requires relatively few regulatory changes and relatively few changes in market processes and IT. However, this model has an impact on the consumer, especially in cases the consumer has self-consumption, and it also creates a market entry barrier for IAs serving large C&I consumers. In addition, additional metering costs may be an issue, which should be kept to a minimum, especially in the residential segment

2. Implementing a second model, either the Central Settlement Model or the Corrected model, next to the split-responsibility model. Implementing one of the two models may improve the level playing field for IAs for certain markets and technologies, in particular flexibility products/technologies that involve low activation frequencies. Implementing the Central Settlement Model or the Corrected model comes with additional costs, but these are merely one-off costs (regulatory changes and process/IT modifications with market players) that can further propel a mechanism with the potential to provide significant contribution to the energy transition.
   Out of the two alternative models, the Central Settlement Model may be the best option from the consumer perspective. This model requires a regulated Transfer of Energy price formula (i.e. the compensation for unmatched positions). This study recommends that this compensation should be at retail price level (excluding taxes). If the burden of a regulated price formula is too heavy, the Corrected Model ('separate specification' sub-model) may be the best choice.

INTRODUCTION

Background to this document

Sweden must transpose and implement a regulatory framework for independent aggregation, a new concept introduced in the latest version of the European Electricity Directive (2019/944) in the Clean Energy Package for Europeans (CEP) [1], which stipulates that all Member States should enable the role of independent aggregator (hereafter 'IA'), i.e. a *market participant engaged in aggregation who is not affiliated to the customer's supplier.*

During the spring of 2020, the Nordic Energy Regulators organisation (NordREG) approved a number of recommendations on how to implement the independent aggregation model in the Nordic countries [2]. NordREG does not present proposals for national law, since that is a task for each Nordic country. The Energimarknadsinspektionen, i.e. the Swedish Energy Markets Inspectorate (hereafter 'Ei'), has started a project with the purpose of presenting the proposals and amendments needed in Swedish law to implement a model for independent aggregation in Sweden, according to NordREG's recommendations. DNV GL was commissioned by Ei to support this activity.

Purpose of this document

Based on the NordREG report, Ei is considering implementing the *split-responsibility*[1] model to facilitate independent aggregators. The purpose of this study is to assess whether there are benefits in implementing one or more additional models to facilitate independent aggregation, by:

- Describing potential alternative models that meet the following requirements:
    - Allow for independent aggregation (i.e. not needing consent from or contract with the supplier of the customer);
    - Assign balance responsibility to the aggregator; and
    - Be suitable for accessing both balancing and wholesale markets (and preferably future products e.g. DSO congestion management)
- Assessing the impact of both the split-responsibility and alternative models on the main stakeholders
- Providing recommendations on compensation mechanisms for all models, to the extent needed
- Providing recommendations on which (if any) of the alternative models to implement, including justification.

The study should be based purely on economic / market analysis, not including legal assessments.

This document largely follows this structure: Section 1 describes the possible models and verifies these against the requirements. Section 2 discusses the compensation topic. Section 3 describes the impact of all identified models on the main stakeholders. Section 4 further analyses the models, before the final recommendations are presented in section 5.

[1] See the next section for a further description of this model

1 AGGREGATOR IMPLEMENTATION MODELS

The aggregator role has been implemented in several regulatory frameworks across the European Union, often providing facilities for independent aggregation (IA).

Next to the IA concept, Member States are implementing and formalising the Balancing Service Provider (BSP) role, as per Article 16 of the Electricity Balancing Guideline [3]. This development has triggered discussions on how the combination of the IA and BSP roles should be facilitated and whether IAs would have the same responsibilities acting in the balancing market as they should in other types of markets.

In this section we first present a review of the models to organise the aggregator role that the Universal Smart Energy Framework (USEF)[2] [4] identified in the Workstream on aggregator implementation models [5], based on the aforementioned developments. After describing the models, we perform an initial screening based on an initial assessment against the CEP requirements. The models resulting from the initial screening will be assessed further in the subsequent sections.

1.1 Model categorisation criteria

Aggregator Implementation Models can be classified based on the following criteria:

1. **Is there a contract between the aggregator and the customer's original[3] supplier?**

   This criterion categorises the models as *contractual* and *non-contractual*. It can be already anticipated that the contractual models will not be the focus of this study. However, it is useful to also understand the possible contractual models, since such models should always be possible next to independent (non-contractual) models[4] (market parties in deregulated markets have the freedom to trade with the counterparty of their choice).

2. **How is the balance responsibility organised?**

   As illustrated in Figure 1, there are two categories under this criterion: single balance responsible party (BRP) and dual BRP models. Models in which the aggregator delegates their balance responsibility to the supplier's BRP are called *single BRP models.* In *dual BRP models* the aggregator assigns its own BRP, independently from the original customer's supplier. The dual BRP model can be further split in two subcategories:

   2.1. Split balance responsibility: the balance responsibility for the connection is split in two fixed parts. One part consists of the asset(s) controlled by the aggregator, a second part for the remaining load (non-controlled assets).

2 The Universal Smart Energy Framework (USEF) is an open framework that present a market model for the trading and commoditisation of energy flexibility, and the architecture, tools and rules to make it work effectively. [4]

3 We use the term *original supplier* since one model has two suppliers. The original supplier is the party that was delivering energy to the customer / connection prior to the aggregator serving this customer.

4 If both parties agree that a bilateral contract is more appropriate for their particular situation than the regulated arrangement, they should have the option to exert it.

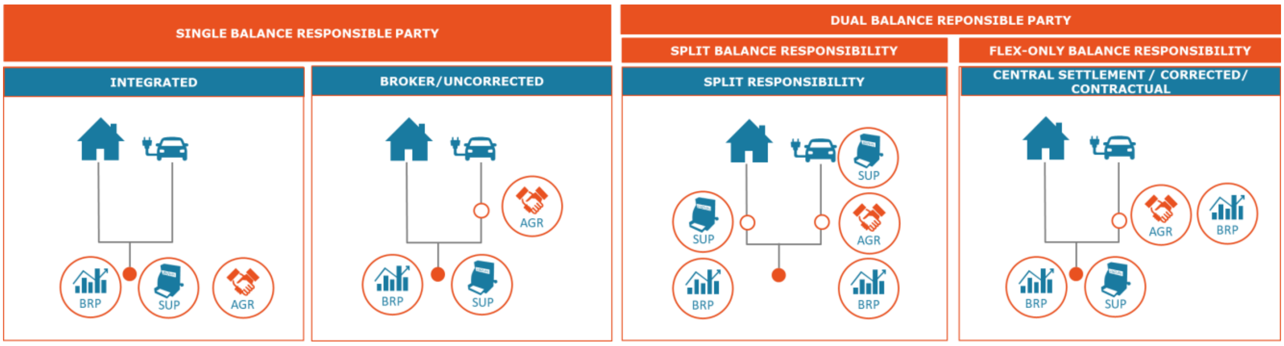


Figure 1 Balance responsibility classification schematic. The models in the blue bar are the specific models derived from the general classification and they are further developed in the next section. [modified USEF illustration [5]*].*

2.2. *Flex-only balance responsibility*: These models make the aggregator responsible only for the flexibility activation and leave the supply task fully with the original supplier. This arrangement has an extra layer of complexity and it is important to understand the following underlying principles:

- The supplier is responsible for the energy supply of the customer
- The BRP of the customer's supplier (BRP_{sup}) bears full balance responsibility for the consumer connection outside flexibility activation periods
- Within flexibility activation periods, BRP_{sup} bears balance responsibility for the customer, where the measurements of the controlled asset(s) are replaced by the corresponding baseline
- Within activation periods, the BRP associated with the aggregator (BRP_{agr}) is responsible for the imbalance it causes when activating flexibility
- The BRP_{agr}'s balance responsibility in relation to the so-called rebound effect[5] also needs to be considered, as this typically occurs outside the activation periods. Also ramp times (inside or outside of activation period) need to be considered. This is not inherently resolved by most of the proposed models and may need additional measures
- During flexibility activation periods, the BRP_{agr}'s balance responsibility is limited to the flexibility assets that are activated. An alternative approach is that an aggregator takes responsibility (during activation periods) for its own full portfolio, including assets that are not activated during that specific deployment
- The flexibility activated volume is equal to the difference between the baseline and the actual measurement. This volume must be transferred between the aggregator and the supplier to match their balancing and sourcing positions. This process is also known as the *Transfer of Energy (ToE)*
- The ToE can be arranged in multiple ways; the different arrangements are described within the models in the following section
- The energy that is transferred (this can be two-way) between the aggregator and supplier may be remunerated, this is sometimes referred to as "supplier compensation" (although in

5 For rebound effect we use the definition of the phenomenon that the load reduction (or increase) triggered by a demand response event, is compensated partly or fully outside the activation period or by other resources.

case of demand turn-up this would be aggregator compensation). The ToE compensation issue will be addressed in section 2.

1.2 Model descriptions

The categorisation in the previous section leads to the following model overview:

Table 1 Aggregator implementation model overview

<table>
<tr><th colspan="2"></th><th>Contract between aggregator and original[3] supplier</th><th>No contract between aggregator and original supplier</th></tr>
<tr><td colspan="2">Single BRP</td><td>• Integrated
• Broker</td><td>• Uncorrected</td></tr>
<tr><td rowspan="2">Dual BRP</td><td>Flex only BR</td><td>• Contractual</td><td>• Corrected
  ○ Meter reading modification
  ○ Separate specification
• Central Settlement</td></tr>
<tr><td>Split BR</td><td></td><td>• Split-responsibility</td></tr>
</table>

As described in the previous section, the contractual models are not the focus of this study, they are however relevant and worth mentioning:

- **Integrated model:** The supplier and aggregator are combined in one market party
- **Broker model:** The aggregator has a contractual relationship with the supplier. The aggregator transfers the balance responsibility to BRP_{sup}. All arrangements between aggregator and supplier are based on a bilateral contract (implying that the aggregator typically interacts with more than one BRP)
- **Contractual model**: The aggregator assigns its own BRP and holds balance responsible only during flexibility activations. Balances are corrected through a deal between the BRP_{sup} and BRP_{agr} and the Transfer of Energy process and compensation are based on contractual arrangements

A more detailed description of the non-contractual models is included in the sections below.

Note that there are alternative models not described by USEF that propose to eliminate the ToE concept and treat DR as 'avoided generation', i.e. negative production. In Appendix A, we explain why we discarded this model.

1.2.1 Split-responsibility Model

A "straight-forward" way of organising the aggregator role, is to split both the energy supply and the balance responsibility for the connection in two (or more). As presented in Figure 2, one part consists of the asset(s) controlled by the aggregator, a second part for the remaining load (non-controlled assets). Hence, the aggregator will supply and operate the controllable part of the connection and the supplier the remaining.

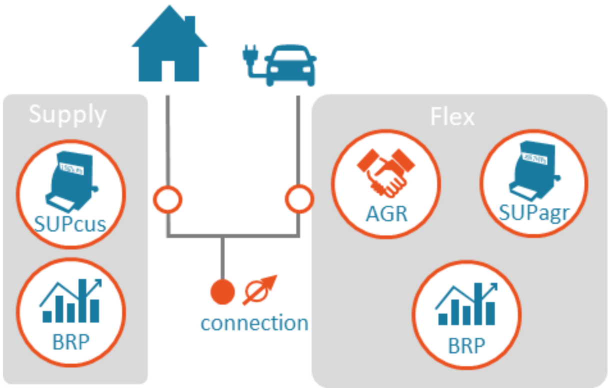


Figure 2 Split-responsibility model. Left part is supply to the uncontrollable load; right part is supply to flexible asset.

In the example above, the aggregator is responsible for contracting supply for and operating the EV, whereas the customer's supplier is responsible for the rest of the household load (and generation). The aggregator can fulfil its sourcing and balance responsibilities either by contracting with a single supplier (and BRP) for all its customers, or by performing this role itself.

Through controlling a specialised type of load, the IA will be able to optimise their customers' positions on the wholesale market and sell explicit flexibility products to the balancing markets as a BSP and local flexibility markets.

This model is typically implemented by using additional meters, either parallel at the connection or through sub-metering or potentially meters already installed in the flexible resources. However, synthetic profiles or advanced algorithms (meter data disaggregation) could also be used, at least in theory.

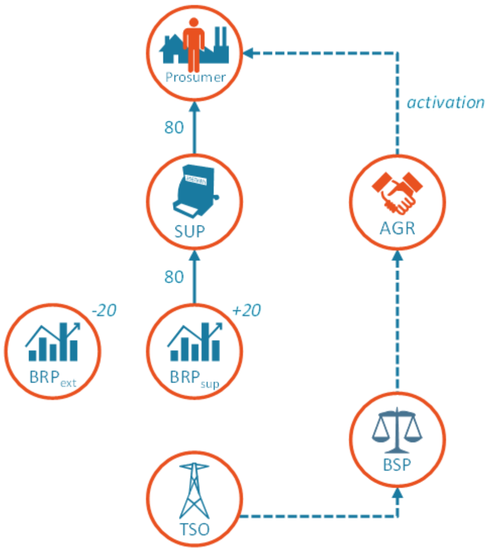
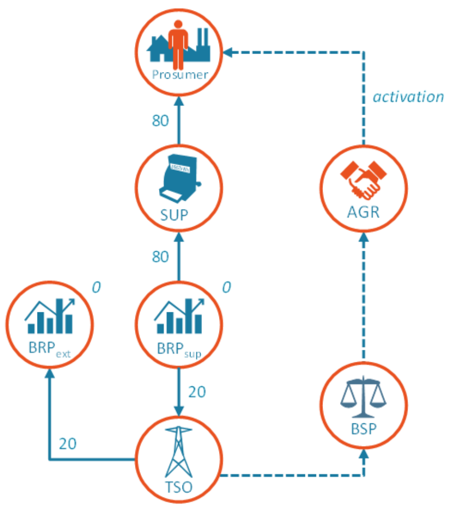
1.2.2 Uncorrected model

In this model, the aggregator does not need to assign a BRP and there is no transfer of energy between the aggregator and the supplier. When the aggregator activates flexibility, it creates imbalance in the BRP_{sup}'s position. However, when the flexibility activation is in the 'right direction' (contributing to the system balance[6]), the BRP_{sup} is remunerated through the imbalance settlement because of passive contribution to balance restoration. Generally, if the aggregator is active on balancing or adequacy services, the remuneration takes place against favourable balancing/market prices. Currently, the Nordic TSOs apply a split balancing system, where production portfolios are exposed to dual pricing and other portfolios are exposed to single pricing. Single pricing for all imbalances will be implemented from 1 November 2021. In this report, the change is anticipated, and examples are written with this in mind. The example above does not hold in the current setup if the relevant BRP accounts are production portfolios (and the BRPs does not manage to move imbalances to a consumption-portfolio). As the details are not known, we have assumed that the single price regime will not distinguish between active and passive support, although an imbalance fee is being discussed.

This model is usually implemented in capacity services or low-energy intensive services. For example, in Belgium the uncorrected model is used in the FCR service.

The example below shows the functioning of this model in the balancing markets. This model is not suitable for trading in the power market, since the aggregator has no means to source the energy (related to the demand response (DR) event) that they intend to offer to the wholesale market.

6 Or reducing the system imbalance.

Uncorrected model in balancing markets [5]	
	The aggregator activates flexibility by reducing the load at the consumer by 20. As a result, the aggregator creates an imbalance of +20 with BRP_{sup}.
	Restoring energy balance: Through the regular balancing mechanism, the imbalance of BRP_{sup} passively contributes to the restoration of the system imbalance. BRP_{sup}, having sourced 100 but only delivering (through the supplier) 80 to the customer, delivers the remaining +20 through the balancing mechanism to BRP_{ext}.[7] Assuming a market in which passive contribution to balance restoration is rewarded by the balancing mechanism[8], BRP_{sup} is remunerated against balancing prices.

1.2.3 Corrected Model

In the corrected model, the aggregator assigns its own BRP. it only holds balance responsibility during flexibility activations. A central entity, typically the TSO, corrects the perimeter[9] of the BRP_{sup} based on the activated flexibility volumes to avoid imbalance charges.

The Transfer of Energy is organised through the customer. A central entity corrects the load profile (i.e. the metered consumed energy) of the customer, replacing it by fictive values simulating what would have been realized with no flexibility activation. The supplier uses the corrected values to charge the consumer at retail prices. The aggregator compensates the consumer the corresponding activated flexibility volumes.

In practice, there are 2 alternatives to correct the metered load values:

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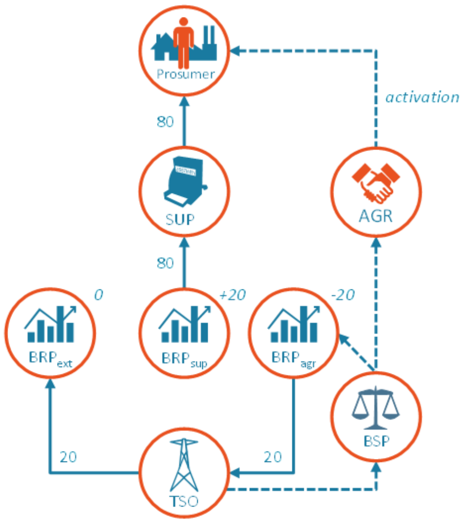
7 BRP_{ext} is a third BRP who will cause a system imbalance upon which the TSO will act by invoking a service.

8 At the time of writing this report, the Nordic TSOs have not clarified if they intend to implement an imbalance fee to prevent self-balancing. If such fees are in place, the BRP_{sup} may need additional compensation to be indifferent wrt. to the aggregator.

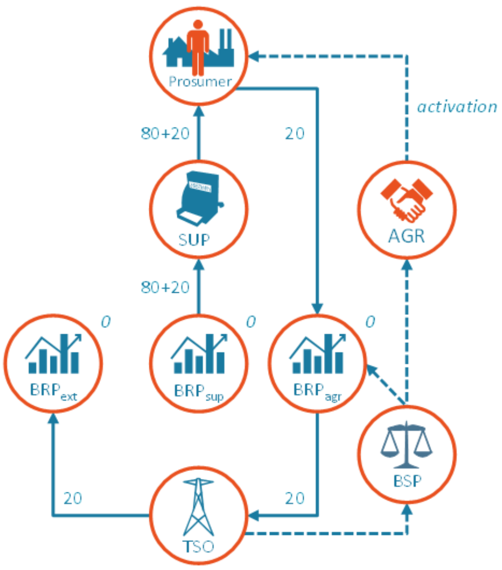
9 A perimeter correction is an adjustment of the imbalance volume, typically performed by the Allocation Responsible Party (ARP) role. (In the Nordic region, the ARP role is, if we understand the situation correctly, performed by eSett Oy.)

1. Correct the meter readings by extracting the activated volumes during the flexibility activation (i.e. the difference between the measurements and the baseline, which could be based on a sub-meter). This alternative requires modifying the meter data, which may not comply with regulation in certain countries. This model has been implemented in France for large connections (sites connected to the TSO grid or remotely measured sites connected to the DSO grid with a connection larger than 36 kVA). It is used for both balancing services and wholesale trading.
2. Notify the supplier of the flexibility activated volumes. The supplier would then need to adjust the consumer bill to charge for the activated volumes, or at least has the right to require the consumer to pay for the non-delivered energy (due to the flexibility activation). This model has been implemented in Germany for balancing products.

The example below shows the functioning of this model in the balancing markets. The example is also applicable for aggregators trading in the power market by replacing the TSO by the *power exchange* and eliminating the Balancing Service Provider (BSP) role.

<table>
<tr><th colspan="2">Corrected models in balancing markets [5]</th></tr>
<tr><td>
</td><td>The BSP releases balancing energy by activation of flexibility through the aggregator. The consumption reduces from 100 to 80 units.

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

The aggregator has reduced the consumption of the consumer to 80. Without a correction, the BRP_{sup} (having sourced 100) would only be able to bill 80, rendering an open supply position and an imbalance of +20, as depicted in the figure.</td></tr>
<tr><td>
</td><td>Restoring energy balance:

A central entity corrects the perimeters of BRP_{agr} by transferring energy into BRP_{agr}.

During each DR event, the consumer pays the supplier based on the baseline, not on the actual consumption. In this example, the consumer pays for 100, despite the reduction. The aggregator compensates the consumer by paying for the 20 units of energy, next to a possible remuneration for the flexibility.
There exist two variants of this model:
Meter reading modification
This will not disclose the DR event to the supplier as they will only receive a regular load pattern
Separate specification
The supplier is informed about the activated DR volumes, so they can invoice these with the consumer.
The correction of the measurements thus restores the</td></tr>
</table>

	energy balance of the BRPs. Both the grid tariffs and taxation will still need to be based on the measured values. This may cause a taxation problem for the meter reading modification sub-model, since the supplier only receives modified values. Further modifications to energy taxation should be studied if this sub-model is implemented.

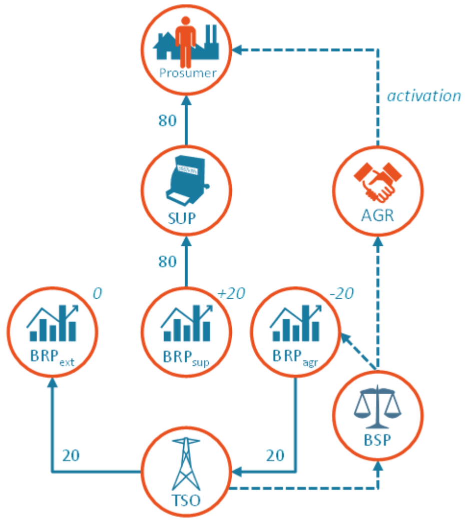
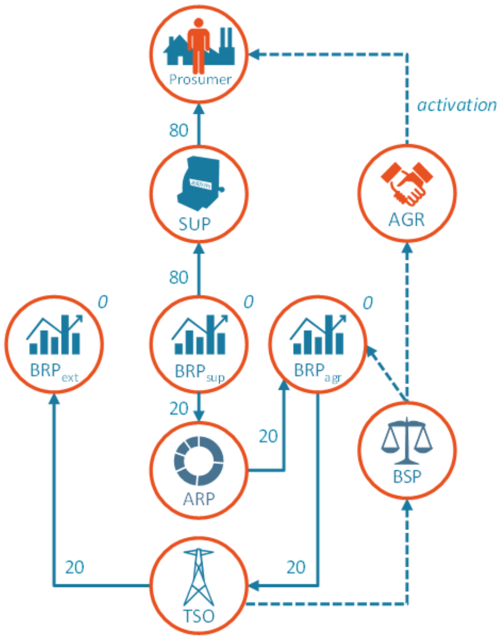
1.2.4 Central Settlement Model

Similar to the corrected model, in this model the aggregator assigns its own BRP and only holds balance responsibility during flexibility activations. The activated flexibility is quantified by comparing the measurements with a baseline.

Unlike the corrected model, the central settlement model does not require any meter reading correction. The perimeter correction of BRP_{sup}, BRP_{agr}, and the ToE process are all arranged centrally. The ToE compensation needs to be set by regulation and the settlement may also be handled centrally.

This model is implemented in France for small connections (below 36 kVA) for both balancing products and wholesale, as well as in Belgium for balancing.

The example below shows the functioning of this model in the balancing markets. The example is also applicable for aggregators trading in the power market by replacing the TSO with the *power market* and eliminating the BSP role.

Central settlement model in balancing markets [5]	
	In the central settlement model, the BSP associates with a BRP$_{agr}$ to be able to deliver 20 to the TSO. Through the balancing mechanism, 20 is delivered to BRP$_{ext}$, restoring the balance in its portfolio. However, BRP$_{sup}$, having sourced 100 but only delivering (through the supplier) 80 to consumer, is faced with an imbalance of +20 and an open supply position of 20. BRP$_{agr}$ on the other hand has sold 20, yet did not source this energy.
	Restoring energy balance: A central entity (denominated as allocation responsible party (ARP) in the figure) corrects the perimeters of BRP$_{sup}$ and BRP$_{agr}$ by transferring energy from BRP$_{sup}$ into BRP$_{agr}$. In general, the ARP role is performed or organised by the TSO (i.e. eSett Oy for Sweden). The TSO would also handle the financial settlement based on a regulated ToE compensation (that should be approved by the regulator (Ei)). Particularly, in this case, the aggregator pays 20*price (€/MWh) to the supplier. The ToE compensation is further discussed in section 0.

1.3 Selection of aggregator implementation models for further analysis

The purpose of this section is to select the aggregator implementation models to further analyse in the following sections.

As identified by the NordREG report, the **split-responsibility model** was identified as an interesting model to implement *independent aggregation*. Therefore, this model will be further analysed.

To select other models from the previous section, it is worth looking at the regulatory context of independent aggregation. The purpose of this report is not to make a legal analysis of the models' compliance in relation to European or national law. However, even a shallow analysis of the requirements places some of the models out of scope.

The current directive (EU) 2019/944 [1] defines ‘independent aggregator’ as a *market participant engaged in aggregation who is not affiliated to the customer's supplier.*

Further, as per article 17.1, ‘*Member States shall allow and foster participation of demand response through aggregation. Member States shall allow final customers, including those offering demand response through aggregation, to participate alongside producers in a non-discriminatory manner in all electricity markets.’ Member States shall ensure that their relevant regulatory framework contains at least the following elements.* And as per article 17.3:

(a) the right for each market participant engaged in aggregation, including independent aggregators, to enter electricity markets without the consent of other market participants;

…

(e) provision for final customers who have a contract with independent aggregators not to be subject to undue payments, penalties or other undue contractual restrictions by their suppliers;

In addition, article 5 specifies that*: ‘All market participants shall be responsible for the imbalances they cause in the system (‘balance responsibility’). To that end, market participants shall either be balance responsible parties or shall contractually delegate their responsibility to a balance responsible party of their choice. Each balance responsible party shall be financially responsible for its imbalances and shall strive to be balanced or shall help the electricity system to be balanced.’*

When evaluating all possible aggregator implementation models (that could supplement the split-responsibility model) against the CEP requirements of ‘*independent in all markets’*, ‘*balance responsibility’* and the ‘*non-consent from other market participants’*, we conclude that:

- The integrated, contractual and broker models, although easy to implement from a regulatory perspective, do not fulfil the CEP *‘independence in all markets’* and the ‘*non-consent from other market participants’* requirements. Therefore, we do not further evaluate these models in this study. However, they could be used (and are used) to facilitate non-independent aggregation into the market.
- The uncorrected model fulfils the ‘*non-consent from other market participants’* requirement but not the ‘*balance responsibility’* requirement. The advantage of this model is the very low administrative burden; it could be considered for capacity products or products that have a negligible energy component, e.g. Frequency Containment Reserve (FCR). It could be argued that the savings in administration outweighs the potential effect on the supplier and/or aggregator. Therefore, it could be considered for certain products, but *not for all markets*. Hence, it’s will not be evaluated further in this study.
- The **corrected model** and the **central settlement model** seem to fit all requirements and are therefore further studied, next to the **split-responsibility model**, in the following sections.

2 ENERGY COMPENSATION BASED ON MARKET ANALYSIS

2.1 Background

As explained in the previous section, the flex-only BR models have a Transfer of Energy (ToE) mechanism in place, reflecting the energy the aggregator sources from the supplier during flexibility activations. Hence, the ToE safeguards the administrative balance of the system, and allows the aggregator to trade energy. In general, any energy transaction involves a price. For example, suppliers pay for the energy that they source in the power market. So, if the aggregator is sourcing energy from the supplier, should they pay for it? Even if they are making a positive societal impact? These questions are triggered by the CEP, and in this section, we explore the answer.

The CEP states, in article 14.4 of Directive (EU) 2019/944 [1]:

Member States may require electricity undertakings or participating final customers to pay financial compensation to other market participants or to the market participants' balance responsible parties, if those market participants or balance responsible parties are directly affected by demand response activation. Such financial compensation shall not create a barrier to market entry for market participants engaged in aggregation or a barrier to flexibility. In such cases, the financial compensation shall be strictly limited to covering the resulting costs incurred by the suppliers of participating customers or the suppliers' balance responsible parties during the activation of demand response. The method for calculating compensation may take account of the benefits brought about by the independent aggregators to other market participants and, where it does so, the aggregators or participating customers may be required to contribute to such compensation but only where and to the extent that the benefits to all suppliers, customers and their balance responsible parties do not exceed the direct costs incurred. The calculation method shall be subject to approval by the regulatory authority or by another competent national authority.

The NordREG report 'Nordic Regulatory Framework for Independent Aggregation' [2] describes different levels of compensation for the unmatched position of the supplier (i.e. the transfer of energy): full, partial or no compensation. The full or partial ToE cost could be socialised to reflect the so-called societal 'net benefit'.[10]

In the analysis below, we explore the extent different mechanisms cause ***market distortions***. A market distortion in this context is i) activation of resources which are out of the money (e.g. starting a generator with marginal costs above the relevant market price) or ii) failure to activate resources that are in the money (e.g. not starting a generator with marginal costs below the relevant market price), or similarly for reservation of resources. A ToE mechanism creating market distortions can potentially lead to adverse incentives and cause major inefficiency problems.

2.2 Analysis of compensation

Although the IA activities may have a (positive) impact on wholesale/balancing prices and thus, a societal benefit, should the ToE compensation be fully or partly discarded (or socialised)?

To answer this question, we have illustrated the market functioning under different scenarios and ToE arrangements. In the example below, a consumer owns a (small) generator, which is associated with a fixed marginal cost, and has a contract with a supplier and (in most cases) an IA. We chose the

10 Underlying principle: When the total sourcing costs of the supplier decrease due to a lower day-ahead price (caused by the IA activities), parts of the cost of the transfer of energy can be socialised (net benefit principle).

generator example because there is a clear associated marginal cost, which we interpret as a fuel cost. However, this example is also applicable for demand response (and storage) flexibility activations.

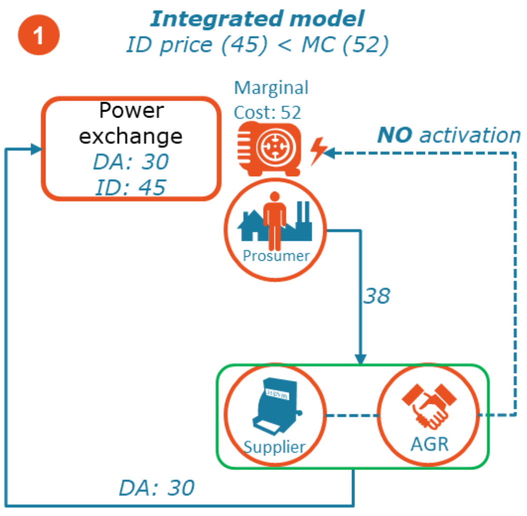
Example number 1 and 2 show different market prices and how the supplier (integrated with an aggregator) would operate the generator in instances where the market price exceeds the marginal cost of the generator, representing a normal functioning of the market.

In example number 3, we include the IA (assuming the IA now controls the generator) and set the ToE price at 0 (i.e. no compensation). In this case, it becomes evident that there is a clear cost-reflectivity problem when the ToE compensation is fully discarded (or socialised), leading to market distortion. With distortion we refer to a situation in which operation of the generator violates the 'price > marginal cost' principle.

In example 4, we illustrate the corrected model, where the ToE price is the same as the retail price. In this scenario the IA would respect the market principles and would not activate the generator unless the market price is above the marginal cost of the generator.

Finally, in example 5, we illustrate the central settlement model and analyse different ToE prices. From this case we conclude that ToE partial compensation would also lead to market distortion.

Generator example

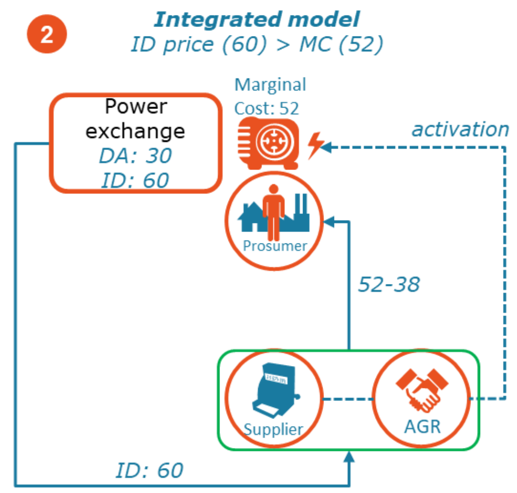
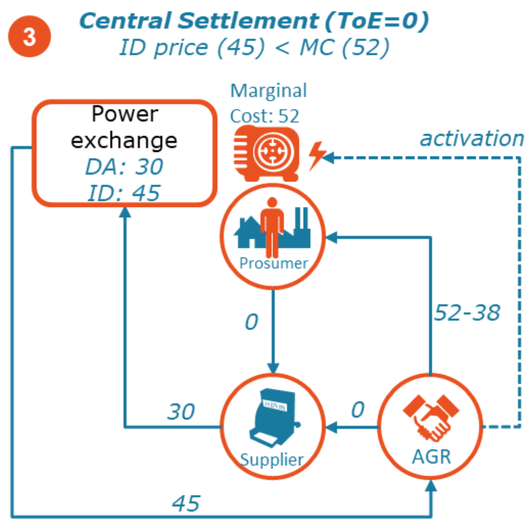


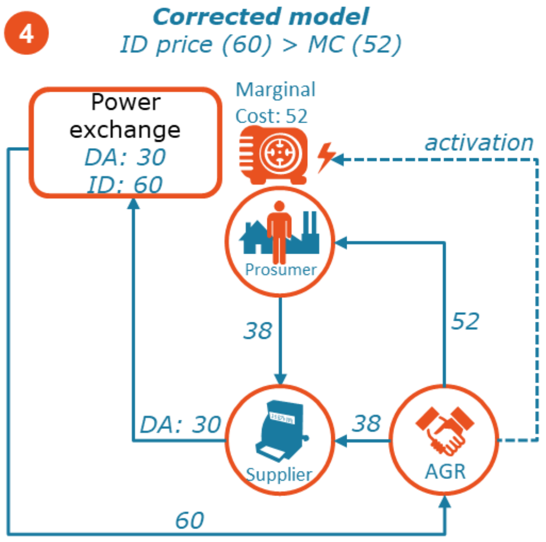
This example illustrates a supplier (integrated with an aggregator) serving a consumer (end user) who owns a power generator. We assume the supplier has the technical capability and the consumer consents to operate the generator. The agreement is that the supplier pays a predetermined fee per MWh for using the generator (52 €/MWh), which covers all costs and corresponds to the actual marginal cost (MC).

The day-ahead (DA) wholesale price is 30 €/MWh. During intraday (ID) trading the market price is 45 €/MWh. The consumer retail tariff is 38 €/MWh.

Since the retail tariff is higher than the market price, the supplier makes a profit, or margin, of 8 €/MWh when supplying the consumer DA.

In this situation, there is no economic reason to start the generator as the marginal costs exceed both the DA and the ID market price.

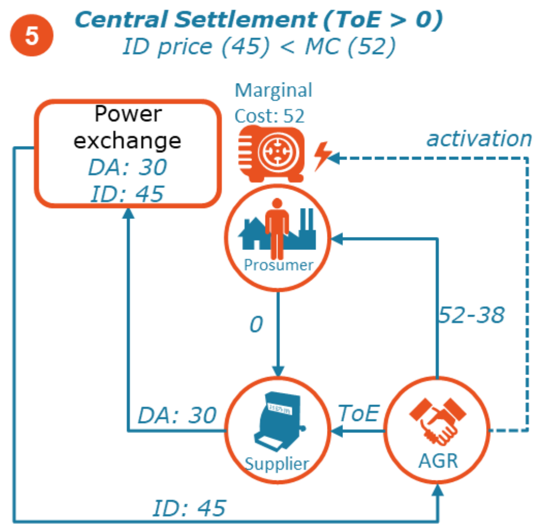
	Now, what happens if the intraday market price increases to 60 €/MWh? In this case, since the supplier/aggregator is constantly exposed to wholesale prices, there is an economic reason for the supplier to activate the generator because the marginal cost is lower than the market price (52 €/MWh < 60 €/MWh). The supplier compensates the consumer with the marginal cost of the generator (52 €/MWh) minus the retail tariff price (38 €/MWh). The supplier subtracts the retail price because the consumer is still consuming electricity, but the production will not show on the meter or the energy bill, as it is generated behind the meter.
	Adding an IA to the equation, we assume that the IA, not the supplier, has the technical capability and the consumer consents to operate the generator. Like in case 1, the DA market price is 30 €/MWh; the supplier is still delivering energy against the retail tariff of 38 €/MWh. Just like the supplier in the previous example, the IA has an arbitrage option against the wholesale market. However, the IA's arbitrage may be different, depending on how the ToE is organised and compensated. If the IA activates the generator to sell the energy in the wholesale market, the consumer needs to be compensated for the use of the generator, with the deduction of the retail tariff (52-38=14 €/MWh). In this case, the *central settlement model* is applied, and the *ToE is set to 0* (i.e. no compensation or 'fully socialising the ToE'), the IA's arbitrage would lead to the generator activation whenever the DA or ID market price is higher than 14 €/MWh. In this example, at an ID price of 45 €/MWh (>14€/MWh), the IA activates the generator. **This would clearly create a market distortion** (generator activation regardless if market value is below marginal cost).



If the *corrected* model is applied, the consumer is billed the retail price by the supplier, as if the generator was not activated.

To compensate the consumer, the IA needs to pay for the generator, but this time the retail tariff cannot be deducted, since the consumer still needs to compensate the supplier for the non-consumed energy against the retail tariff. In this example, there is an arbitrage option, the IA has to pay 52 €/MWh and can receive 60 €/MWh on the market. The IA will therefore start the generator.

The IA will only start the generator when optimal, i.e. when market prices are higher than 52 €/MWh, which is the marginal cost of using it, and therefore respecting the market principles. **No distortion is created.**



If applying the *central settlement* model with a ToE price above 0, the aggregator would compensate the ToE directly (through a central entity) to the supplier. The IA's arbitrage then takes the following form:

The generator will be activated when wholesale price exceeds (ToE price + marginal costs – retail price); in our example: ToE + 52 – 38 = ToE + 14.

ToE price examples:

- *50 % of the DA wholesale price* (partial compensation): The ToE would be 15 €/MWh. The IA would start the generator when the wholesale price is higher than 29 €/MWh. **This would still distort the market.**
- *100 % of the DA wholesale price* (full compensation): ToE= 30 €/MWh. The IA would start the generator when the wholesale price is higher than 44 €/MWh. **This would (in this example) create a market distortion, yet a higher DA price could still avoid a market distortion.** The challenge is that the production decision is not evaluated against the relevant market value (which is ID in this example but could be the DA price in another setup), and that there is a 'fixed' spread between ToE price and the revenue for the aggregator. Due to the spread, the distortion is not eliminated by replacing DA with ID in the ToE definition.
- *100 % of the retail tariff* (full compensation): ToE=38 €/MWh. The IA would start the generator when the wholesale price is higher than 52 €/MWh. **This would clearly not create a market distortion** but would yield a different arbitrage option compared to the previous example based on wholesale prices (retail tariff is ('more') fixed, whereas the wholesale prices are volatile). Therefore, also for this model, the ToE should be as close to the retail price (excl. taxes) as possible. The implementation problem is that the retail price is essentially an individual commercial agreement between supplier and consumer, not known to

	others. In a competitive market, however, it should be possible to develop a proxy for the retail price.

2.3 Conclusion

As conclusion, to safeguard the market principles and avoid distorted cost reflectivity (i.e. market distortion), the ToE needs to be fully remunerated at the level of the retail price (as explained in example 5 in section 2.2). Hence, even if there is a net societal benefit due to demand response utilisation, the 'net benefit principle' cannot justify the reduction of the ToE remuneration.

If the regulatory agency would like to reflect the 'social net benefit' of flexibility activation and arrange a reward for the IA, they need to consider that:

1. The reward should be based on capacity rather than energy to avoid the problem described above; and
2. Other forms of flexibility, for example, suppliers applying implicit mechanisms, or even companies offering energy efficiency measures, would also contribute to the net societal benefit in the same way as IAs do and, therefore, should also be eligible for such reward.

3 QUALITATIVE IMPACT ASSESSMENT BY ACTOR

Having identified the 'viable' IA models, including the appropriate compensation, the next step is to describe the impacts these would cause on the different roles. Therefore, this section analyses the three different models (split-responsibility, corrected and central settlement) in terms of their (relative) impact on the consumer, IA and supplier.

This impact assessment does not describe the impact of allowing demand-side flexibility entering balancing and wholesale markets, as this is already possible, but largely limited to suppliers (and to aggregators that have contractual relationship with one or more suppliers). We will therefore consider the Integrated Model as the base case, where the supplier is also performing the aggregator role, by directly controlling flexible assets of the consumer. Since we are considering models that can supplement the split-responsibility model, a comparison between alternative models and the split-responsibility is also relevant. This will be further considered in section 4.

The next sections describe the impact when adding these models. Only the *direct* impact to either the supplier, consumer or IA will be assessed. For example, cost increases for the supplier may lead to higher retail prices for the consumer, these *indirect* effects will not be analysed.

3.1 Impact on the supplier

3.1.1 Impacts addressed by the three models

The aggregator's activation of flexibility during a DR event, either serving the wholesale markets or a balancing product, can lead to two important effects:

1. Balancing position is affected (volumes)
   A supplier needs to ensure balance with its portfolio of in-feed, off-take and deals. If the IA activation disturbs this balance, the supplier will face imbalance costs (or revenues).
2. Sourcing position is affected (volumes)
   An energy supplier sources energy on wholesale markets and sells energy to retail consumers (end-users). The supplier will typically strive to ensure the amount of purchased energy equals the amount of sold (consumed) energy. The supplier will make a margin if the retail prices are (on average) exceeding the wholesale prices. If this balance is disturbed by the IA activities, it can lead to a financial impact on the supplier.

One of the criteria for the models is that the balance responsibility is properly assigned. The split-responsibility model ensures that any activation by the aggregator only affects its own perimeter, the other models ensure that the effect on the perimeter of the supplier's BRP is neutralised. Therefore, there is no impact on the balancing position in any of the models.[11] This is in noticeable contrast to the uncorrected model.

In the split-responsibility model, the aggregator does not influence the amount of energy sold by the supplier to the consumer. For the other models, our analysis in section 2 led to the conclusion that the ToE price should be close to the retail price. As a consequence, the sourcing position of the supplier is also neutralised. Therefore, there is no impact on the sourcing position in any of the models.

[11] Since the flexibility quantification is based on the use of a baseline, prerequisite for this neutralisation is a sufficiently accurate baseline methodology. This can be accomplished for non-volatile load and in case of infrequent activations (also considering that the supplier's forecast is not perfect), but it can be more challenging for volatile load (or storage or generation), in combination with frequent activations. This aspect is further explored in the impact analysis.

3.1.2 Assumptions and considerations

In this section, some potential effects are described that will not be further considered in our analysis, including a justification.

Sourcing prices

If the IA activation leads to different prices on wholesale markets it will impact the sourcing costs of the supplier. However, this also holds true for the base case, therefore we exclude it from our analysis.

One could argue that allowing IAs to enter the market will bring more flexibility to the market, which will increase this effect. This aspect is addressed in section 4.

Balancing prices

If the IA activation leads to different balancing prices it will impact the sourcing costs of the supplier.

Here the same reasoning as above applies.

Energy efficiency

In certain circumstances, not all reduced load is consumed at a later point in time (i.e. no full rebound). For example, an air-conditioning unit that has been curtailed may be switched off before the rebound occurs.

Here the same reasoning as above applies.

Retailers' competitiveness.

Since the number of market players influences the level of competitiveness in the market, a high competitiveness puts pressure on the margins of the supplier, and low competitiveness allows for higher margins to be made. IAs entering the market could have an impact on the competitiveness of energy supply. However, we consider this a natural and positive part of a competitive market and can be considered one of the main objectives for implementing IA models.

This development, especially the split-responsibility model, also creates an opportunity for suppliers, as they can position themselves as a supplier-of-choice for the aggregator, increasing its business with a portfolio with low balancing-risk.

3.1.3 Impact assessment

Modifications to regulatory framework / market processes to allow IA

Since Independent Aggregation is currently not supported by the Swedish regulatory framework, several modifications can be expected to enable this, the type of modifications is dependent on the chosen model / implementation. These changes are likely to impact all relevant market actors.

The regulatory setup of the markets influences the total administrative cost. Examples of administrative costs are: (additional) metering requirements, ToE mechanism, (additional) billing, etc. We will further analyse these in section 4.4.

Metering costs

The costs for installing and operating meters (incl. data extraction and validation) are strongly dependent on the metering requirements for each model. Different models have different metering requirements and since the described models are not yet implemented, it is difficult to assess the exact impact.

In general, we expect that all models would require a second meter[12] (next to the existing meter at the connection point), although the flex-only BR models can also be applied to the main meter only. Since the IA typically uses its own sub-meter for on-line monitoring of the flexible asset - a sub-meter that often is built-in to the flexible technology (e.g. an EV charger) -, there is a common understanding that the placement of a third meter should be avoided. However, the meter requirements associated to the model could have an impact on the costs of the sub-meter (either embedded or not).

When examining international practices, the meter requirements on split-responsibility models are often higher than for those for flex-only BR models.[13]

Table 2 Supplier impact analysis

Model	Supplier impact
Split-responsibility	None
Corrected - meter reading modification	Customer service may face more questions as energy bill does not correspond with meter display reading. Rebound effect could lead to higher imbalance cost, may need more advanced forecasting algorithms, but can also increase energy sales. A poor baseline quality and poor meter data quality could yield erroneous meter data corrections, which will affect both the balancing and sourcing position.
Corrected – separate specification	Customer service may face more questions as energy bill includes separate payment for non-consumed energy. Energy bill needs to include activated energy by IA. The supplier needs to validate the energy that is activated per consumer. Rebound effect could lead to higher imbalance cost, may need more advanced forecasting algorithms, but can also increase energy sales. A poor baseline quality and poor meter data quality could yield erroneous perimeter corrections, which will affect both the balancing and sourcing position.
Central settlement	The supplier needs to validate the energy that is transferred to/from its perimeter. Rebound effect could lead to higher imbalance cost, may need more advanced forecasting algorithms, but can also increase energy sales. A poor baseline quality and poor meter data quality could yield erroneous perimeter corrections, which will affect both the balancing and sourcing position.

12 Since energy bills are based on meter readings of the second meter, we deem mathematical models not suitable as an alternative for this second meter, as estimates are less suitable for customer billing.

13 As an example, in the Netherlands the split-responsibility model has been implemented (“MLOEA: (translated) multiple suppliers per connection). The requirements for the second meter are equal to the main meter, leading to the need to install a second DNO smart meter); whereas flexibility service providers are allowed to use their own meter in flex-BR models (e.g. in mFRR product). [8]

Regarding the ***rebound effect*** (only applicable for the Corrected + Central Settlement models):

In case an IA operates either DR or storage within its portfolio, most (if not all) of the reduced / enhanced load will be shifted to another period. E.g. charging an EV can be halted for a period, but the battery will need to be charged at a later time. Also, industrial processes like manufacturing can be halted, but the manufacturing process will likely be scheduled at a later time.

Typically, the rebound effect occurs after the event, sometimes before (e.g. pre-heating or pre-cooling), but rarely during the event (using other assets). Assuming the IA does not control the rebound and does not (need to) take responsibility for the rebound, the effect of the rebound ends up with the supplier.

- Sourcing position: One could think that the sourcing position is solved by the rebound, since the energy that is not consumed during the DR event, is consumed at another time. However, the supplier still needs to source the additional energy that is required by the rebound for the period(s) that it occurs (the ToE does not occur in the opposite direction during the rebound period). There is, however, no open supply position during the rebound period (additional sourced energy is paid for by the consumer).
- Balancing position: Since the rebound effect is strongly depending on the asset type, the consumer and specific circumstances, it is in generally hard to predict. Therefore, the rebound is likely to create additional imbalances to the suppliers' perimeter.
- Administrative costs: The supplier may mitigate the impact on its balancing position by enhancing its forecast capabilities, either to foresee the IA's activations and/or to foresee the rebound effects. This could lead to additional costs.

3.2 Impact on the IA

In this section we present the impact on the IA for the different models.

First it is important to realise that the impact of specific models can differ significantly, depending on the type of assets the IA is operating, the type of markets the IA is active at, and the customer segment.

We take a closer look at two specific examples to explain the difference:

1. IA operating a large set of EV charging points ("EV IA")
   Given the low marginal costs of this flexible asset, this IA would typically operate its flexible assets on a day-to-day basis, valorising it on wholesale markets and balancing products (FCR, aFRR). This example is not yet common practice but is expected to become viable when the penetration degree of EVs further increases.
2. IA operating a small set of large industrial customers (load curtailment) ("commercial and industrial (C&I) IA")
   Given the high marginal costs of this flexible asset, this IA would typically operate its flexible assets in capacity products, covering up-front costs by capacity payments, with very low activation frequency, i.e. a few times per year. Example markets / products are manual frequency restoration (mFRR) and adequacy mechanisms (e.g. countries with strategic reserves). These examples represent the current practice of most IAs in Europe.

The market and the IAs' business models are expected to develop, leading to more versatile and heterogeneous portfolios, yet these examples will be used in our analysis below.

Table 3 Independent aggregator impact analysis

Model	IA impact
Split-responsibility	The IA either (a) perform the supplier role itself or (b) needs to contract a supplier. Option (a): • For IAs serving large commercial and industrial (C&I) consumers, the financial risks of the supplier role may be too large for smaller IAs. • For IAs serving smaller consumers, performing the role of the supplier means an additional burden and costs for the IA. Also, it requires the IA to be competitive on energy supply (especially against incumbent suppliers that also offer DR services), which is difficult in a commodity market for companies with totally different competences and expertise. We therefore conclude that option (b) is far more likely to occur, option (a) is mainly applicable to existing suppliers that also seek to perform independent aggregation. Option (b): • Teaming with an existing supplier may imply that part of the revenues needs to be shared with the supplier. However, the EV IA (in our example above) has an interesting portfolio to offer to the supplier, with hardly any balancing risk as it is fully controlled, and many opportunities to lower the sourcing costs. The EV IA also needs a BRP, so finding a SUP/BRP combination in the retail segment in the highly competitive Swedish market cannot be considered a large entry barrier. • Looking at the C&I IA (in our example above), the situation is completely different. The value of the flexibility is dwarfed by the costs of energy supply. When partnering with a supplier, the IA will effectively only compete on commodity price, not on the value of the flexibility services. This can be considered a serious market entry barrier. Depending on the future metering requirements associated with this model, the IA or consumer may need to install (and pay for) an additional smart meter. This will affect the business case of the IA.
Corrected - meter reading modification	The IA needs to compensate the consumer against retail prices. The IA needs to perform or outsource the BRP role. The IA needs to validate the energy that is transferred to/from its perimeter. Depending on the future metering requirements associated with this model, the IA or consumer may need to install (and pay) an additional smart

Model	IA impact
	meter. This will affect the business case of the IA.
Corrected – separate specification	The IA needs to compensate the consumer against retail (or negotiated) prices. The IA needs to perform or outsource the BRP role. The IA needs to validate the energy that is transferred to/from its perimeter. The supplier is informed about IA's activities, which may reveal commercially sensitive information. This is problematic because the supplier would know which consumers are part of a flexibility programme (i.e. which of their many supply customers have valuable flexibility) and might try to compete with the IA unfairly. Additional metering requirements may increase the equipment costs for the IA.
Central settlement	The IA needs to compensate the consumer against regulated prices. The IA needs to perform or outsource the BRP role. The IA needs to validate the energy that is transferred to/from its perimeter. Additional metering requirements may increase the equipment costs for the IA.

3.3 Impact on the consumer

In this analysis, with *consumer* we refer to the consumer that is served by the IA, not all end-users in general.

It should be noted that a large part of the impact, especially for the consumer, is dependent on several implementation choices corresponding to each of the different models. Our analysis is based on some of the implementations of these models in other countries, for example France, Belgium and Germany.

Table 4 Consumer impact analysis

Model	Impact on consumer
Split-responsibility	Consumer self-consumption can be limited / discouraged as it is determined on meter level rather than on connection level.[14] Depending on the future metering requirements associated with this model, the consumer may need to install (and pay) an additional smart meter. The consumer will receive an additional energy bill.
Corrected - meter	Meter readings on the energy bill will deviate from the meter readings on

14 See the example below this table.

Model	Impact on consumer
reading modification	the display (and other devices that show meter readings). Volumetric grid fee charges, as well as volumetric taxes may be inconsistent with the energy volume on the bill. Consumer needs to pay for energy that is not physically delivered or doesn't need to pay for energy that is delivered, this may face legal issues. Consumer needs to be reimbursed by the IA for the energy as well as the flexibility, this requires the consumer to validate the energy settlement with the IA which is complex and not transparent. This leads to a more complicated billing procedure which may be difficult for the consumer to understand. A poor baseline quality and poor meter data quality will impact the energy bill. However, since that same (incorrect) volume is compensated by the aggregator, this effect is minimal.
Corrected – separate specification	Consumer needs to pay for energy that is not physically delivered or doesn't need to pay for energy that is delivered, this may face legal issues. Consumer needs to be reimbursed by the IA for the energy as well as the flexibility, this requires the consumer to validate the energy settlement with the IA which is complex and not transparent. This leads to a more complicated billing procedure which may be difficult for the consumer to understand. A poor baseline quality and poor meter data quality will impact the energy bill. However, since that same (incorrect) volume is compensated by the aggregator, this effect is minimal.
Central settlement	None

Regarding the **self-consumption** (only applicable for the split-responsibility model):

Consider an example where a customer that already has rooftop PV and an EV charger, considers offering the inherent flexibility of the EV charger to the market.

Let's assume that at a certain point in time the consumer's PV generates 5 kW, their EV charges with 4 kW and their home has a demand of 1 kW.

- If the consumer offers their EV flexibility to their original supplier (acting as aggregator in the integrated model), they can simply consume its own energy, and the energy bill will show a net zero consumption for that period of time.
- If they consumer offers their EV flexibility to an IA that uses the split-responsibility model, the IA is responsible for sourcing the energy at the level of 4 kW. In other words, the EV charger has its own meter showing 4 kW, so this needs to be sourced by the IA's supplier. Even if the IA would like to use the locally produced energy by the PV, this energy is in the original supplier's perimeter. Therefore, to use that energy the IA would need to perform a wholesale transaction to acquire the locally produced energy. In any case, the consumer will need to pay energy taxes / VAT on the

energy used for charging the EV, which would be avoided in the case in the integrated model (or in any of the flex-only BR models).

There may be ways to solve this issue by performing some kind of roaming / central settlement, but this is probably more complex than any of the flex-BR models. E.g. think about adding a heat pump to the equation, operated by another IA. Who decides if the PV energy is used by the EV or by the heat pump, or both?

4 CONCLUSIVE ANALYSIS

In this section a short summary of the suitable models is provided. We indicate that the split-responsibility model is a logical model to implement and apply. We also provide arguments for implementing a second model. We conclude by studying the proportionality of a second model.

The impact of any regulatory decision can generally be split into two parts:

1. Impacts on the parties directly involved (e.g. the IAs, their consumers, suppliers, TSO, regulator)
2. Impacts on society at large (societal impacts), e.g. generally larger utilisation of demand side flexibility, a more competitive energy supply, environmental benefits, etc.

While IA implementation may improve the competitiveness of the end user market in Sweden, we do not have reasons to assume there are significant differences between the IA models in this respect. There is not yet sufficient experience about which model is more efficient at promoting demand response. The same applies for environmental benefits. Hence, we cannot distinguish which model has the most attractive impacts on the society at large (part 2 above) in the long term, based on empirical evidence. Therefore, such impacts are outside the scope of this report.

The impacts on consumers, suppliers and the IAs are studied in detail in chapter 3 and summarised below. Impacts on the TSO, including the ARP role, and the regulator are outside the scope for this analysis, but some of such impacts are briefly reflected in table 7 and 8 below.

4.1 Summary of the models

The impact on the consumer, supplier and IA has been described in the previous section. Below, the impact on regulatory framework and the suitability for all markets is explained.

Table 5 Model impact summary

	Impact on regulatory framework	Suitable for all markets / products / technologies	Impact on consumer	Impact on supplier	Impact on IA[15]
Split-responsibility	Low	Yes	Low to high[16]	None	Low (for small consumers) and Medium (for C&I consumers)
Corrected – meter reading modification	High	No	High	Low to medium	Low
Corrected – separate specification	Medium	No	Medium	Low	Low to medium
Central settlement	High	No	None	Low	Low

Impact on regulatory framework

15 Impact assessment assumes that there are no additional requirements for metering. If this is the case (depending on the model), the impact can be high, especially for residential customers.

16 Impact is low for customers without self-consumption (in this case limited to receiving an additional bill), impact is medium to high for customers with self-consumption, i.e. those that have either solar PV, battery or EV with vehicle-to-grid capabilities. In this case, the exact impact is depending on the specific situation.

The next section describes the low impact of the split-responsibility model on the regulatory framework. The other three (flexibility-only BR) models require significant changes to the regulatory framework, these include:

- Formalisation of the aggregator (or flexibility service provider) role and associated responsibilities, e.g. in relation to consumer protection;
- Organisation / facilitation of the transfer of energy, including the financial settlement (somewhat similar to the reconciliation process)[17];
- The ToE, whether organised through the customer or centrally, leads to a financial settlement. The supplier will receive an invoice or remuneration that, depending on the implemented model, does not provide full transparency. For example, in the Central Settlement Model, the supplier is (typically) not informed about the affected consumers. This could lead to legal obstacles and / or the need for third-party assessments;
- Definition of baseline methodologies for the verification of the physical delivery;
- Managing and allocating baseline (and potential synthetic profiling if sub-metering is not used) error between actors, including on consumers;
- Design of (suitable) metering requirements, especially when validation occurs on sub-meter level; and
- Additional market processes and information exchange between market players and regulated entities.

Suitable for all markets / products / technologies

Both the corrected and central settlement model require a (regulated) baseline methodology for the transfer of energy, which is sufficiently accurate and acceptable for all parties involved. The baseline methodology is used to describe the load/generation pattern of an asset during a DR activation event, in case the DR was not activated (the "counterfactual"). In other words, it describes the normal, uncontrolled behaviour of an asset. For an asset that is controlled frequently (e.g. on a day-to-day basis), the "normal" behaviour is difficult to assess, as DR activation becomes part of the "normal".[18] Therefore, the corrected and central settlement model are suitable for market-asset combinations with low activation frequency (e.g. capacity products), but less suitable for market-asset combinations with high activation frequency, e.g. EV charging in wholesale markets.

The corrected model, with meter reading modification, may face legal issues, as energy is invoiced that is not physically delivered. We do not expect this model to be feasible for the residential segment.

Finally, there is no economic reasoning to apply either the corrected or central settlement model in wholesale markets for consumers that are already exposed to the same wholesale markets through their energy tariff. Any services offered by a third party, optimizing the load profile against the energy tariff, can be delivered to the consumer directly (in an Energy Service Company (ESCo) role[19]), with (potentially) direct remuneration by the consumer.

17 A process to correct the open supply position caused by the wholesale allocation process being based on synthetic load profiles for small consumers. It's a settlement between the suppliers based on the yearly (or monthly) meter readings.

18 For specific products, sufficiently accurate baseline methodologies are available, also in case of frequent activation. Main examples are (near-) real time products with short sustain time, e.g. the faster balancing products.

19 An energy service company (ESCo) is a company that offers auxiliary energy-related services to consumers.

4.2 Use of split-responsibility model

Based on our analysis, we recommend implementing the split-responsibility model as a suitable model for certain types of IA (mainly assets with low marginal costs, activated with high frequency – e.g. day-to-day basis), for the following reasons:

1. From a regulatory perspective, the model can be used for all markets and products, and for all segments (the market / business perspective will be analysed separately).
2. The regulatory changes needed to implement the model, are limited. Also, administrative changes within market parties are limited.
3. It will not lead to market distortions, instead it may even increase the competitiveness of the retail market.
4. There is no direct impact on the original supplier – therefore no reason for the (original) supplier to be compensated.
5. The model could improve the implementation of article 4.12 of the Alternative Fuels Infrastructure Directive (*Member States shall ensure that the legal framework permits the electricity supply for a recharging point to be the subject of a contract with a supplier other than the entity supplying electricity to the household or premises where such a recharging point is located*.) [6] and support the implementation of article 4 of the Directive (EU) 2019/944 in the CEP [1].

4.3 Need for a second model to facilitate independent aggregation

Despite the general applicability of the split-responsibility model, our analysis yields two arguments for implementing a second model. These are further elaborated in the next subsections.

4.3.1 Generalisation of the BSP-IA model

The NordREG report [2] introduces the BSP-IA model for IA that are active in balancing products. In accordance to the Balancing Guideline, the BSP-IA model is facilitated through a perimeter correction of the affected BRPs. It should be noted that:

- the perimeter correction does neutralize the affected BRPs' positions, but does not solve the open supply position;
- the IA does not need to apply the split-responsibility model (it is an alternative model);
- in its current form, the BSP-IA model does not allow/facilitate the IA to access other markets, especially wholesale markets; and
- the BSP-IA is held responsible for any imbalance it creates (by delivering more or less balancing energy than agreed), but does not need to assign a BRP.

Implementing any of the three proposed alternative models will not only support the implementation of the electricity balancing guideline, but will also address all above mentioned issues. This is further explained in Appendix B.

4.3.2 Potential entry barrier for IAs

Note that in this analysis, we focus on differences between the studied models. Potential entry barriers that may exists for demand-side participation in general (e.g. those related to prequalification requirements) are out of scope of this analysis.

As argued in section 3.2, the split-responsibility model may create a market entry barrier for an IA, since it needs to either perform the supplier role, or partner with an existing supplier. However, depending on the approach of the IA, it may also open opportunities that otherwise would have been hard to get, e.g. a joint venture between an IA and a supplier can make both more competitive: the IA able to reach more potential customers and the supplier better dressed to compete with other suppliers that also may offer demand response services (through the Integrated model).

The alternative is to partner with an existing supplier. This may be feasible within a strongly competitive market, such as the Swedish market. This supplier is likely to face low imbalance costs if the IA controls all the load in its portfolio and the sourcing costs can be optimised. Since the IA needs to partner with a BRP anyway to access wholesale markets, partnering with a supplier/BRP is not a significant burden.

However, for IAs operating industrial flexibility (which value is dwarfed by the electricity costs of these customers) the need to also supply energy will remove the value of their competitive edge on flexibility control. In this case, the IA's core business is quite remote from energy supply (which includes sourcing optimisation), as the IA's portfolio does not provide economic means to optimize a supplier's portfolio on a day-to-day basis.

For this case, the extent to which the performance of the supplier role can be considered an entry barrier can be analysed by examining markets with existing IAs. As observed earlier, the IAs in these markets currently (and predominantly) operate industrial flexibility. Even without the split-responsibility model, IAs can combine DR services with the supply role for their existing consumers, since they have a close relationship with their consumers by the nature of their services. However, in none of these markets (France, Belgium and Germany), we observe the tendency of IAs to perform the supplier role (nor to develop strategic partnerships with suppliers), suggesting it can be difficult to be competitive in supply markets.

4.4 Proportionality of a second model

Although the introduction of the BSP-IA model already would create a second model, extending this model to facilitate IAs entering other markets, will come at additional costs. Deploying the model may have additional costs but may also show benefits. In this section we will analyse the associated costs of a second model, and the potential benefits this may bring, based on empirical data. We consider the split-responsibility model as the base case.

4.4.1 Qualitative costs and benefits of implementing and applying the Central Settlement or Corrected model

In this section we show the costs and benefits of both implementing and applying the Central Settlement or Corrected model, relative to the split-responsibility model. Both models could be used for all markets (although limitations exist with respect to activation frequency).

The table below presents the one-off costs and benefits associated with implementing these models. Primarily costs associated with modifications in administrative processes of both the supplier and IA, as well as modifications to the regulatory framework and market facilitation are concerned.

Table 6 One-off cost/benefits of Central Settlement or Corrected model implementation

	Consumer	Supplier	IA	Regulatory framework	Market facilitation
Administrative processes		- ToE verification[1] - consumer billing[1]	+ no need to implement split-resp. processes - ToE verification	- Grid code modification - ToE monitoring	- ToE facilitation

[1] Not relevant for the Corrected model – meter reading modification.

Table 7 shows the recurring costs and benefits of applying the Central Settlement or Corrected model, relative to applying the split-responsibility model. Compared to the split-responsibility model, the most significant cost is associated with the supplier. The supplier might face costs associated with the rebound effect and the limited transparency that will create difficulty on the validation of the ToE. Whereas, consumer and IA might see benefits due to fewer energy bills and potentially to lower metering requirements (depending on the implementation). Finally, if the consumer has their own distributed generation (or batteries / EV with discharging capabilities), they would see improved options for self-consumption. Regarding market functioning, barriers for market entry will be lowered for IA and consumers will consequently benefit from improved market functioning and more choice.

Table 7 Cost/benefits of Central Settlement or Corrected model application

	Consumer	Supplier	IA
Billing	+ single energy bill + improved options for self-consumption	+/- impact on customer support[2]	+ no billing needed, or only needed for activated energy
Metering	+ lower costs[3]	None	+ lower costs[3]
Rebound effect	none	- impact on imbalance	None
Transparency	- payment for non-consumed energy[5]	- ToE difficult to validate[4]	None
Market functioning	+ consumer benefits from improved market functioning + more choice	None	+ no revenue sharing with (other) supplier + lower market entry barriers

[2] Single bill could lead to fewer consumer questions, Corrected model could lead to more questions.

[3] Depending on metering requirements for all models.

[4] Especially relevant for Corrected model – meter reading modification, also relevant for Central Settlement model, less relevant for Corrected model – meter reading modification

[5] Only relevant for Corrected model.

4.4.2 Additional benefits of implementing the Central Settlement or Corrected model based on empirical analysis

To assess the benefits of implementing a second model, we look at markets where the ToE has already been implemented, and examine to what extent IAs are active in these markets using the ToE facilitation, or whether demand-side flexibility is dominantly offered by (i) suppliers using the integrated model (ii) IAs using a Contractual model (the split-responsibility model is not implemented in the Belgian market).

In the Belgian case for the mFRR product (R3), as indicated in Table 8, nearly two thirds of the R3 awarded capacity is signed under a Transfer of Energy arrangement. Whereas only 36% of the capacity comes from either suppliers acting as BSPs or aggregators with a supplier contractual arrangement. It is evident that the ToE option is the preferred option for aggregators. It is worth noticing that the R3 flex product has very limited activations, in particular in 2019 it was activated 3 times.

Table 8 2019 Elia ToE statistics on R3 product **[7]**

	ToE	**Integrated / contractual**	**Total**
Number of Delivery Points	112	146	258
Total R3max up (MW)	952	545	1497
Share of R3max up (%)	64 %	36 %	100 %

To examine the counterfactual, we take a look at the IA's flexibility portfolio. If the ToE would not have been facilitated, their flexibility portfolio could be split into three parts:

1. One part would not have been disclosed and brought to the market. This would have lowered the supply, leading to higher market prices.
2. A second part would have been offered by a (competing) supplier through the integrated model. In the current market, the IA has shown to be more competitive, therefore this part would have been participating against a higher price
3. A third part would have been offered by the same IA using an alternative (available) model. Since the IA has opted for the ToE methodology, this indicated that this is economically the preferred option. Therefore, also this part would have been participating against a higher price.

We observe in the Belgian market that the least benefit the ToE mechanism has brought the IA, is a better negotiation position with the original supplier. Apparently negotiating the ToE price isn't the largest hurdle (considering volumes are low), but the many aspects that need be agreed upon (e.g. flexibility quantification/verification) is considered a high burden.

4.4.3 Conclusion on proportionality

Implementing a second model comes with (mainly) administrative costs for the markets. The deployment of such a model comes with some additional costs, but also with benefits, especially for the consumer.

The benefits are difficult to quantify. In an emerging market, where business cases are still weak and uncertain, removing market entry barriers is key to encourage market participation, especially in a business with relatively high up-front costs on consumer side. Provided the market for demand side participation can grow with some significance, the one-of costs for implementing a second model can be justified.

4.5 Choice of a second model

If a second model will be implemented, from the three examined flex-only BR models, a choice needs to be made between the Central Settlement Model, the Corrected Model with meter reading modification and the Corrected model with separate specification.

In general, the differences between these models are limited, both in costs and effects. Assuming the regulated ToE price methodology is close to the retail price (needed to neither distort the market nor the IA's business model), the economic effects are very similar. The main differences are listed in the table below.

Table 9 Main differences between Central Settlement and Corrected model

	Central Settlement Model	**Corrected Model – meter reading modification**	**Corrected model – separate specification**
Need for regulated ToE price methodology	Yes	No	No
Protection of IA's commercial sensitive information	Largely	Yes	No
Transparency for supplier	Partly	No	Yes
Impact on consumer billing process (supplier and consumer)	No	No	Yes
Impact on consumer remuneration process (IA)	No	Yes	Yes

When weighted equally, the Central Settlement Model seems the most appropriate model, but this all depends how the different characteristics are weighted by the policy makers.

5 RECOMMENDATIONS

We base our recommendations on the analysis of direct impacts discussed in the previous chapters, and conclude as follows:

1. Implementing the split-responsibility model

   This model has several benefits, as it can be generically applied, and can serve other purposes as well (e.g. efficiency improvement of the implementation of article 4.12 of the AFID and article 4 of the EC's Electricity Directive (2019/944)). The costs for implementation are relatively low, since it requires relatively few regulatory changes and relatively few changes in market processes and IT. However, this model has an impact on the consumer, especially in cases the consumer has self-consumption, and it also creates a market entry barrier for IAs serving large commercial and industrial consumers. In addition, additional metering costs may be an issue, and should be kept to a minimum, especially in the residential segment.

2. Implementing a second IA model

   Implementing either the Central Settlement Model or the Corrected model will, for certain markets and technologies, improve the level playing field for IAs. At the same time, it will also align the IA-BSP role with the Swedish wholesale settlement mechanism, while addressing the compensation issue. It comes with additional costs, but these are merely one-off costs (regulatory changes and process/IT modifications with market players) that can further propel a mechanism with the potential to provide significant contribution to the energy transition.

   Out of the three alternative models, the Central Settlement Model may be the best option from the consumer perspective, where the ToE price formula should be at retail price level (excluding taxes). If the burden of a regulated price formula is too heavy, the Corrected Model – separate specification may be the best choice.

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[2] NordREG, "Nordic Regulatory Framework for Independent Aggregation," 2020.

[3] "COMMISSION REGULATION (EU) 2017/2195 Guideline on electricity balancing," [Online]. Available: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017R2195.

[4] "Universal Smart Energy Framework," [Online]. Available: https://www.usef.energy/.

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APPENDIX A DISCARDED MODEL - FLEXIBILITY CONSIDERED AS 'AVOIDED GENERATION'

This model, as described below, assumes that there is no need for Transfer of Energy if the DR activation is considered as negative generation.

1. The IA has the same responsibilities as a generator. i.e. It has no responsibility for matching its customers' consumption with energy, but is responsible for ensuring its 'production' is delivered.
2. Its products are measured and traded as normal wholesale market production products, but in practice are the delivery of negative volume.
3. Products are measured as the difference between the baseline load and the actual measured load
4. Customers will have other BRPs for their consumption, normal suppliers, that will be responsible for matching the customers load with purchased production from the wholesale markets

In this appendix, we show how this method would disturb the overall administrative balance through the examples below.

We need to make a clear distinction between the different BRP's depicted in the examples. If not, then we may jump to the wrong conclusion.

- BRP-sup: the BRP that is affected because the DR is performed at a consumer in its perimeter
- BRP-agr: the BRP of the aggregator
- BRP-req: the BRP of the supplier buying the flexibility
- BRP-gen: the BRP of the generator (used to explain the example)

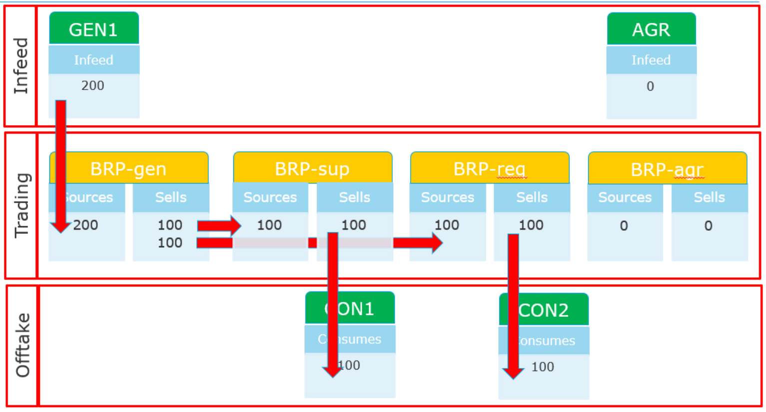
Example 2 below show why the "avoided generation" method will not work.

Main reason is that, whether DR is applied or not, the total in-feed always equals the total off-take. If you would allow "avoided generation" into this equation, then the balance is lost, and the whole mechanism of balance responsibility collapses.

Since the avoided generation model does not keep the administrative balance, we can conclude that with an aggregator active in BRP_{sup}'s perimeter, as shown in example 3, a Transfer of Energy is needed to balance both perimeters (for DA and balancing trading).

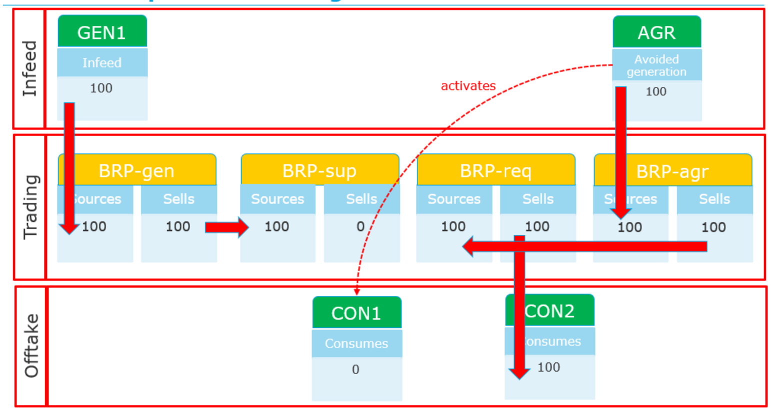
Avoided generation vs ToE

No Demand Response



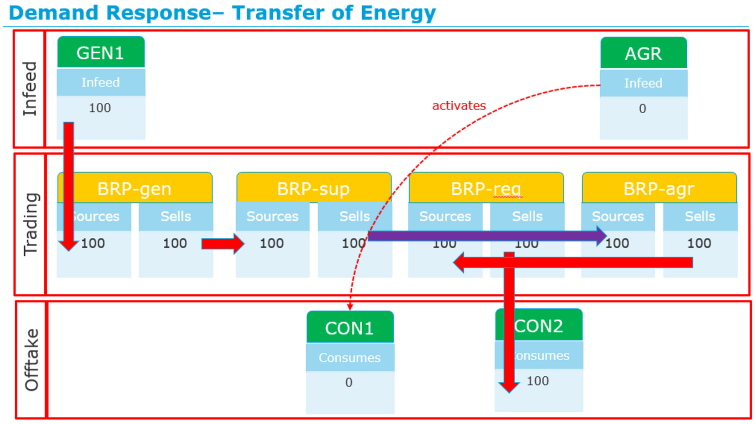
1. This example shows the BaU trading activity without any DR event. As depicted, the BRP-sup is (through its associated supplier) supplying energy to consumer CON1 and BRP-req is (through its associated supplier) supplying energy to consumer CON2. Both, administrative and physical balance are maintained in this situation, i.e. the perimeters of both BRPs are balanced.

Demand Response– *avoided generation* model



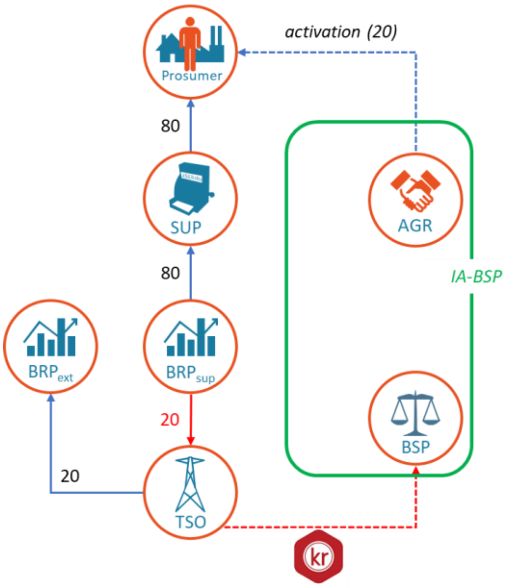
2. In this case, the aggregator deploys DR by sourcing avoided generation (100) and selling it to the BRP-req. Since the BRP-req now buys the energy from the aggregator, the Generator reduces its production by 100. At the same time the supplier BRP-sup sources 100 from the generator BRP-gen. The energy that BRP-sup sourced is not used by the consumer due to the DR activation, as shown in the administrative balance of the supplier.

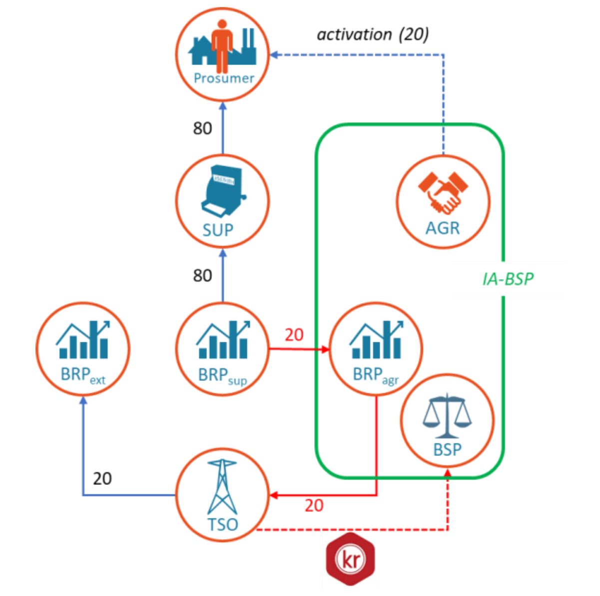
Although the system is balanced 'physically', the administrative balance is not maintained. The physical balance implies that the total in-feed always equals the total off-take, whether DR is applied or not. This also implies that, after the balancing perimeter corrections have been applied, all perimeters should be in balance. By allowing an aggregator to source its energy (i.e. balance its perimeter) through "avoided generation", this is no longer the case (BRP-sup is out of balance).

	**3.** When adding transfer of energy to the equation, we can observe how all parties' infeed are equal to their offtake, maintaining the physical and administrative system balance.

APPENDIX B GENERALISATION OF THE BSP-IA MODEL

The description below focuses on the central settlement model, but the same logic also applies to the corrected model.

Generalisation of the BSP-IA model (BSP-IA delivers according to plan)	
	This example is similar to the example elaborated in section 1.2. Here we focus on a market party the combines the aggregator and BSP roles, the so-called BSP-IA. Main characteristics of the BSP-IA model, according to the Balancing Guideline: • There is no contract with or consent by the consumer's supplier or its BRP needed • The BSP-IA is paid by the TSO for the balancing services • The balancing energy is taken out of the perimeter of the affected BRP(s) • Although the BSP-IA may be penalised for over- or under-delivery, they have no formal BRP role (not stipulated by EBGL but proposed by several Nordic TSOs).



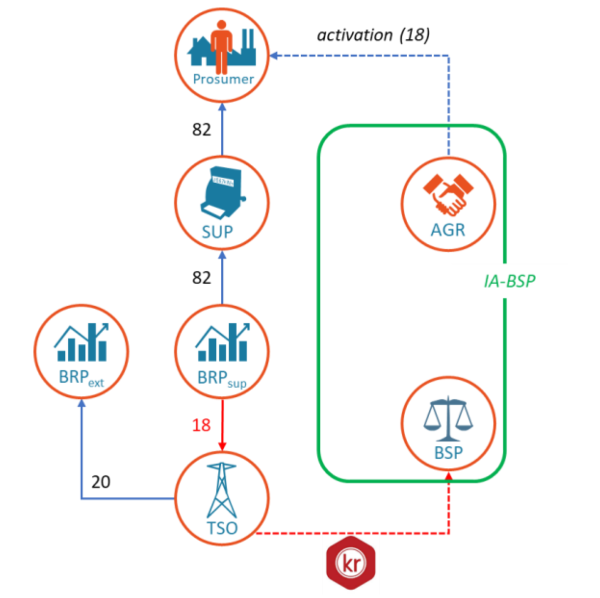
By just redrawing the red line between BRP_{sup} and the TSO (routing it through the BSP-IA), the mechanism is far more consistent with balancing services and wholesale settlement.

- Both payment and energy transfer are now between the BSP and TSO
- The DR activation (at the retail side) is mirrored by a wholesale transaction between the supplier and the aggregator (the "ToE")
- The ToE is the obvious mechanism to resolve the unmatched supplier position.

To make this wholesale transaction possible, the BSP-IA needs to perform (or assign) the BRP role. This has further advantages:

- It allows the IA to enter all other markets, especially wholesale
- It automatically solves the issues of the BSP-IA affecting the system balance, by under- or over-delivery, as demonstrated in the next example.

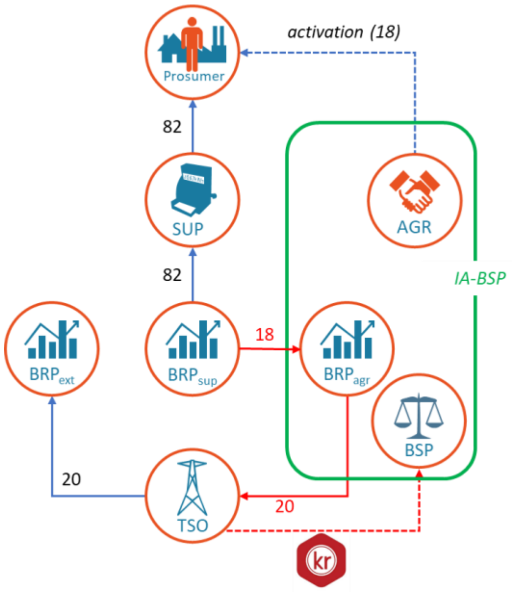
Generalisation of the BSP-IA model (BSP-IA falls short in delivery)



In this example the BSP-IA has agreed with the TSO to activate 20 units of balancing energy. In reality, it only activates 18 (which only becomes clear ex-post).

In the proposed BSP-IA model:

- The balancing energy is taken out of the perimeter of the affected BRP(s) based on measurements, so this BRP is not affected by the under-delivery (his portfolio is still balanced).
- The missing 2 units will have to be delivered by another BSP (not shown in the figure).
- Since the BSP-IA has no BRP role, the under-delivery has to be penalised through a separate mechanism.

	The generalized BSP-IA model (in this example the central settlement model), since it is fully embedded in the regular balancing and wholesale settlement mechanism, takes care of the under-delivery. • Since the ToE is also based on measurements, the BSP-IA only sources 18 units. • By committing to 20 units in the balancing product, the BSP-IA faces an imbalance of 2. • Costs for restoring this imbalance (by calling upon a second BSP) will be borne by the BSP-IA. The same mechanism applies for over-delivery.

The ToE facility can be made available for BSP-IAs that prefer this option. BSP-IA may still enter into a contractual agreement with the supplier of the consumer, and organise the transfer of energy bilaterally (the Contractual Model).

APPENDIX C ABBREVIATIONS

AFID	Alternative Fuels Infrastructure Directive
ARP	Allocation responsible party
BR	Balance responsibility
BRP	Balance responsible party
BRPagr	Aggregator's balance responsible party
BRPsup	Supplier's balance responsible party
BSP	Balancing service provider
CEP	Clean Energy Package
C&I	Commercial & industrial
DR	Demand response
DSO	Distribution system operator
EBGL	Electricity balancing guideline
ESCo	Energy service company
FCR	Frequency containment reserve
IA	Independent aggregator / independent aggregation
MC	Marginal cost
mFRR	Manual frequency restoration reserve
NordREG	Nordic Energy Regulators
ToE	Transfer of energy
TSO	Transmission system operator

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