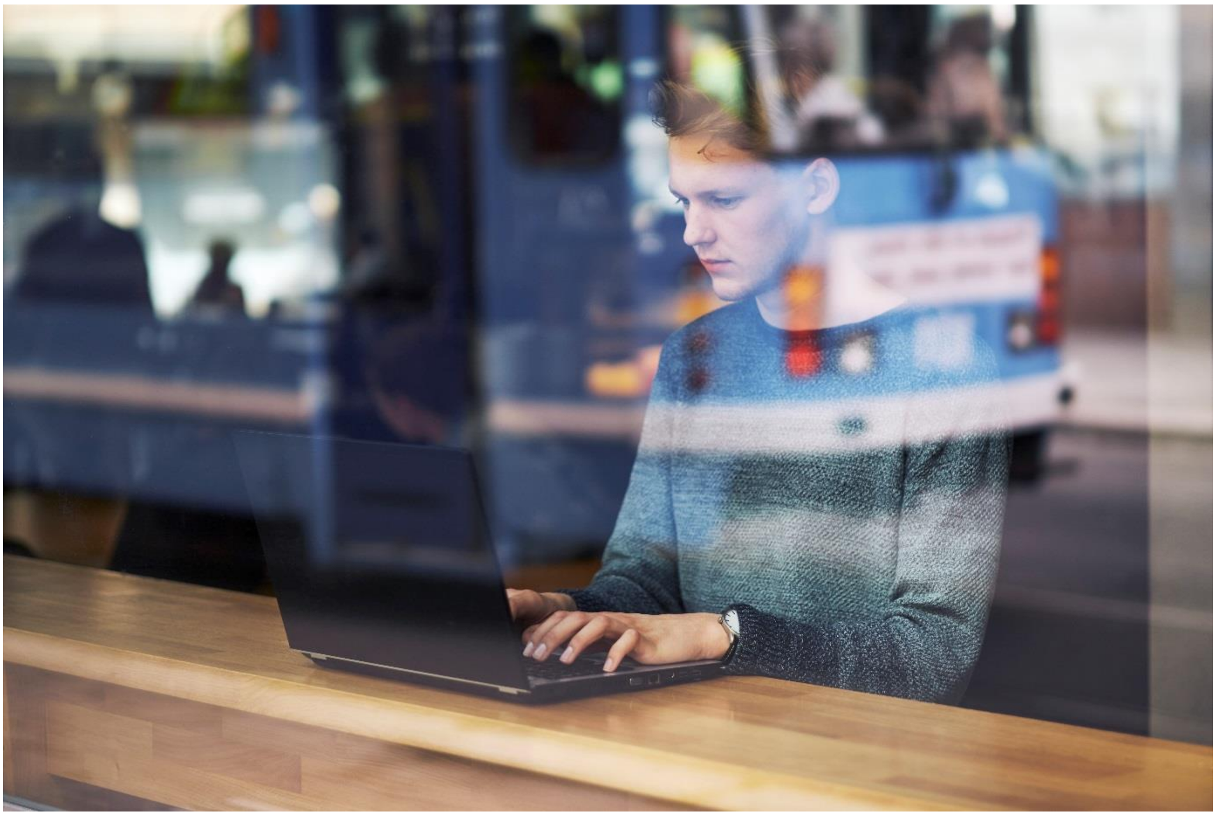
Unlocking flexibility

Nordic TSO discussion paper on third-party aggregators



Content

Abbreviations

For further explanations see Glossary list Chapter 6.

BRO – Balancing Resource Owner
BRP – Balance Responsible Party
BSP – Balancing Service Provider
CEP – Clean Energy Package
DSO – Distribution System Operator
DSR – Demand Side Response
EV – Electrical Vehicle
EBGL – Electricity Balancing Guideline
FCR – Frequency Containment Reserves, FCR-N (Normal) and FCR-D (Disturbance)
FRR- Frequency Restoration Reserves, aFRR (automatic) and mFRR (manual)
TSO – Transmission System Operator

1. Executive summary

As Nordic TSOs, we find it important to make use of the most socio-economic solutions for balancing. This includes that all consumers and generators are able to provide their flexibility to the market, meaning that they can alter and sell their flexibility in demand and generation according to system operation needs. Well-functioning balancing markets increases the security of supply.

Aggregation is a tool that enables smaller resources to participate in the market. This discussion paper investigates aggregation from a TSO perspective and is written by the four Nordic TSOs. Our focus lies with the balancing markets.

The paper does not go deep into the barriers of aggregation and measures to overcome these, rather we discuss how we may meet the ongoing development of new actors wanting to enter the market. That said, discussions about aggregation in electricity markets tends to be a polarized debate. Whilst new actors may argue the electricity market holds barriers that prevent them from entering, conventional actors may argue that it is the lack of profitability, not the market design, that is the real barrier.

The paper provides examples of models which are being or have been tested in pilots in the Nordics. There are multiple models for how to allow third-party aggregation. The models span from a centralized model where the TSO handles the reimbursement mechanism to a solution where multiple meters enables multiple BRPs per connection point. Whereas there is currently no "one solution" in the Nordics, the examples can provide a discussion basis for continued development. It furthermore illustrates the different paths the Nordic countries are and have been trailing, and which will lead to a diverse range of lessons learned. Although the different Nordic countries may choose one or several different models in the end, there will be elements that may be harmonized already today.

These are our key findings:

- We should aim for harmonization of the aggregation rules in the balancing markets. It implies that actors can relate to one instead of four different national concepts in the Nordics, enabling a faster and more harmonized development of the Nordic balancing markets.

- Common Nordic framework would foster market actor mobility in the Nordic area. However, the national markets for aggregation and for demand side response are in different phases of development/piloting. Hence, there is currently no "one solution" in the Nordics. It may well be that multiple models will be implemented, also on a national scale. We must therefore harmonize what can be harmonized, such as e.g. requirements for metering and verification.

- Balance responsibility is an important principle working as an incentive for market actors to plan and operate and correct their portfolio to be in balance. It has been suggested from the EU Commission that all market actors, including aggregators, will have to be balance responsible parties (BRP) or delegate their responsibility to a party of their choice[1]. Still, the Clean Energy Package (CEP) is not finalized yet, so the coming months will show what will be the final result. It is clear that any changes to existing market design must assure fair and transparent solutions that ensure socio-economic efficiency. Freeriding hindering these solutions to be efficient must be prevented.

[1] Proposal for EU Regulation on the internal market for electricity, Article 4.1 Balancing Responsibility

2. Introduction to the discussion paper

This discussion paper is a result of a Nordic TSO project commissioned June 2016 with the aim of investigating the role third-party aggregators may and could have in the Nordic balancing markets. This discussion and work is still in process, and hence this paper aims to be a basis for discussion rather than to provide firm recommendations. We have a goal to develop harmonized solutions in the Nordics, and this paper provides the first steps towards a common Nordic approach for aggregation. In this process, we find continued dialogue with market stakeholders important, and due to this a stakeholder workshop is planned for in 2018.

2.1 Why are the TSOs interested in aggregation and third-party aggregators?

Concerns about keeping a high security of supply have raised while the share of intermittent renewable electricity generation is increasing. During the past years, we have investigated several options to unlock available flexibility both from generators and consumers. In August 2016, the four Nordic Transmission System Operators (TSOs) Statnett SF, Energinet, Fingrid and Svenska kraftnät, published the report "Challenges and opportunities for the Nordic Power System". One of the identified challenges was to "meet demand for flexibility by ensuring that market prices reflect the value of flexibility"[2]. Given the developing demand for flexibility and technology it is time to rethink who can be providers in both energy and balancing markets.

One measure to increase the flexibility in the markets is to enable market actors to aggregate resources (eg. loads and generation) more freely than today. Aggregation is a tool that enables smaller resources to participate in the market, and can be done by conventional suppliers and BRPs. Still, new actors including third-party aggregators, have the potential to think outside of the "path of depedency" that may come with conventional business. This may not only enable more resources to participate with their flexibility, but also trigger conventional market participants to develop new services to their customers using smart technology. Still, new market actors also implies new challenges. Discussions about aggregation in electricity markets tends to be a polarized debate. Whilst new actors may argue that the electricity market holds barriers that prevent them from entering, conventional actors may argue that it is the lack of profitability, not the market design, that is the real barrier. Any changes to exisiting market design must assure fair and transparent solutions that ensure socio-economic efficiency. Freeriding hindering these solutions to be efficient must be prevented. There is a need for thorough discussions to consider solutions, and discussion paper investigates aggregation from a TSO point of view.

[2] http://www.statnett.no/Global/Dokumenter/Challenges%20and%20opportunities_Executive_Summary_pdf.pdf

2.2 Scope: Third-party aggregators and model examples for the balancing markets

A third-party aggregator is a Balance Service Provider (BSP) which is outside the conventional chain of energy supply i.e. is neither the Balance Responsible Party (BRP) nor the Supplier to the Balancing Resource Owner (BRO).

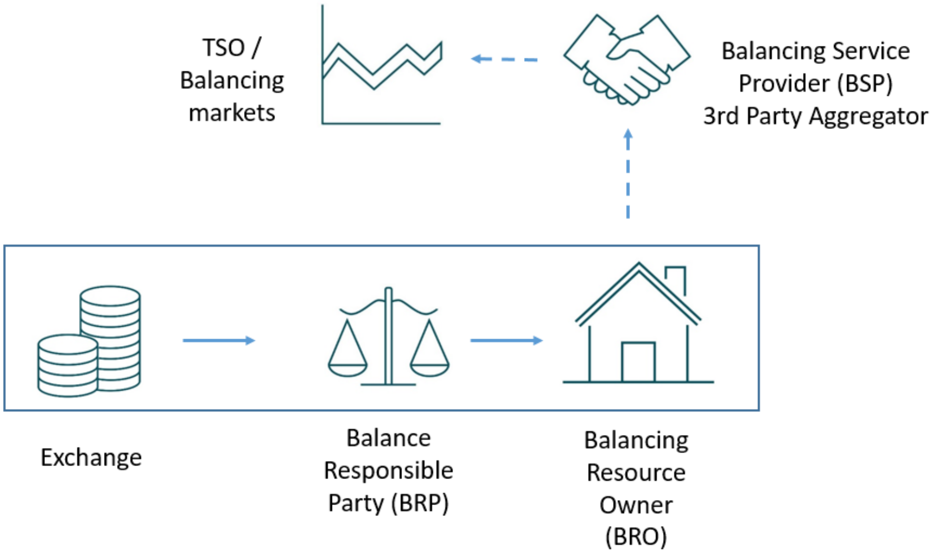


Figure 1 Third-party aggregator is a BSP that comes outside of the conventional supply chain

In this paper we lay out several models for aggregation in order to discuss the possibility for both existing and new market actors to participate in the balancing markets. We do not go deep into the barriers of aggregation and measures to overcome these, rather we present models that are variations of how the third-party aggregator may integrate and/or interact with the other parties in the supply chain. The models are or have been tested through pilots in the Nordics, and are meant as model examples more than solutions. As the paper concludes, there is currently no "one solution" in the Nordics. It may well be that multiple models will be implemented, also on a national scale.

We have scoped the discussion in this paper to only treat balancing markets. These markets encompass frequency restoration reserves (mFRR and aFRR) and frequency containment reserves (FCR). We organize and are the single buyers in the markets, while both generators and consumers provide the products. The markets are vital tools both for TSO grid operation and balancing. The need for new aggregation rules rise especially in the balancing markets as new actors are wanting to enter there already now. Hence, this paper discuss how we as TSOs may meet the ongoing development of new actors wanting to enter the balancing markets.

That said, aggregation takes place and have a potential value in all power markets, from retail to wholesale markets encompassing day-ahead, intraday and balancing markets. A retailer purchasing power in the day-ahead market to provide electricity to his customers or updating his position in the intraday market is in reality aggregating demand to a portfolio. In the same way, a producer with multiple energy production plants can aggregate production and sell them as one production bid in the day-ahead market and intraday market. Furthermore, the Nordics have a solid potential to exploit demand side response with a well-developed retail market where the end-consumer can freely switch between suppliers. The introduction of the smart meters enables hourly metering and billing which will provide customers with stronger price signals.

3. From challenges to transparent rules for all market actors

3.1 Aggregation challenges seen from a TSO perspective

What are the practical implications of facilitating the balancing markets for all market actors? And furthermore, what should be the TSO role in enabling more aggregation in balancing markets?

It is clear that the TSOs will have a decisive role in developing future requirements in the balancing markets. The aggregator and BSP roles will be regulated through the new proposal from EU on electricity regulation CEP and the EBGL, and hence implemented in the national regulation. It is important that our proposals are in line with this and furthermore that it do not interfere with other measures such as e.g. national schemes for tariffs.

The Nordic balancing markets are mainly designed for participation of larger units/consumers. Current minimum bid sizes require a certain volume to be aggregated for participation to be possible. For several years it has been discussed in ENTSO-E and the Nordic countries to lower the bid size and e.g. apply a European standard of 1 MW for FRR. However, a common agreement has yet to be implemented, which means that even larger market actors may have trouble bidding individually. An aggregator will need to gather a rather large amount of resources eg. up to 5000 heat pumps or 3000 EVs to reach the 10MW limit which is currently the mFRR minimum bid size in Norway/Denmark and most areas in Sweden. In Finland, the mFRR minimum bid size is 5MW if electrical activation is used. Lowering bid sizes implies that we and the market actors develop and implement solutions for electronic bid activation ordering. With more automatization and facilitated IT-systems, such as electronic bid activation ordering, lower volumes may be allowed to access the market.

One of the aspects with aggregation that needs to be solved is the verification of the delivery, including measurement in a suitable time resolution. We must question when and where we need e.g. real time data. There is a different information need in different phases and different markets. Hence, the information need for the FCR market may be different than for the mFRR market[3]. Online metering for resources which are participating in the balancing markets is needed to be able to predict flow changes in grid and system security i.e. minimum frequency. To smaller resources, online metering on resource level is seen as a general challenge to the aggregator business model. This is due to the relatively high cost of acquiring metering equipment especially on smaller units where the quantity of flexibility and possible revenue per BRO is relatively small. Bringing down equipment cost would help, still the cost of physical installation of meters needs to be covered in the aggregator and/or supplier business model. Furthermore, there are fixed communication costs €/month for online metering. In the USEF work[4] it was recommended that a metering from the aggregator can be used to avoid "double metering" if it is validated by the meter data responsible (a neutral party, e.g. DSO). Trials in Denmark showed that if the flexibility comes from a homogenious portfolio of resources, a statistical approach may be used as an alternative to submetering.

The Nordic TSOs are managing the development process of data-hubs for smart metering data in the respective Nordic countries. Smart meters can be used for real time measurements, with expanded functionality within the meter or through add-on technology/Home Area Network (HAN) port[5], but there is no real time values in the hubs. At the most, the hubs may develop towards quarterly measurements. Hubs may be used for verficiation of delivery if "metered data for settlement" can be used. Yet, with the current regulation, data settlement is not available before earliest the day after, and also at the time frame that the connection point is settled at.

[3] The Danish regulator has approved the change in the market regulation, and it is no longer a requirement in DK for FCR.

[4] Universal Smart Energy Framework

[5] http://www.gartner.com/it-glossary/home-area-network-han

Finally, can we use what the aggregators may offer us? Traditionally arguments against small volumes for TSO balancing purposes are that in order to actually help balancing the system, volumes must be of a certain size. It is based on a practical aspect, the TSOs need to introduce electronical ordering in order to make it realistic for smaller resources to participate. Lower bid volumes would reduce the need for aggregation, still the smallest resources such as households and singular units, are not realistic flexibility providers unless you have someone who is bundling these and providing this to the market.

A fundamental question in defining future rules for DSR is not only to integrate an aggregator in the market design, but also to make sure that the physical infrastructure is capable of transporting the electricity. In this process the DSO and TSO needs to be aligned and to make sure that although the two parties face different problems it is necessary to find a common solution that supports secure grid operation including enabling aggregation on both TSO and DSO level.

Increased participation from demand side response can be used for grid operation (congestion management) at both DSO and TSO level. To the TSO, DSR can increase elasticity in day-ahead markets, be used for voltage regulation and balancing among others. But there will always be a risk that the flexibility a TSO intends to use will be locked by the network structure for various reasons. With an increasingly complex power grid operation, it is imperative that TSOs and DSOs cooperate in order to enable that the flexibility is used where it has the greatest benefit to the society. Distributed flexibility from demand and generation can contribute with ancillary services both to TSO and DSO, and at the same time respond to price signals from the day-ahead market.

Central questions are what information should go to whom, when and how it shall be exchanged. CEP says that DSOs shall make data available to third parties. Still, data from a connection point or consumer data is personal data and need to have authorization from the end user. Furthermore, if an aggregator makes an installation within the premises of a consumer, this data does not have to be made available to third parties.

Secure information exchange, including both secure communication between parties and data storage is vital, and definitions and requirements should be developed. As with metering, it is important also to consider the cost of information, including the need for development of cost-efficient and reliable data sharing and information solutions. Also the value of information must be considered, i.e. related to competition issues between different market actors.

3.2 Development of transparent rules for all market actors

CEP will be decisive for how market rules for aggregation and novel demand response services will develop. Still, some leeway is left for national regulators for the implementation and e.g. specification of rules. Pilots provides us with knowledge of what path of development we should follow in order to develop the best solutions fit for the Nordic context. In the following we point to some of the major issues which are discussed in our models; balance responsibility, polluter must pay principle and independency.

Balance responsibility for all market actors. The CEP proposal for regulation on the internal market for electricity aims for all market actors to have balance responsibility or delegate their responsibility to a party of their choice[6]. That means that the principles behind balance responsibility, where market actors are incentivized to plan and keep themselves in balance will be supported also with new actors appearing in the market.

[6] 2016/0379 Proposal for a regulation of the European Parliament and of the Council on the internal market for electricity , Article 4.1 Balancing Responsibility

In the Nordics, it has traditionally been a requirement that market actors need to be BRP to participate in the balancing markets. Finland is currently the only country in the Nordics where direct participation of resource owner is allowed, i.e. BRO can be BSP and decide to participate to the balancing markets independently. The current practice in Finland is that BSP informs the BRP about balancing market participation, but BRP cannot deny participation if it is in accordance with the BRO's retail agreement. The uncorrected model and reimbursement model are models where BSP are directly participating in the balancing market, without going through BRP.

Polluter must pay. We would like to enable that the most socio-economic resources are accessed. Still, market rules must be fair. The polluter pays principle applies for all the models discussed in this paper. If e.g. there are multiple BRPs at one connection point, the other BRP(s) should be aware of changes in the resource owner's behavior. It determines the risk level connected to planning of consumption of that customer in question. Also reserve activations may challenge BRP's balance control and if BRP has real-time measurement of the resource, it might end up doing counter measures for that imbalance. Thus, it is important to give the necessary information to the BRP.

Imbalances must be handled fairly, and if there are multiple BRPs, the respective actors must be kept neutral in relation to each other. It is important that rules are transparent and secure so that there is no freeriding and that polluter pays. This principle is practiced in the balancing markets today, and basically it means that if a market actor, e.g. a resource in the market actors portfolio, is responsible for creating an imbalance in the system the cost for the imbalance must be allocated to the specific actor. For aggregators activating flexibility and e.g. contributing to restoring the system balance this means that imbalances caused by the aggregator should be remunerated or corrected towards the involved BRPs.

In the new proposal, the CEP is trying to prevent that market actors can block each other. This implies amongst other provisions the establishment of transparent rules and procedures for remuneration of energy fed into the system during the activation period.

Independency. If an aggregator doesn't need to associate with BRO's supplier and BRP in order to aggregate, the aggregator is called an independent aggregator. If aggregator needs permission or contract with the supplier and BRP, aggregator is dependent on the BRP. Permission is always required from the resource owner, in both the dependent and independent model.

Independent aggregators are in specific challenging to handle in the current Nordic market design. Two of the four models discussed in this paper are models through which an independent aggregator concept can be tested: The uncorrected model and the reimbursement model. In the integrated model, the BRP and the aggregator is the same entity. The dual supply model is an example of how multiple BRPs can be allowed at one connection point. Then each BRP would carry their responsibility as today and aggregator would not be dependant on BRO's current BRP.

4. Examples of aggregator models in a Nordic perspective

This chapter provides examples of models which are being or have been tested in pilots in the Nordics. Whereas there is currently no "one solution" in the Nordics, the examples can provide a discussion basis for continued development. It furthermore illustrates the different paths the Nordic countries are and have been trailing, and which will lead to a diverse range of lessons learned. Although the different Nordic countries may choose one or several different models in the end, there will be elements that may be harmonized, such as e.g. standards for verification and metering.

4.1 The low-hanging fruit: The integrated model

When the aggregator is the only balance responsible party for the consumer, the relation to other market participants is uncomplicated as any imbalances caused by aggregation activities would only affect the BRP itself.

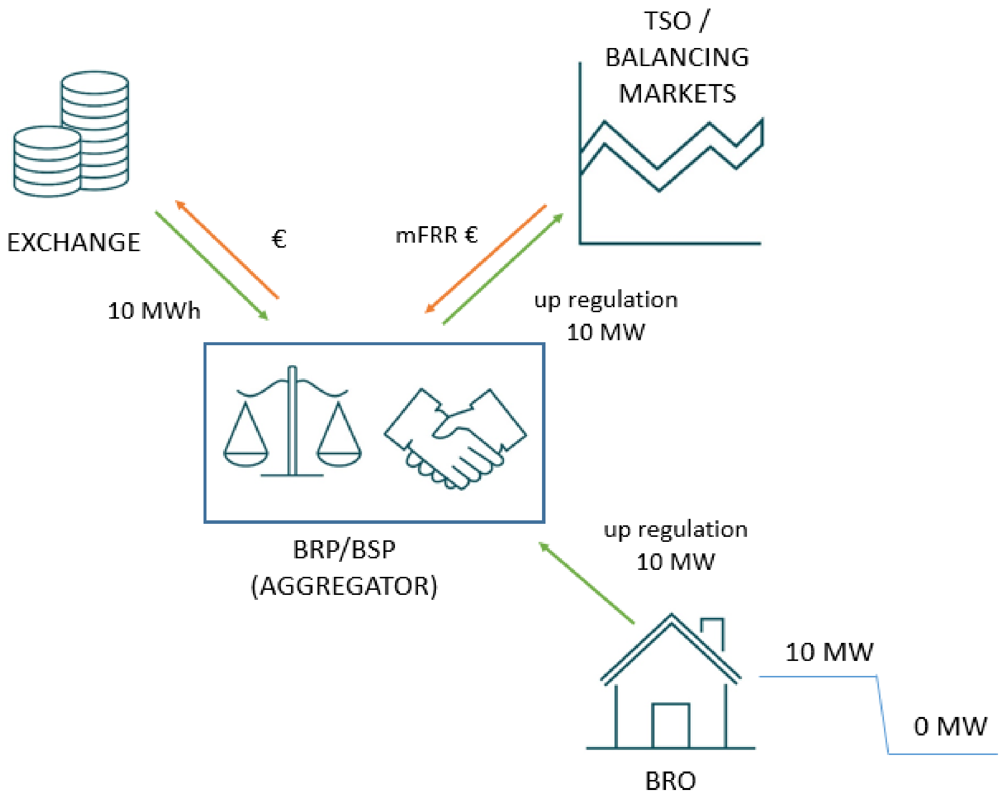


Figure 2 Integrated model

Data and financial exchange is between the following parties:

- Compensation for reserve products from TSO to BSP/BRP, and possibly from BSP/BRP to BRO for flexible volume
- Information exchange between TSO and BRP/BSP, and between BRP/BSP and BRO

Why we have included this model: Low-hanging fruit. The integrated model is the first step to increase aggregation in the balancing markets, and is already done in the Nordics today. The model is possible to implement with none or minor adjustments in today's balancing market requirements.

Status in the Nordics: Room for improvement. Considering that there are relatively few integrated aggregators operating on the Nordic market especially within the demand side, we can assume that the model still faces some barriers. First, the entry to balancing markets is limited to BRPs in most cases. This means that possibly new third parties cannot enter the market directly.

They can only have a service provider role to BRP or they have to become BRP themselves and get the resources to their portfolio. Secondly, it is not typically allowed to aggregate load and generation in the same bid even though they belong to same BRP. Thirdly, it is allowed to aggregate only within one bid zone. Norway is currently piloting in RKOM (option market mFRR) in NO1, allowing aggregation of bids within the price area, 5 MW as minimum bid size and the possibility to participate in the interruptible load tariff scheme and RKOM. This year's pilot was preceded by a similar pilot winter 2016-2017 which enabled the bidding from an integrated aggregator and a thermal heat company, raising the mFRR volumes with an average of 60 MW[7].

Main advantages	**Main disadvantages**
Can be, and is, implemented already today	BRP role required for all BSPs, may limit the range of actors participating in the market
BRP role required for all BSPs, means today's incentives for market actors to plan and be in balance can still be used	Limited access to resources as only those in BRP portfolio can be pooled
	Does not enable multiple BRPs per balance resource owner

[7] www.statnett.no/Page-Files/14840/THEMA%20rapport%202017%20Evaluering%20av%20pr%C3%B8veordning%20med%20unntak%20i%20NO1.pdf

4.2 Adding another supplier for the flexible resources: The dual supply model

Similarly to the integrated model, the dual supply model can be implemented in the existing balancing market design without any major adjustments in market rules, since aggregator and supplier is considered to be one entity.

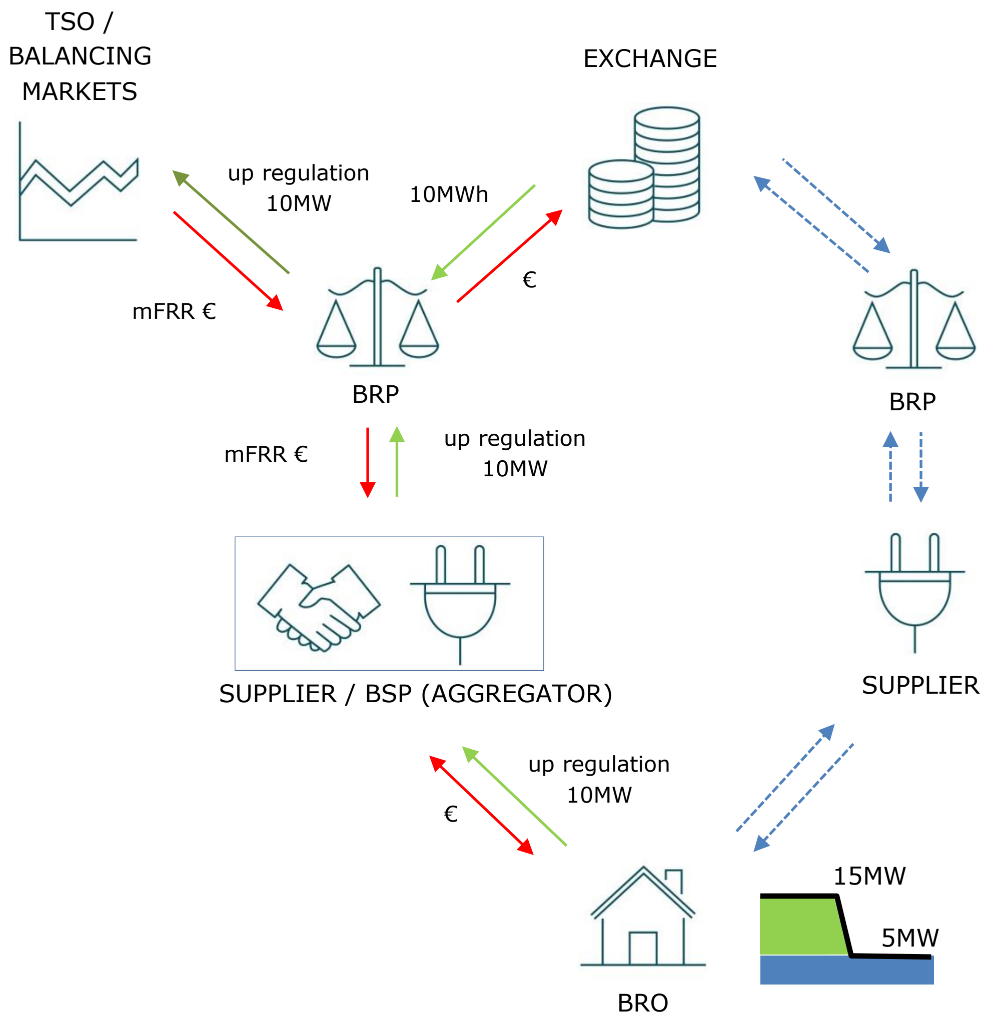


Figure 3 Dual supply model

Why we have included this model: A split of responsibility lower the barriers for aggregator

The dual supply model is typically implemented by adding sub-metering to the resources that are used for balancing. Those resources are separated to a different supplier than the rest of the BRO's consumption. Hence, the aggregator is able to serve a customer with services exploiting its flexibility, without having a contractual relationship with, or consent from the original Supplier or BRP serving that same customer.

The dual supply model is seen as an interesting model for aggregators to offer their service as e.g. electric vehicle service providers. The model provide them the opportunity to supply the energy and trade the flexibility of the charging process as one market actor. Today the DSO has the overall meter responsibility. Still it is a fundamental wish for aggregators to use the existing electricity meter in the charging unit of the electric vehicle as a sub-meter and as the basis for validation of delivered flexibility, since this will lower the costs for aggregators and improve the overall business case towards end customers.

In the model the roles of Aggregator, Supplier (and possibly BRP) are combined in a single market party (like in the integrated model). All settlement both towards TSO and customers is handled through the exisiting market processes and the need for data exchange is similar to need in the integrated model.

Status in the Nordics: The dual supply exists already, but need developing.
It is already today possible to divide connection point (i.e. household) to two suppliers, but that requires installation of new official metering. Due to costs of adding new official metering, there is not a business case with this kind of model especially in case of smaller loads. Possibility to use other meter, i.e. meter installed to devices already at the factory, should be looked into. This could create interesting options also for consumers, they could be buying deals “device + electricity to it” instead of pure devices in future.

Main advantages	**Main disadvantages**
Is partially already implemented in Nordics	Does not allow flex-only aggregators – aggregator is required to be or have contract with a supplier for the actual delivery of electricity
Aggregator handles the entire portfolio of flexibility through one BRP/Supplier	Requires new metering equipment which is costly and often kills the business case
It allows “service providers” to bundle supply and flex in an integrated service towards customers which creates value both to customers and aggregators	Adds complexity, i.e. two bills to customer. Either DSO and/or hub will have to do corrections between the different suppliers

4.3 Possible to apply limitedly: The uncorrected model with third-party aggregator access and multi-BRP aggregation

The uncorrected model is a model without imbalance adjustment i.e. BRP's balance is not corrected when reserve is activated. The uncorrected model is applied in the FCR-D in the Nordics today due to short and few activations which lead to low amount of activated energy. However, the current model is limited to only BRP participation and single balance (only consumption or production units) aggregation in Nordics except in Finland. In Finland the model is including third-party aggregator access and multi-BRP aggregation, but currently applied only in the FCR-D.

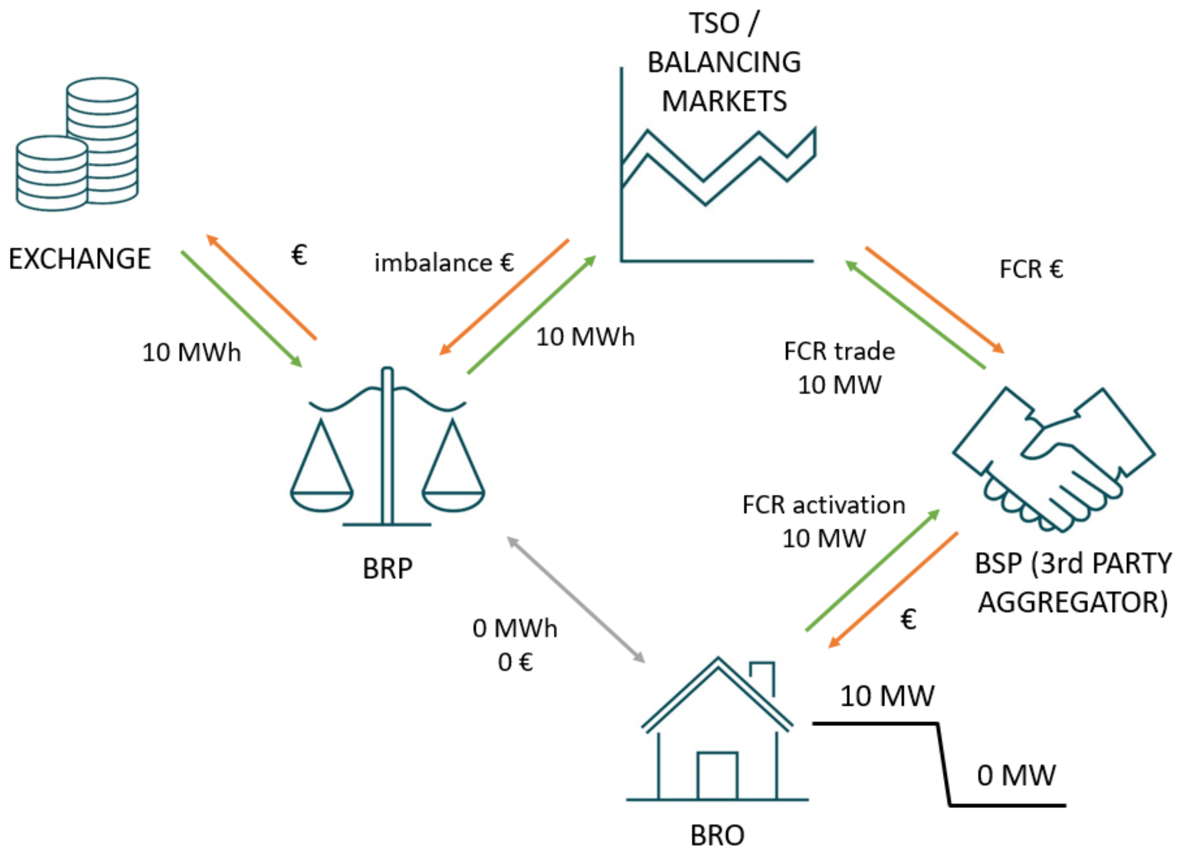


Figure 4 Uncorrected model, example DSR participates in FCR up-regulation

Data and financial exchange is between the following parties:

- Compensation for reserve products from TSO to BSP
- Bilateral contract between BRO and BSP
- Information exchange between TSO and BSP, BSP and BRP and BSP and BRO
- No energy correction

Why we have included this model: Simple model to develop aggregation conditions. The uncorrected model is quite simple way to allow third-party aggregator participation and multi-BRP aggregation. This can lead to increased offering and more efficient use of current resources.

Status in the Nordics: Model implemented in Finland in FCR-D. The uncorrected model with third-party aggregator access as independent aggregators and possibly to pool resources from different BRPs (multi BRP-aggregation) was implemented in Finland at the beginning of 2017 in the FCR-D. That lead to significant increase in offering of DSR and new BSPs entering the market as aggregators. In addition, some existing BSPs have enlarged their portofolios or entered to FCR-D markets as new providers in FCR-D market due to this change.

In the model implemented in Finland, resources can be aggregated regardless of who is the resource's BRP. Multi BRP-aggregation is allowed and BSP is independent but it has to inform the BRPs about balancing market participation. It is important that the BRP is aware of changes in the BRO's behavior and is not making countermeasures in order to balance his portfolio. The BRP should know the participating volume and maybe even single BROs if they are playing significant role in it's portfolio.

Because the FCR-D is currently only procured as upward regulation, activation causes surplus to the BRP's balance. Typically, it is an up-regulating hour when disturbances happen. In case of load participation, the BRP's sale to the BRO will be lower than without any reserve activation. However, the TSO is buying the surplus energy from the BRP with the up-regulating price and this often leads to profiting BRP more.

Also in generation's case, the BRP gains due to surplus in up-regulating hour but the surplus is a bit lower, it is priced with the day-ahead market price. In the more uncommon case of the FCR-D activation during down-regulation hour, result would be unprofitable to the BRP if generation is participating and remains neutral if load is participating.

As explained above, this uncorrected model causes actually that TSO is paying or charging indirectly for the activated energy to or from the BRP. Also seen from TSO's point of view, this model is not eligible in case of larger amounts of activated energy. If this model would we applied for products that have energy compensations, TSO could end up paying twice for the energy and this would increase balancing costs.

Main advantages	**Main disadvantages**
Low entry barriers for aggregators, allows third-party aggregation	Not corrected, can be unprofitable to BRP, even though it is in most cases neutral or profitable
Simple model, easy to implement (IT changes etc.)	Information exchange needed to avoid counter measures from BRP
	Suitable only for those reserve products where amount of activated energy is low and energy compensations do not exist.

4.4 To be tested in pilots: The reimbursement model with third-party aggregator access and multi-BRP aggregation

Reimbursement to BRP can be applied in order to maintain BRP's neutral position if third-party aggregation is allowed in reserve products having larger amounts of activated energy.

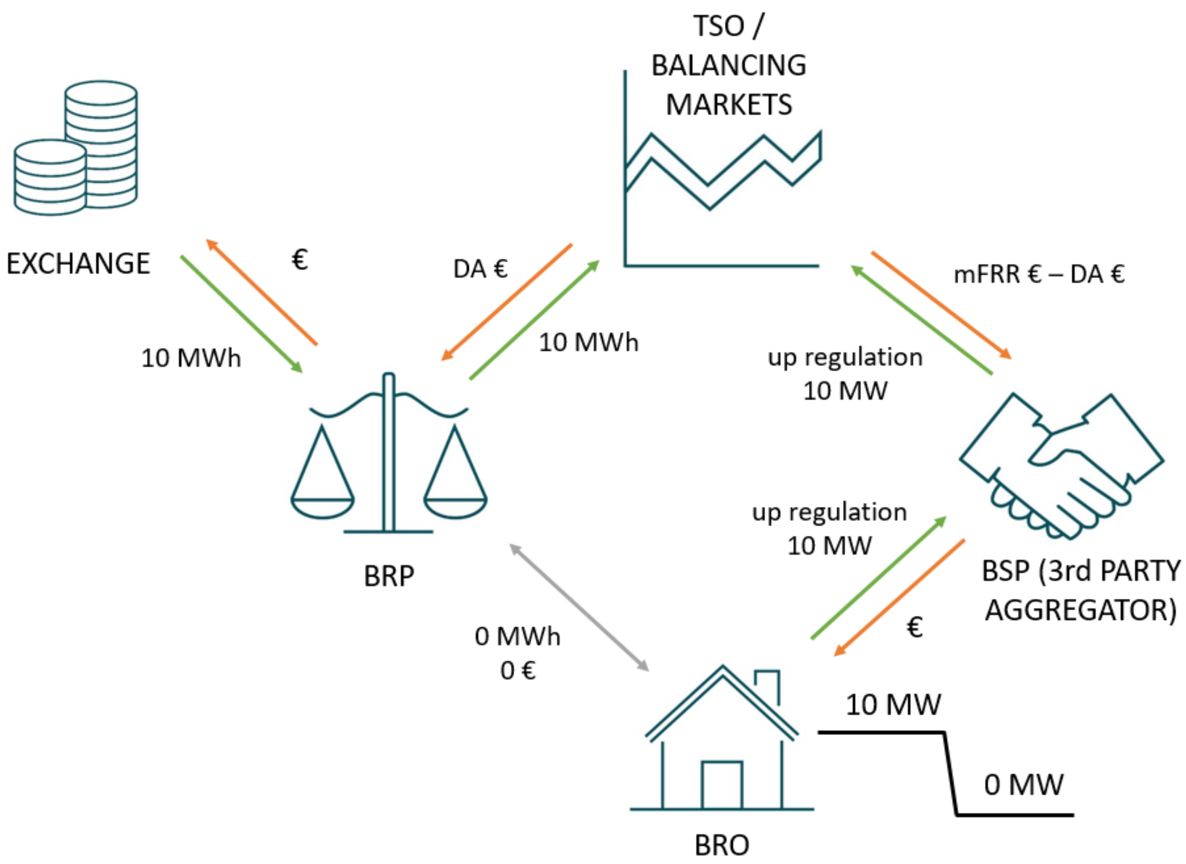


Figure 5 Reimbursement model (set up in Finnish mFRR pilots), example DSR participates in up-regulation

Data and fincancial exchange is between the following parties:

- Compensation for balancing act from TSO to BSP
- Compensation for activated energy between TSO and BRP (reimbursement)
- Imbalance adjustment: sale of activated energy between TSO and BRP
- Bilateral contract between BRO and BSP
- Information exchange between TSO and BSP, BSP and BRP and BSP and BRO

Why we have included this model: reimbursement guarantees fair conditions to all players. The reimbursement model enables third-party aggregator participation and multi-BRP aggregation and hence adds more flexibility to the balancing markets.

If there would be no reimbursement, the BRP would be negatively or positively affected depending on the case. For example:

- Negative impact to the BRP if consumption participates in up-regulation: the BRP would have bought electricity in advance but would end up not selling it to the BRO, instead the energy would be transferred to the TSO with zero price.
- Positive impact to the BRP if consumption participates in down-regulation: the BRP would be selling extra electricity to the BRO, and getting that extra energy from the TSO with zero price instead of paying it in advance.

If the aggregator would receive the full mFRR price, the aggregator would gain extra profit compared to the BSPs who are BRPs when it comes to up-regulation. The third-party aggregator has not bought the electricity but would get paid for it. Vice versa, down-regulation with positive prices would always be unprofitable to the aggregator. The reimbursement model is solving both of these problems.

Status in the Nordics: Reimbursement model will be piloted in Finland in mFRR in two different pilots which aim to start in late 2017. In the pilots, the TSO verifies the activated energy based on real time measurements which the aggregator is delivering to the TSO according to general requirements in the Nordic mFRR market. TSO calculates the actual delivery and the imbalance caused by reserve activation per BRP based on the measurements and a case specific baseline model. Then TSO removes that imbalance from the BRP with a trade that is priced with the day-ahead market price for the activation hour. This neutralizes BRP’s position. The aggregator receives the difference between the mFRR price and the day-ahead market price as compensation of the balancing act. In total, the TSO pays the mFRR price, as to other market participants.

In both pilots, the aggregator participates as independent aggregator and aggregates resources from multiple balances. The aggregator has to inform the BRPs about balancing market participation and bid activations.

Both of Fingrid’s pilots use the reimbursement model but they differ in aggregator’s responsibility of the reserve delivery: (A) the aggregator has balance responsibility and (B) the aggregator has financial responsibility of the delivery.

A. In case of non-delivery, BSP gets imbalance.
B. In case of non-delivery, BSP faces monetary penalty.

In case A, the aggregator assigns its own BRP, to take responsibility for the imbalances reserve activations cause. In case B, the imbalance caused by failure in reserve delivery comes to TSO and the aggregator pays for that to the TSO. In both cases, the imbalances to resources’ BRPs are adjusted based on the actual activation so that there is no imbalance to the BRPs.

Room for development. Although this model is an interesting option for allowing third-party aggregators, it also introduces a substantial level of complexity in the present market design and IT infrastructure. In addition, the right methods for e.g. determining baselines, handling rebound effect, validating an activation and carrying out reimbursements need to be found.

Main advantages	**Main disadvantages**
Fair conditions to BRPs and BSPs	Changes needed to overall BRP conditions
Can potentially be used for all markets except in day-ahead market	Quite complex model, larger changes needed to IT systems, event though potential to implement in national systems or to eSett system
Low entry barriers for aggregators, allows third-party aggregation	Measurements and baselines needed in order to verify the delivery

5. A possible approach to further development

To reflect the current and future need of balancing resources, it is important that we develop balancing markets to make it easier for market actors to participate in balancing. EBGL requires TSOs to enable a smooth functioning balancing market with level-playing field for all stakeholders. Furthermore, well functioning markets with a high level of competition should in the long run provide lower costs for total reserves and allows capacity to be used where it benefits most. Additionally, if we jointly can accept some form of harmonization of the market set-up for aggregation in the balancing markets, it will spur development. This through giving the market actors one set-up to relate to instead of four completely different concepts, and by that increase the mobility of both technical solutions and market actors in the Nordics.

During the project we have found that the Nordic countries are at different levels in both aggregation and DSR participation in the balancing markets. Together, we have found that it may be difficult to achieve a harmonization at the first stage. Below we propose a possible approach to for future development. Note that the suggested elements are not necessary are sequential, and may as well be developed in parallel.

5.1 Make product requirements for demand side participation in the balancing markets

Pre-qualification requirements have been a question in e.g. the Revision of the Nordic Frequency Cointainment Process (FCP) project[8] recently. The revised requirements in FCP are technology neutral, i.e. the same requirements are put upon any provider. However, the project has seen that it may be troublesome for an aggregator to show the aggregated behaviour if the loads are spread out over a larger geographical area. Testing is required and it's necessary to show the behaviour for the providing unit/entity for a certain frequency signal. How to handle this for x number of loads, simultaneously, in a smooth way? It is important that FCR can be controlled, i.e. that the providers are able to deactivate the response if their bid is not accepted. If not, the market may experience overdelivery of FCR, which sometimes is currently the case in Norway. Furthermore, in order to optimize the use of resources the market participants request the possibility of unsymmetric delivery in FCR-N. TSOs need to develop products so that the resources can be combined in the best possible way for everyone's gain in the future.

However, there is currently no decision for the FCP implementation and the current technical requirement and pre-qualification rules need to be adapted in order to enable DSR participation. Can we harmonize the pre-qualification rules for consumption in any other Nordic forum or can we develop a "light" version that are acceptable especially for measurement and verification? Maybe it would be efficient if there is a separate initative on setting rules for verification for aggregated loads? However, it is important not to create unfair playing fields.

5.2 Actively share information to existing and new market players about their balance market potential

The potential of balancing markets is still unknown to many players. There is a need for more information efforts from the TSOs. Existing and new actors are more actively looking for new business cases, but even among the already active, few have seen the possibilities of being a part of the balancing markets. Hence, we must actively share information to both existing and new market players with a flexibility potential to enable their participation in the balancing markets.

5.3 Introduce the BSP role

The Guideline on Electricity Balancing (EBGL) introduces the BSP role as a separate role from the BRP role. The new role will lead to some changes in today's market. The balance responsible party

[8] http://www.statnett.no/Kundeportal/Kundeinformasjon/Nordisk-prosjekt-for-frekvensforbedring/

will be financially liable to a TSO, while BSP will be the party acting in the balancing markets, i.e. bidding and activating the resources and getting compensated for that. In the case of aggregation, it will also be a BSP that acts as an aggregator or for an aggregator. In the Nordics today, Finland and Norway are operating with the BSP role.

5.4 Remove barriers for aggregation

The network codes will remove some of the perceived barriers for aggregation, such as high minimum bid size. Introducing smaller bid sizes will allow smaller resources to participate, eg. 1 MW is suggested as a new standard product for mFFR. Another suggestion recently being implemented in Finland is mixing generation and consumption in the same balancing bid, i.e. enable 10 MW mFRR bid consisting of 5 MW load and 5 MW generation under same BRP. It requires some IT changes, but it is still a change that has been easily implemented in Finland. Another possibility to solve this issue is to implement single balance model (no separate consumption and generation portfolios) as the EBGL recommends as well. These are some of the topics we should look into:

a. Lower minimum bid size
b. Aggregation of generation and consumption in one bid and/or implementing single balance model
c. Information exchange towards TSO – verification of activated flexibility
d. Local geographical issues / requirements for activation

5.5 Learn through Nordic and European pilots

There is a multitude of flexibility pilots which have or will be performed in both Nordic and European countries. This means that there is a large potential for knowledge transfer and learnings from what others have done. We don't have to do all steps by ourselves, we should build networks together, share documentation and reports in order to share insights from pilots in the different countries. Examples of pilot issues where we would profit from a common Nordic discussions are:

a. Stakeholder communication and dialogue in order to get feedback on further development and priorities.
b. Proof of concept – Test and evaluation of models and market set-ups e.g. impact of independency.
c. What do we need to change in market regulation in order to trigger development?

The following table provides an overview over performed and planned Nordic TSO pilots relevant for enabling more aggregation in the balancing markets. We find continued dialogue with market stakeholders important, and due to this a stakeholder workshop is planned for in 2018. We will amongst other topics share findings from our pilots.

Table 1 Overview performed and planned Nordic TSO pilots enabling aggregation

What?	Where?	2014	2015	2016	2017	2018
Demand response pilot	NO4 in Norway	X	X			
Enabling aggregation of bids in 10MW volumes in mFRR	NO1 in Norway				X	
Enabling aggregation of bids in 5MW/10MW volumes in mFRR	NO1 in Norway					X
Large scale demand response pilot	NO4 in Norway					X
Pilot of flexible households in FCR-N	SE3 Sweden			X	X	
Testing new solutions in FCR-D	Sweden				X	X
Demand response pilots in different balancing products	Finland	X	X	X		
Pilot of indepedent aggregator and multi-BRP aggregation in FCR-N	Finland			X		
Independent aggregators and multi-BRP aggregation allowed in FCR-D	Finland				X	
5 MW bid size in mFRR	Finland				X	
Aggregation of generation and load in mFRR	Finland				X	
Pilot of indepedent aggregator and multi-BRP aggregation in mFRR	Finland					X
Independent aggregators and multi-BRP aggregation allowed in FCR-N	Finland					X
Market Model 2.0 testing e.g. third-party aggregators and sub-meters	Denmark	X	X			
Electric vehicle validation for FCR-N	Denmark			X	X	X
Heat pump project testing e.g. sub-meter and hub communication	Denmark			X	X	
Battery project testing mFRR	Denmark			X	X	
Flexibility from industries developing measurements, baseline, pricing etc.	Denmark			X	X	X

5.6 Implementation of aggregator models

We must work together to ensure harmonization of aggregator models in the Nordics. Still, it is likely that there will be multiple models in the Nordics, even on a national basis. Different models can be used for different purposes, there is not one model that fits all. There are many uncertainties that must be solved before we can conclude on which models that could and should be implemented. Network codes must be implemented, Clean Energy Package is not final negotiated and there are different national preferences of how the final regulation should be formed. However, it is possible to have a gradual implementation of the different models – starting with the simple measures and adding complexity later on.

Market regulation for aggregators includes implementing CEP. Yet, the regulation leaves some degree of freedom to the Member States for National implementation. We should preferably have harmonized rules on a Nordic level. This includes implementing the BSP-role as set out in EBGL Article 18. EBGL Article 18.4 (b) points to that aggregation shall be allowed and 18.4 (c) that both demand facilities, third parties, power generating facilities and energy storage units can become BSPs.

5.7 Evaluation and continued development

Continued development and implementation of models and products includes assessment of the impacts they will have on the Nordic power system. Are the suggested solutions e.g. creating new barriers? The current experiences and development may also provide us with ideas for new models and balancing products. An example of this is the idea of a secondary market for FCR that came up as an output from a Finnish pilot.

6. Glossary list

This glossary explains the roles in the Nordic market, based on the definitions from EBGL.

Balancing markets

EBGL defines balancing market as the entirety of institutional, commercial and operational arrangements that establish market-based management of balancing;

Balancing markets in the Nordics are mFFR (manual Frequency Restoration Reserve), aFFR (automatic Frequency Restoration Reserve), and FCR-N/D (Frequency Containment Reserves for Normal Operation / Disturbances).

Balancing Resource Owner

Balance Resource Owner (BRO) is the owner of the resource that is used in the balancing markets for balancing. BRO can for example be the company that owns a power plant, a super market chain or even a single person, in case of a household.

Balance Responsible Party

EBGL defines BRP as a market participant or its chosen representative responsible for its imbalances.

Balance Responsible Party (BRP) is economic responsible for imbalances in its portfolio and can therefore be affected of reserve activations. This discussion paper also include the current BRP role in Nordics (BRP acting both as BRP and BSP).

Balancing Service Provider

EBGL defines Balancing Service Provider (BSP) as a market participant with reserve-providing units or reserve-providing groups able to provide balancing services to TSOs.

BSP is in contractual relationship with the TSO for providing reserves and receiving compensation for that. BSP is also the party that is responsible to the TSO for the reserve delivery and all issues connected to that (i.e. information exchange). BSP shall always have BROs' permission to use their resource in the balancing markets because BRO will have the impact on his resources with the reserve activations.

Aggregator is a form of **Balancing Service Provider** that combines resources, and in this discussion paper we have divided them into three categories:

- ***BRP/BSP aggregator***

In the current CEP draft of the electricity directive, aggregator is defined as; a market participant that combines multiple customer loads or generated electricity for sale, for purchase or auction in any organised energy market

In the BRP/BSP aggregator set-up, the BSP is the BRP to the resources that it aggregates and uses in the balancing markets.

- ***Third-party aggregator BSP***

In this set-up, the BSP is not part of the supply chain, i.e. not the BRP or BRO. It's like a service provider but with a agreement with the TSO to be a BSP.

- ***Independent aggregator***

In the current CEP draft of the electricity directive, the independent aggregator is defined as an aggregator that is not affiliated to a supplier or any other market participant.

This means that a third-party aggregator that doesn't need permission from a BRP in order to operate in the balancing markets.

Distribution System Operator
The electricity directive (2009/72/EC) defines DSO as a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.

Distribution System Operator (DSO) is facing flows changing due to reserve activation and is responsible for the active management of the distribution grid. The DSO is responsible for the cost-effective distribution of energy while maintaining grid stability in a given region.

Network Codes
A set of rules drafted by ENTSO-E, with guidance from the Agency for the Cooperation of Energy Regulators (ACER), to facilitate the harmonisation, integration and efficiency of the European electricity market. This discussion paper refer mostly to Guidelines for Electrical Balancing (EB GL) the "balancing code".

Service Provider
Service provider is not acting as a BSP itself but providing services to a BSP. Currently possible in the Nordics. It's typically a technology provider which is not acting the balancing market itself, but delivering the technology to an aggregator/BSP/BRP which then again is acting on the market.

Supplier/Retailer
In the current CEP draft of the electricity directive supply is defined as the sale, including resale, of electricity to customers.

A supplier/retailer is a natural or legal person that sells energy to the final customers.

Transmission System Operator
The electricity directive (2009/72/EC) defines TSO as a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the longterm ability of the system to meet reasonable demands for the transmission of electricity.

Transmission System operator (TSO) is the market operator and single buyer in the balancing markets. TSO is also responsible for developing the balancing markets.