DEMAND RESPONSE THROUGH AGGREGATION – A HARMONIZED APPROACH IN BALTIC REGION

Concept proposal

2017

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Executive summary

Overview of the report

The goal of this paper is to present a harmonized view from Baltic TSOs on Demand response (DR) introduction in balancing market with mFRR product with a focus on independent aggregation services. The report consists of seven parts:

1. **Background** provides an overview of basic concepts as well as explains the drivers behind the need to introduce DR to the market;
2. **Overview of the current situation in EU** provides insights in the current development state of independent DR introduction in EU both from practical and legal point of view;
3. **Overview of different settlement models for aggregation introduction**. Settlement models deal with the cash-flows between different market parties. In total six models are reviewed.
4. **TSOs' suggested approach** for aggregation introduction and objectives of the future market framework.
5. Elaboration of the **suggested approach in details**.
6. Overview of alternative approaches for **delivered DR amount determination** methodology, which is crucial for independent DR introduction (regardless of settlement model chosen).
7. Overview of the **relevant pilot studies** currently running or to be commenced, which will be used to prepare for aggregation introduction.

Background

DR is a temporal change in consumer's energy consumption/generation due to a reaction to price signals or by other measures. System flexibility via DR service can be provided by households, local municipalities, public sector and industry in the means of change in consumption, distributed generation, storage etc. DR is able to increase the system's adequacy and to substantially reduce the need for investments to cover peak demand by shifting consumption away from times of high demand. It can act as a cost effective balancing resource for variable renewable generation. Adding stability to the system, it lowers the need for coal and gas fired spinning reserves – most running power plants burn fuel continuously in order to be ready to supply power at short notice. It furthermore decreases the need for local network investments, as it shifts consumption away from peak hours in regions with tight network capacity. The need for DR in Baltic system rises over time. After desynchronization from IPS/UPS DR could play a key role in the provision of holding reserve and deliver significant cost saving potential for the Baltic system.

While the DR potential can be utilized in all wholesale markets, the TSOs have put the initial focus on explicit DR participating in Baltic balancing market by providing mFRR energy product. TSOs consider balancing market (mFRR product) would benefit the most from the aggregation introduction in the Baltics.

Objective of the proposed market framework

To develop a framework for a harmonized market, the parties involved have to agree upon a common vision of the future market that particular framework aims to facilitate. During discussions the following objectives have been identified by the TSOs:

- Ensure that all willing and technically sound energy resource holders (both consumers and generators) are able to participate in balancing market regardless of their size without facing discrimination or entry barriers;
- Limit market distorting regulations and/or cross-subsidies that can harm liberalized and non-discriminatory market;
- Limit the risks of negative impact on retail prices (either from an increase in administrative costs for market participants (including TSO) or an increase in imbalance costs for BRPs);
- Facilitate DR market growth.

Proposed approach

After a careful analysis of the best practices, existing settlement models' advantages/disadvantages and regulatory requirements, TSOs propose the following approach:

- **Integrated aggregation should be facilitated and encouraged**. Appropriate regulatory requirements should be introduced as soon as possible.
- **Independent aggregation should be facilitated and encouraged**:
  - **Voluntary agreements between involved market participants** should be facilitated and encouraged.
  - Additional steps should be taken to **ensure that the market operates transparent and non-discriminatory manner** towards all market participants. TSOs identify two alternative approaches to ensure the market is fair.

Agr → Sup Settlement Model	Con → Sup Agreement Model
For Aggregators unable to enter into business relationships with BRP/Supplier, there is an option to join the market via direct agreement with TSO. In this **case the TSO ensures the energy transfer and settlement between respective BRP(s) and aggregator via centralized mechanism** at a reference price (e.g. respective day-ahead spot price). In case Aggregators have entered into business relationships with the respective BRPs/ Suppliers, energy transfer takes place directly between Aggregator and BRPs/Suppliers.	Aggregators can join the market without an agreement with the respective BRP/Supplier, however aggregators are required to provide the respective **BRP/Supplier all the information necessary to ensure that BRP/Supplier is able** to identify consumers participating in activation and the amount aggregated from their portfolio **to avoid countermeasures in balancing their portfolios and to be able to adjust the terms in agreements with the consumers participating in DR services.** Aggregators can also enter into business relationships with BRPs/Suppliers, and in that case energy transfer takes place directly between Aggregator and BRP/Supplier.

Role of the pilot studies

TSOs consider that pilot studies are essential to ensure that the market model ultimately proposed and introduced in Baltics is efficient. Pilot studies and case studies not only allow testing technical readiness of market participants and system operators but also allow to test out assumptions in a safe environment. The main objectives of the pilot studies are to:

- Review and test technical feasibility and data exchange processes;
- Identify potential improvements for market models/technical requirements;
- Identify and if possible mitigate unforeseen barriers or risks;
- Collect feedback (advantages/disadvantages) from market players;
- Decide between the two alternative approaches.

Summary of the pilot studies is presented below:

Dimension	Estonia	Latvia	Lithuania	Finland
Scope	Aggregation pilot study	Case study involving individual DR resource owners	Case study involving individual DR resource owners	Aggregation pilot study
Expected min portfolio size	1 MW (can be combined from generation and DR)	TBA	1 MW (DR only)	5 MW (can be combined from generation and DR).
Progress	Aggregator(s) working towards building up portfolio	Preparation for project initiation	Initial call for interest from market parties	Two aggregators working towards building up portfolio
Expected start date	Q4 2017	Q2 2018	Q1 2018	Q1 2018

1. Introduction & Background

1.1 Objective of the paper

This paper is the first report prepared by the Baltic TSOs with a goal to develop a proposal for harmonized market framework for explicit DR and aggregation service integration in the Baltic countries. The goal of this paper is to present the concept of harmonized Baltic DR market model for aggregators participating in balancing market (mFRR standard product). The report shall include the following:

1. Review of the current EU requirements and guidelines for inclusion of DR and aggregation,
2. Proposal on the roles and responsibilities of the market participants,
3. Definition of the technical requirements/standards for mFRR resources,
4. Proposal on the arrangement of DR service settlement.

1.2 Demand response concepts

Demand response is a temporal change in consumer's energy consumption/generation due to a reaction to price signals or by other measure. System flexibility via Demand response service can be provided by households, local municipalities, public sector and industry in the means of change in consumption, distributed generation, storage etc. DR programmes can be categorised into two groups:

A) Explicit DR refers to a program where demand competes directly with supply in the wholesale, balancing and ancillary services markets through the services of aggregators or single large consumers. This is achieved through the control of aggregated changes in load traded in electricity markets, providing a comparable resource to generation, and receiving comparable prices. Usually, consumers receive direct payments to change their consumption upon request (i.e. consuming more or less). Consumers can earn from their flexibility in electricity consumption individually or by contracting with an aggregator. The latter can either be a third-party aggregator or the customer's retailer. Currently this type of DR service is not actively commercialized within Baltic markets, due to missing market framework and regulations.

B) Implicit DR (sometimes called "price-based") refers to consumers choosing to be exposed to time-varying electricity prices or time-varying network tariffs (or both) that partly reflect the value or cost of electricity and/or transportation in different time periods and react to those price differences depending on their own possibilities (no commitment). These prices are always part of their supply/grid contract. Implicit DR does not therefore allow a consumer to participate alongside generation in a market. Implicit DR is currently introduced in Baltic States "dynamic tariff" in retail market.

It is important to note that neither form of DR is a replacement for the other. The requirements and benefits of each are different and build on each other. The two are activated at different times and serve different purposes within the markets. They are also valued differently. While both DR programs typically give the participating consumers lower electricity bill, additionally in Explicit DR programs consumers may also get direct payments or some other benefits, like lower network entry fees in case of large consumers, etc.

Explicit DR provides a valuable and reliable operational tool for system operators to adjust load to resolve operational issues. Implicit DR (dynamic pricing) does not allow a customer to participate in the balancing or ancillary services markets, or in most existing capacity markets. It will also not allow for regional demand-side services for TSOs and DSOs, and it does not provide the system as a whole with a dispatchable resource.

On the other hand, Explicit DR does not have the same market reach as a retailer-enabled dynamic pricing programme. Both forms are therefore required to allow all consumers to fully participate and benefit from their flexibility.

Aggregator means a market participant that combines multiple customer loads or generated electricity for sale, for purchase or auction in any organised energy market. Aggregator can aggregate both

reduction/increase of consumption, reduction/increase of generation or provide a product where generation and consumption are combined. **Independent aggregator** refers to an aggregator that is not affiliated to an energy supplier or any other market participant. An aggregator which is affiliated with an energy supplier is called **Integrated aggregator**. Depending on the market framework Aggregator can be required to be balance responsible or simply act as an energy trader only providing fixed deliveries. When discussing distributed flexibility (including, but not limited to DR), an aggregator is a necessary market player as it offers an opportunity to small load owners to participate in wholesale markets and support the system. While main focus of this report is on the introduction of DR via aggregation, the market model to be developed is considered valid for aggregation services for both consumers and generators.

1.3 Need for a market model explained

DR is able to increase the system's adequacy and to substantially reduce the need for investment in peaking generation by shifting consumption away from times of high demand. It can act as a cost effective balancing resource for variable renewable generation. Adding stability to the system, it lowers the need for coal and gas fired spinning reserves – most running power plants burn fuel continuously in order to be ready to supply power at short notice. It furthermore decreases the need for local network investments, as it shifts consumption away from peak hours in regions with tight network capacity. DR delivers these benefits by providing consumers – residential, commercial or industrial – with control signals and/or financial incentives to adjust their consumption at strategic times.

DR potential can be utilized in a balancing timeframe throughout explicit DR and in a day-ahead, intra-day timeframe throughout implicit DR, particularly via hourly electricity tariffs or time-zone electricity tariffs. However, currently only generation units are participating in the Baltic balancing market. Additionally, markets for other ancillary service products as primary and secondary reserves (aFRR, FCR) have not yet developed due to the Baltic countries being a part of the Russian IPS/UPS Synchronous System. Therefore, the initial focus of TSOs is explicit DR participating in Baltic balancing market by providing mFRR energy product.

1.3.1. Increase in intermittent generation

Similarly to the trends in the Central and Southern Europe, the energy system in the Baltics becomes more reliant on the intermittent distributed generation. Since 2010 the wind energy generation has increased more than three times and currently the total wind capacity in the Baltics has reached almost 796 MW while solar capacity is 70 MW (Figure 1) As of 2016 the installed capacity of intermittent (distributed) generation (wind & solar) is more than 10% of total generation capacity in the Baltics (Figure 1). Furthermore, the trend is upwards sloping – wind has been with the highest installed capacity increase rate, and it is expected to be further amplified by the upcoming oil shale production reduction in Estonia after 2020 due to facilitated lower CO_2 emissions.

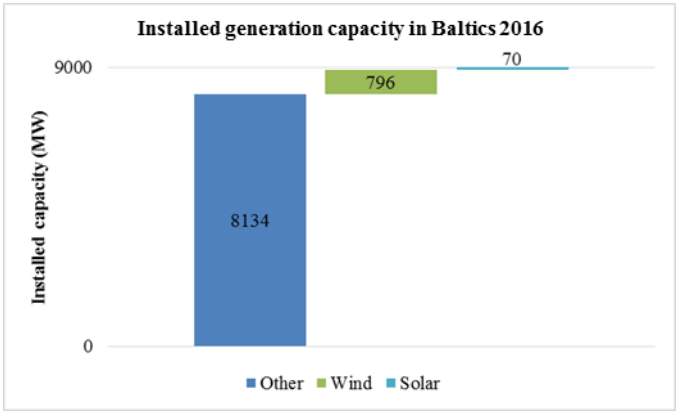


Figure 1 Installed generation capacity in Baltics 2016

1.3.2. Need for higher balancing market liquidity

Currently there is only one business entity participating in each of the Baltic countries' balancing market. While there has not yet been a situation where all submitted balancing bids are activated, having a single market participant is traditionally seen as suboptimal. Allowing aggregators to participate in Baltic balancing market would diversify the balancing market bid offers. Furthermore, the lack of demand side

flexibility results in low energy price elasticity [14]. Increased demand side flexibility would have positive effect on market prices in all energy markets (including balancing market).

1.3.3. The legislative framework requirements

Both existing and upcoming requirements from the legislative framework designed by the European Commission have already emphasised that the Member States are to develop a market model where DR resource owners (both resident and non-resident) can freely participate in the respective energy markets. According to the [6], [7], [9] while none of the countries have special obstacles disallowing DR, the lack of appropriate framework for DR inclusion in different energy markets has made DR inclusion virtually impossible. Furthermore, the "Clean Energy Package" originally published on the 30th of November 2016 continues to stipulate the requirements of the market model in a greater detail than before [2]. The precise requirements are reviewed in the following sections.

1.3.4. Desynchronization from the Integrated Unified Power System

Desynchronization from the Integrated Unified Power System (IPS/UPS) is one of the priorities outlined in the EU Energy Strategy. After desynchronization from the IPS/UPS, Baltic States energy system will require even more flexibility for frequency regulation. Explicit DR has been considered as one of the sources for this flexibility. [15].

1.3.5. Conclusion

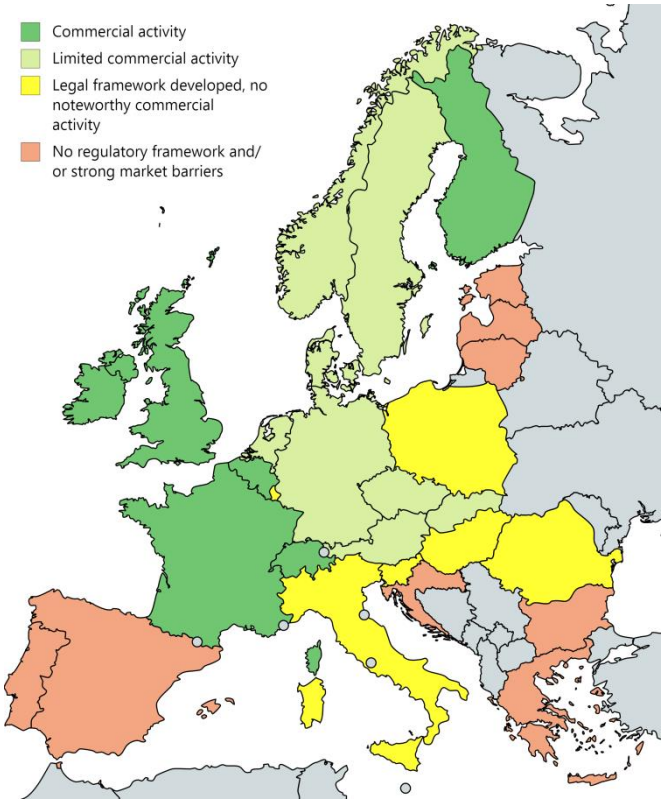
It is clear that the value of DR to the Baltic system rises over time. Taking into account the Baltic region's specific set up within IPS/ UPS and that the wind & solar energy penetration for the Baltics is still below Western Europe, it follows that the pressure to integrate DR in the energy markets are comparatively lower in the Baltics than in the rest of Europe. However, this situation will change after upcoming desynchronization from IPS/UPS as DR could play a key role in the provision of holding reserve and deliver significant cost saving potential for the Baltic system.

The aim of the European energy policy is to involve different groups of consumers and enable different programs to participate in DR. All DR resources should be involved and every consumer should have the opportunity to make use of his flexible energy usage in a competitive manner and price. Therefore, the aim in the Baltic region should also be to make DR attractive to all consumers and involve different groups of consumers. Based on experience in the EU the time required for DR market to become commercially active is five or even more years [7]. Accordingly, the preparations should start already now.

2. Current situation in EU

2.1 Overview of explicit DR integration in EU

As of 2017, the majority of Member States still need to fully adopt the Efficiency Directive in practice. According to the latest survey on the DR as of 2017, only in five countries (Switzerland, France, Belgium, Finland, Great Britain, and Ireland) DR products are actively participating in wide range of energy markets [REF: 6, 7, 9]. However, even in these countries, there are still some market design and/ or regulatory challenges.



When reviewing the countries with less substantial progress, three broad groups emerge. Countries where DR has been partly integrated; countries where the market models have been developed, but no noticeable commercial activity in the sector of DR has been observed and lastly countries where no regulatory framework has been introduced or very strong market barriers still persist.

The policy makers of Austria, Denmark, Germany, Netherlands, Norway, Sweden, Czech Republic, and Slovakia have started working towards introduction, however strong market barriers remain and the market growth is fairly limited. For example – Germany and Finland have started working towards introduction of independent Aggregator, while Austria has been working to incrementally improve bilateral agreement model currently employed. The policy makers of Slovenia, Italy and Poland have been working towards initial introduction of DR in the energy markets and market activity is expected, while Romania, Hungry and Luxemburg have developed regulatory framework but market barriers or energy system characteristics have rendered those markets inactive. The policy makers of Spain, Portugal, Baltics, Greece, Croatia, and Bulgaria have yet to develop basic regulatory framework for DR or have to remove significant synthetic market barriers [6], [7], [8]. Overall, the situation in EU can be characterized as fairly heterogeneous.

2.2 EC legal framework

2.2.1 Key issues – approved legislation

Currently the central regulation in regard to the DR is Energy Efficiency Directive (2012/27/EU), more precisely Art.15.

The requirements of Art 15 can be broken down into four areas:

1) DR should be encouraged to participate alongside supply within the wholesale, balancing and ancillary services markets; (Art. 15.(4); 15.(7) 15.(8))
2) TSOs and DSOs must treat DR providers, including aggregators, in a non-discriminatory manner and on the basis of their technical capabilities; (Art.15(6); 15.(8))
3) TSOs and DSOs develop and national regulatory authorities approve technical modalities and operational rules for the participation in these markets on the basis of participants' capabilities (Art.15 (8));
4) These specifications should include enabling aggregators (Art.15.(8)).

2.2.2 Expected changes in the EC legislation

On November 30, 2016 EC published so called draft proposal for "Clean energy package". The package includes complex regulations in regards to DR and Aggregation. Baltic TSOs take into account that these regulations are still in development and subject to change. TSOs treat the "Clean energy package" as a proposal for a guideline. The draft proposal for the directive of internal markets of electricity develops on the initial stance and provides Member States with further details (particularly Articles 13 and 15). The directive stipulates importance of:

1) Granting demand side resources (private and professional) access to all markets (wholesale, balancing, ancillary services) at all timeframes.
2) Empowering the consumer to participate in DR (directly or through aggregation) without the consent of the supplier and to switch aggregation service provider without penalty.
3) Empowering independent aggregators by ensuring that they can enter the market without the consent from the supplier and can participate in the energy markets without compensating the supplier and/ or generator.

Furthermore, the directive proposal states the obligation of the Member State to develop market model for aggregation service which includes but is not limited to:

1) Detailed market entry procedure for third party aggregators;
2) Detailed roles and responsibilities of all the market participants (including energy transfer/ compensation procedures);
3) Detailed data access and exchange procedures;
4) Detailed conflict resolution mechanisms.

2.2.3 Summary of relevant laws and regulations

Regulation	Key points
The 3rd Electricity Directive (2009/72/EC)	Art. 25.7 Requires network operators to consider DR as alternative to system upgrade.
Energy Efficiency Directive (2012/27/EU)	• Art. 15. 4 requires Member States to allow consumers participate in energy markets via DR. • Art. 15.8 requires the Member State to ensure consumer access to energy markets, either individually or through aggregation. • ANNEX XI lists in details what services/ products are included in the broad term "DR".
Network Code on Demand Connection (2016/1388)	Art. 1.3 states obligation of ensuring that system operators make appropriate use of the demand facilities' and distribution systems' capabilities in a transparent and non-discriminatory manner to provide a level playing field throughout the Union.
Draft regulations included in "Clean energy package"	
Directive on the internal market for electricity	• Art.13. lists consumer's rights – most importantly prohibiting aggregation agreement termination penalty and freeing the customer to engage aggregation service without the consent of the supplier. • Art.15. lists aggregators' rights and the requirements for the national framework for DR/aggregation inclusion in energy market. Most importantly that aggregators are not required to pay compensation to supplier/generator and are not required to get consent from other market participants to enter the market.
Directive on the internal market for electricity	• Art. 3.1 & Art 11.1 stipulate that DR and storage should be treated equally to generation. • Art. 6.3 Market operators can develop products and trading opportunities to ensure that market participants are able to access the market individually or through aggregation.

Full text of the relevant articles can be found in Appendix III – Overview of regulations.

3. Description of the settlement models

Settlement models (hereafter – models) refer to the energy transfer and resulting cash-flow between the market participants in case of activation. It does not deal with balance responsibility of the aggregator (as the each of the models can be developed further for both aggregator that is and aggregator that is not balance responsible).

The models reviewed in [5], [6], [7], [8], [9], [10], [11], [12], [13] can be broadly categorized in six types. Within each type, different variations of the model are possible. There are two main groups of the model types for independent aggregator: models where Aggregator directly or indirectly compensates the supplier for the energy transferred (Supplier settlement model, Consumer settlement model, Central settlement model) and models where Aggregators do not compensate directly nor indirectly the supplier for the energy transfer (Socialized settlement model, No settlement model). The Integrated model does not have any energy transfer (and no compensation mechanism is necessary). Each of the groups has a subdivision. For the "compensation group" the subdivision is determined by the party through which the compensation is granted to the supplier. For the "no compensation group" the subdivision is determined by the group of customers who ultimately compensate the supplier. The specific roles and responsibilities of market participants are described in Section 5.1.2).

3.1 Summary of settlement model types

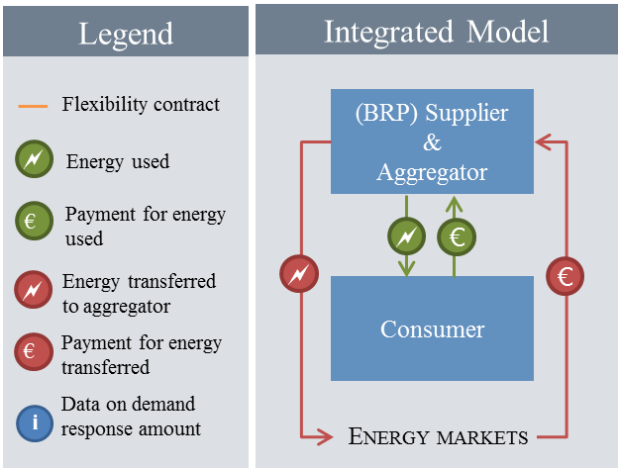
Model	Short description
Integrated	No energy transfer. Supplier and Aggregator are combined.
Supplier settlement model	Balance Responsible Party (BRP) compensated at a price bi-laterally agreed between BRP and Aggregator.
Consumer settlement model	BRP is compensated at retail agreement price by consumer (BRP is impartial).
Centralized settlement model	BRP is compensated by Aggregator via TSO at predefined reference price.
Socialized settlement	BRP's compensated by TSO at imbalance price.
No settlement	No additional compensation to BRP.

3.2 Models with integrated Aggregator

The bundled approach for supply and DR is the simplest way to implement DR and avoids interfering with other stakeholders. However, it does not allow aggregators to operate independently from suppliers, which may prevent unlocking the full DR potential in some markets.

3.2.1. Supplier Load Control Model

The flexibility clause in a supply contract can provide for direct supplier load control in specific situations. In such cases the consumer's load is curtailed by a predefined volume at the request of the supplier, which can then be used by the BRP to take part in balancing markets, self-balance its portfolio or benefit from high market price situations [5].

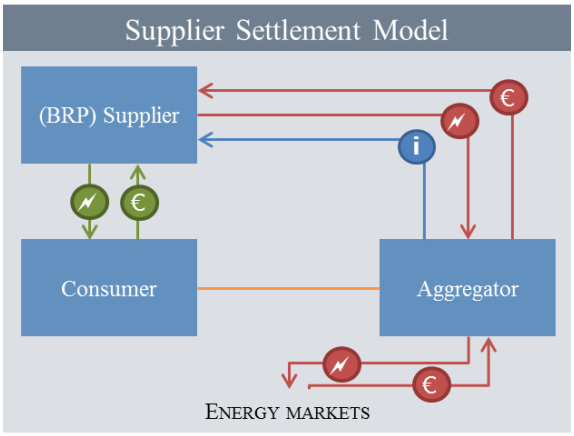


3.3 Models with independent Aggregator

The following models belong to the segment of models featuring "independent" Aggregator (as opposed to integrated Aggregator in Integrated models). In case of independent Aggregator, the consumer has to have two contracts – electricity supply contract (with their supplier) and a "flexibility contract" with an Aggregator. The flexibility contract entails that the Aggregator has a direct control over consumers load. In case of DR activation, the consumer's consumption will be curtailed and the Aggregator can use the unconsumed energy to take part in the energy markets. The compensation or "settlement" mechanisms determine the process and roles if/how the Aggregator compensates the energy transferred ("unconsumed" or "overconsumed") to the Supplier. As stated before, the models can be divided in two groups – with compensation from the Aggregator and with an alternative settlement mechanism (no compensation from the Aggregator).

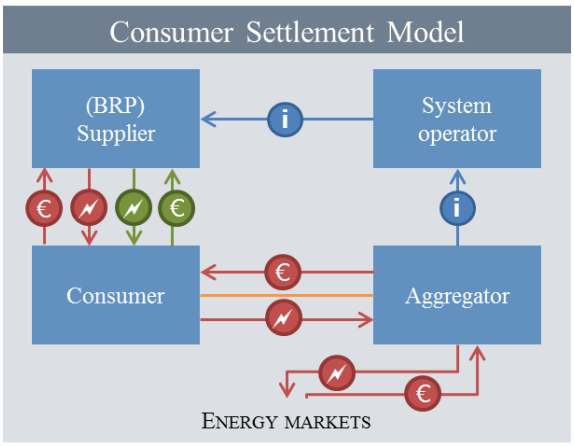
3.3.1 Supplier Settlement Model

The Supplier Settlement Model is a market design in which the independent Aggregator and the BRP conclude a bilateral agreement to solve the issues in regards to energy transfer. The economic efficiency of this model depends on the conditions in the contracts. If the BRP/supplier refuses to sign bilateral agreements with independent Aggregators, or only at an excessive transfer price, it can exert a form of monopoly over flexibility. Aggregator may compensate the consumer explicitly or the consumer will be implicitly compensated via lower energy consumption. Such arrangements fall under the contractual relationship between the Aggregator and the consumer.



3.3.2 Consumer Settlement Model

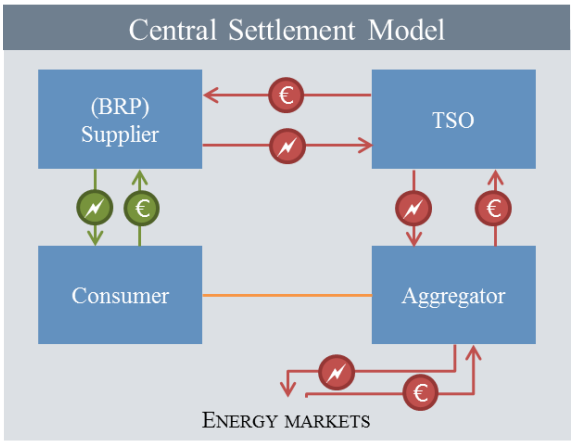
The Consumer Settlement Model requires that the supplier invoices the energy sold on the market by the independent Aggregator to the consumer as if the consumer had consumed it. This way, the transfer of energy is settled directly between the consumer and supplier at the contractual supply price. As the "energy transferred" is calculated and does not correspond to meter readings, it requires changes in the standard invoicing procedure. In this case it is expected that Aggregator will compensate the consumer to at least cover the costs of the non-consumed invoiced energy. Such arrangements fall under the contractual relationship between the Aggregator and the consumer.



3.3.3 Central Settlement Model

The Central Settlement Model requires the transfer of energy to be performed by a neutral central entity and a wholesale settlement price between the independent Aggregator and the BRP to settle the transfer of energy. This settlement price is a reference price that requires some form of regulatory approval.

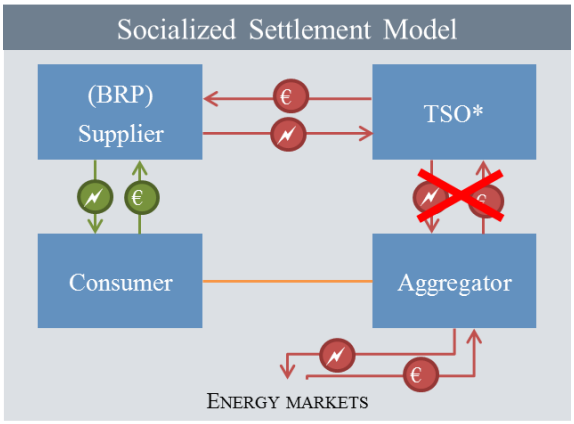
Aggregator may compensate the consumer explicitly or the consumer will be implicitly compensated via lower energy consumption. Such arrangements fall under the contractual relationship between the Aggregator and the consumer.



3.3.4 Socialized Settlement Model

The Socialized Settlement Model is one option for the "no compensation" model. The model allows the consumer's BRP to sell the excess energy to TSO at the standard imbalance price (in all other described models BRP's schedule is adjusted for the activated DR delivery and the BRP does not sell the excess energy to TSO). As TSOs are financially neutral institutions, the excess imbalance payment will increase the imbalance price. Within this model the costs of "unconsumed energy" are borne by all consumers via imbalance price.

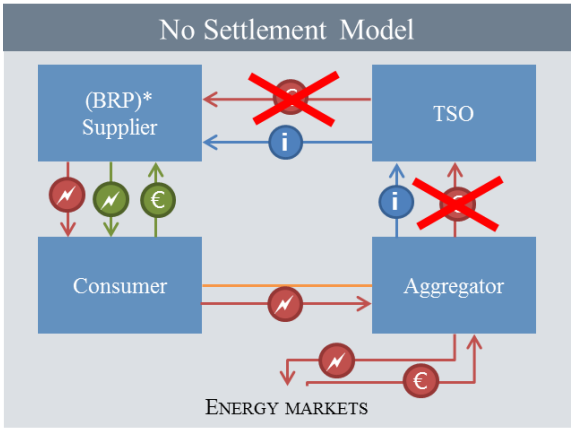
Aggregator may compensate the consumer explicitly or the consumer will be implicitly compensated via lower energy consumption. Such arrangements fall under the contractual relationship between the Aggregator and the consumer.



3.3.5. No Settlement Model

The No Settlement Model is another option of "no compensation" model. In this model the consumer's BRP is not granted any direct monetary compensation of the DR that was activated within the BRP's portfolio, the energy transfer takes place via consumer. . This model puts strong incentive on supplier to directly or indirectly require the consumers participating in aggregation to compensate the costs incurred.

Aggregator may compensate the consumer explicitly or the consumer will be implicitly compensated via lower energy consumption. Such arrangements fall under the contractual relationship between the Aggregator and the consumer.



3.4 Settlement model advantages and disadvantages

Model		Advantages	Disadvantages
Integrated	No energy transfer as Supplier and Aggregator are combined	• Easy to introduce (no need for baseline methodology; no need for changes in market framework.); • No need for market distorting regulations • Business relationships are based on voluntary agreements between relevant parties; • No need to determine energy transfer-price	• Insufficient market framework to facilitate independent aggregators; • Limits DR market competition and industry growth
Supplier settlement	BRP compensated at a price agreed between BRP and Aggregator	• Comparatively easy to introduce; • Limited need for market-distorting regulations • Business relationships are based on voluntary agreements between relevant parties;	• Insufficient market framework to facilitate independent aggregators (BRPs can directly or indirectly disallow aggregators from entering the market); • Limits DR market competition and industry growth (BRPs can created is proportionally unprofitable market environment to discourage Aggregation) • Suppliers can identify (and discriminate) against the consumers engaging with Aggregators.
Consumer settlement	BRP is compensated at retail agreement price by consumer (BRP is impartial)	• Sufficient market framework to facilitate independent aggregators; • Limited need for market-distorting regulations.	• Prohibitively costly introduction in regards to changes in the invoice administration for all market participants (especially in case of "overconsumption") • Reduces aggregator's business case more than other models with mandatory compensation involved (energy transfer price set at retail price as opposed the wholesale cost) • Requires consumer proficiency as invoices become much more complex (transfer energy, different tariffs) • Suppliers can identify (and discriminate) against the consumers engaging with Aggregators
Centralized settlement	BRP is compensated by Aggregator via TSO at predefined reference price	• Sufficient market framework to facilitate independent aggregators; • Limited risk exposure to other market participants (set energy transfer price); • Competent Authorities have some tools ensure that neither suppliers nor aggregators get an "unfair" advantage.	• Requires some market-distorting regulations (transfer price set by TSOs and approved by NRAs) • Somewhat limited DR industry growth (due to limited profit margins for independent aggregator).)
Socialized settlement	BRP is compensated by TSO at imbalance price	• Sufficient market framework to facilitate independent aggregators • Facilitates DR industry growth by providing incentivizing profit margins • Limited risk exposure to other market participants (energy transfer price tied to imbalance price)	• Business relationships are not based on voluntary agreements between relevant parties; • TSO pays double - both to aggregator (balancing price) and BRP (imbalance price) • Market distorting regulation as "procuring balancing" form an Aggregator is disproportionally more expensive than from other Balancing service providers, however it is not reflected in the balancing bid price.
No settlement	BRP schedule is adjusted, no additional compensation to BRP	• Sufficient market framework to facilitate independent aggregators • Facilitates DR industry growth by providing incentivizing profit margins	• Requires some regulations to facilitate BRP-aggregator relationships (e.g. data exchange) without an agreement between them. • Results in more challenging forecasting for BRPs and Suppliers which might put pressure on retail prices (if Suppliers are not provided with detailed data on activations) or might result in discrimination against consumer engaging with Aggregators (if detailed information is available).

4. Proposal for aggregation service integration in balancing market framework in Baltics

4.1 Objectives of the market framework in Baltics

It is indicated that there is a clear need to integrate explicit DR in Baltic markets. However, apart from a few controversial sections from the Clean Energy Package, the drivers presented do not provide clear preference to any of the settlement models. All of the models would allow DR to enter the balancing market, which would then increase the market liquidity and provide TSOs with more flexibility now and in the future when the planned desynchronization from IPS/UPS will take place. Furthermore, the ambivalence in regards to the settlement model is demonstrated by the highly varied approach EU countries have taken as well as the results of the analysis of the compensations itself.

To develop a framework for a harmonized market, the parties involved have to agree upon a common vision of the future market that particular framework aims to facilitate. During TSOs' discussions the following objectives have been identified:

- Ensure that all willing and technically sound energy resource holders (both consumers and generators) are able to participate in balancing market regardless of their size without facing discrimination or entry barriers;
- Limit market distorting regulations and/or cross-subsidies that can harm liberalized and non-discriminate market;
- Limit the risks of negative impact on retail prices (either from increase in administrative costs for market participants (including TSO) or increase in imbalance costs for BRPs);
- Facilitate DR market growth.

When examining the settlement models in regards to their suitability to the harmonized goals of the future market, the TSOs agreed that no single model is optimal for Baltic markets as either of the models is able to capture all the opportunities. The TSOs evaluation of the models is presented in the following Table.

Model	Evaluation	
Integrated	✓	TSOs consider that energy suppliers should be encouraged to expand their product portfolio and provide consumers with options to participate in wholesale/ balancing markets via DR services.
Supplier settlement	✓ / ✗	TSOs consider this as an option for Baltic markets, however the risk of barriers of entry to Aggregators needs to be addressed.
Consumer settlement	✗	TSOs consider this model not to be compatible for Baltic energy markets due to the prohibitive costs entailed for other market and system participants.
Centralized settlement	✓ / ✗	TSOs consider this as an option for Baltic markets, however the lack of option for voluntary agreement between market parties should be addressed.
Socialized settlement	✗	TSOs consider this model not to be compatible with Baltic energy markets as it distorts the market by allowing to DR bids to be undervalued (due to not taking into account the "double" cost for TSO).
No settlement	✓ / ✗	TSOs consider this model as an option for Baltic markets, however BRPs' needs for information should be addressed.

4.2 Proposed approach

While evaluating the advantages and disadvantages of each of the models in the context of Baltic markets, TSOs agree that:

- **Integrated aggregation should be facilitated and encouraged**. Appropriate regulatory requirements should be introduced as soon as possible. Detailed description of roles and responsibilities in Section 5.2.
- **Independent aggregation should be facilitated and encouraged**
  - **Voluntary agreements between markets participants** impacted should be facilitated and encouraged.
  - Additional steps should be taken to **ensure that the market operates in a non-discriminatory manner** towards all market participants. TSOs identify two alternative approaches to ensure the market is fair.
  - The alternative approaches are based on Supplier settlement model, Centralized settlement model and No settlement model. The choice of the best approach should be decided based on the results of pilot studies (more detailed information in Section 6). The feedback from market participants as well as the developments in regulations shall be considered in further work.

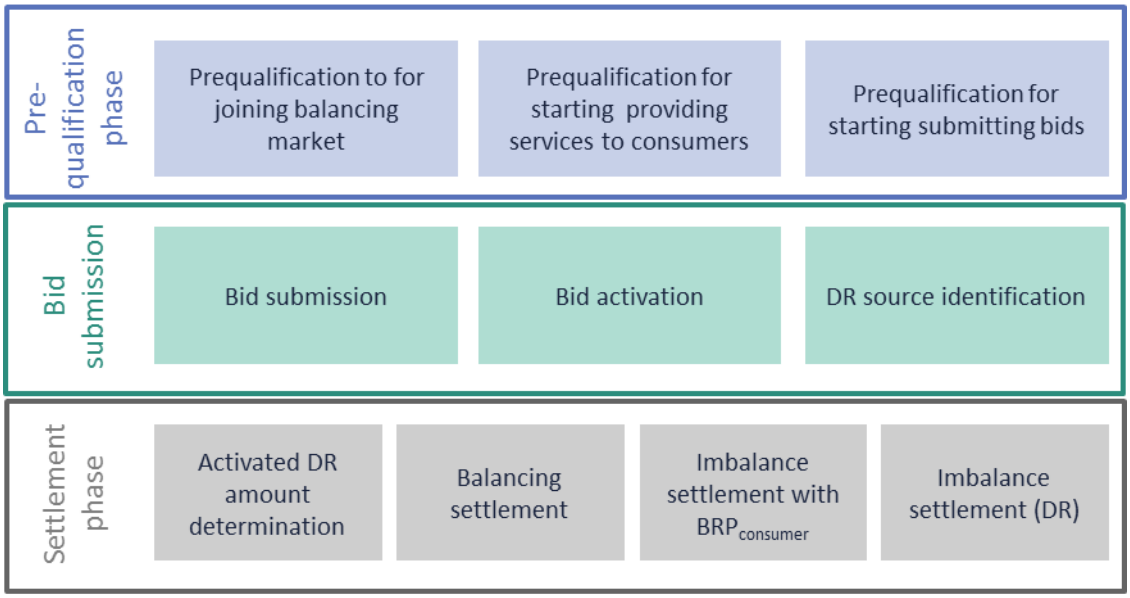
Agr → Sup Settlement Model	Con → Sup Agreement Model
For Aggregators unable to enter into business relationships with BRP/Supplier, there is an option to join the market via direct agreement with TSO. In this **case the TSO ensures the energy transfer and settlement between respective BRP(s) and aggregator via centralized mechanism** at a reference price (e.g. respective day-ahead spot price). In case Aggregators have entered into business relationships with the respective BRPs/Suppliers, energy transfer takes place directly between Aggregator and BRPs/Suppliers. Detailed description included in section 5.3.	Aggregators can join the market without an agreement with the respective BRP/Supplier, however aggregators are required to provide the respective **BRP/Supplier all the information necessary to ensure that BRP/Supplier is able** to identify consumers participating in activation and the amount aggregated from their portfolio **to avoid countermeasures in balancing their portfolios and to be able to adjust the terms in agreements with the consumers participating in DR services.** Aggregators can also enter into business relationships with BRPs/Suppliers, and in that case energy transfer takes place directly between Aggregator and BRP/Supplier. Detailed description included in section 5.4.

5. Market framework description

5.1 Balance market framework composition

5.1.1 Process

In the context of DR integration balancing market framework addresses processes that can be divided in three phases: Pre-Qualification, Bid management, Settlement.



Pre-qualification phase refers to steps necessary for an undertaking to start operating in the region; to start signing agreements with consumers and to start submitting bids to the TSO. Depending on settlement model, there might be only one or two of those steps necessary (or requiring specific action(s)).

Bid management phase refers to the steps directly linked to system balancing. It includes bid submission, bid activation. Whenever independent aggregator (regardless whether it aggregates generation or consumption) is involved, an additional step within this phase is flexibility source identification, as the BRPs and Suppliers have to be informed.

Settlement phase refers to financial relationships between market participants. This will be the phase most variable between different settlement models. For integrated model the steps included in this phase will follow the established process for Balance Service Providers and will not include DR amount determination process.

5.1.2 Roles and responsibilities

Traditionally the balancing market includes the following roles:

Role	General responsibilities within the balancing market
National Regulatory Authority (NRA)	NRA is the competent institution responsible for ensuring that market participants conduct business in a way that is compatible with existing rules. Typically develops and/or authorizes detailed regulations in regards to relationships between market participants.
Transmission system operator (TSO)	TSO is ultimately responsible for the balance within its balancing area. As such TSO acts as a gatekeeper for balancing market, manages bids, activates bids and calculates settlement.
Balance service provider (BSP)	BSP is an undertaking that has an agreement with TSO for providing balancing energy to the system. BSP has to comply with technical and market rules set out by TSO and NRA. BSP is balance responsible and as such always needs to have a BRP.

Role	General responsibilities within the balancing market
Balance responsible party ($BRP_{consumer}$)	BRP is an energy supplier responsible for the balance (imbalance) within its balancing area. BRP has to provide schedule. When the schedule does not correspond to the metering data, BRP is required to buy/sell deficit/excess energy from TSO. $BRP_{consumer}$ refers to the BRP whose balancing area the particular consumer resides in.
Consumer	Consumer has to have an agreement for energy supply and grid connection. Consumer is free to choose any energy supplier in the particular market.
DR resource owner*	Owner is a natural or legal person who/which owns the electric device(s) capable of engaging in DR service. DR resource owner joins in energy markets either via flexibility agreement with and aggregator or via direct agreement with a supplier/system operator.
Aggregator (AGR)*	Aggregator is an undertaking that combines loads of multiple consumers and/or generators and provides the combined load in energy markets. Independent aggregator is one that does not have any energy supply/purchase agreement. Integrated aggregator is one that is also energy supplier and only provides flexibility from its balancing area.
Balance responsible party (BRP_{AGR})*	BRP_{AGR} is responsible for balancing energy the AGR did not deliver to/from the TSO. BRP_{AGR} can be AGR itself or a separate entity.

**New roles*

5.1.3. Methodologies

In addition to the process description and roles description market framework needs detailed regulations.

Regulatory need	Description	Relevant settlement models
Requirements for qualification for entering market (for LV only)	To be developed by Latvian NRA.	All
Principles for AGR-Consumer relationships	Suggested approach needs to be developed by competent authority responsible for retail market regulations.	All
Technical requirements for qualification for balancing market	Based on EC Energy Balancing guidelines and EC Demand Connection network code. Closely matched with standard requirements to BSPs. To be developed by TSOs (Balancing WG).	All
Balancing market standard product definition	Standardized requirements for all BSP to be developed by TSOs.	All
Activated DR amount determination	Suggested approach included in this report, Section 7. Methodology developed by TSOs, approved by NRAs.	Independent aggregation
Data exchange in regards to the energy transfer.	Suggested approach shall be decided.	Independent aggregation
Transfer price determination	To be approved by NRAs. Proposal developed by TSOs if Alternative I is chosen. Typically some form of relevant day-ahead price is used.	Centralized Settlement
Principles for AGR-BRP relationships.	If relevant, to be developed by Baltic TSOs and approved by NRA's.	Supplier settlement

5.2 Summary of the alternative proposals

<table>
<tr><th colspan="2" rowspan="2">Process step</th><th rowspan="2">Integrated</th><th colspan="3"><u>Agr → Sup Settlement Model</u></th><th rowspan="2"><u>Con → Sup Agreement Model</u></th></tr>
<tr><th>Supplier</th><th colspan="2">Central</th></tr>
<tr><td rowspan="3">Pre-qualification</td><td>Joining the market</td><td>Must also be supplier</td><td colspan="4">Registration as AGR</td></tr>
<tr><td>Providing DR services to consumers</td><td>Must have sufficient portfolio</td><td colspan="4">Must have a BRP</td></tr>
<tr><td>Joining balancing market</td><td colspan="5">Standard requirements for BSP.</td></tr>
<tr><td rowspan="3">Bid management</td><td>Bid submission</td><td colspan="5">Standard requirements for BSP.</td></tr>
<tr><td>Bid activation</td><td colspan="5">Standard procedure for BSP.</td></tr>
<tr><td>Energy source identification</td><td>Not relevant</td><td colspan="4">Has to identify participating DR resource owners after the delivery (both to TSO and BRP).</td></tr>
<tr><td rowspan="6">Settlement & Energy transfer</td><td>DR amount determination</td><td>Not relevant.</td><td colspan="4">In accordance to baseline methodology.</td></tr>
<tr><td rowspan="2">Balance settlement</td><td colspan="5">TSO pays AGR $P_{balancing}$ for the $DR_{activated.}$</td></tr>
<tr><td>No additional transfer.</td><td>AGR compensates $BRP_{consumer}$.</td><td colspan="2">AGR indirectly (via TSO) pays $BRP_{consumer}$ for $D_{delivered@}$ P_{ref}</td><td>No additional transfer.</td></tr>
<tr><td>Imbalance settlement ($BRP_{Consumer}$)</td><td rowspan="2">BRP settles with TSO ($P_{imbalance}$) for the under/over delivery (DR_{imb})</td><td colspan="4">TSO imbalance settlement with $BRP_{consumer}$ is not impacted. $BRP_{consumer}$ schedule is reduced by $DR_{Delivered.}$.</td></tr>
<tr><td>Imbalance settlement (BRP_{AGR})</td><td colspan="4">BRP_{AGR} settles with TSO ($P_{imbalance}$) for the under/ over delivery (DR_{imb}).</td></tr>
<tr><td rowspan="2">Consumer</td><td colspan="5">Consumer may receive compensation from AGR.</td></tr>
<tr><td colspan="4">Supplier not expected to require compensation from Consumer</td><td>Supplier may require compensation from Consumer.</td></tr>
</table>

Detailed description of the proposals is provided in Appendix II.

6. Pilot studies

6.1. Objective of the pilot studies

TSOs consider that pilot studies are essential to ensure that the market model ultimately proposed and introduced in Baltics is efficient. Pilot studies and case studies not only allow testing technical readiness of market participants and system operators but also allows to test out assumptions in a safe environment. The main objectives of the pilot studies are to:

- Review and test technical feasibility and data exchange processes;
- Identify potential improvements for market models/ technical requirements;
- Identify and if possible mitigate unforeseen barriers or risks;
- Collect feedback (advantages/disadvantages) from market players.

Additionally, TSOs consider that pilot studies should be **used to decide between the two alternative approaches** for introducing independent aggregator in Baltic balancing market.

6.1.1. Piloting the alternative market frameworks

As described before TSOs consider that the best approach for independent DR introduction in Baltic markets is to create a market framework where market participants agree among themselves on terms and conditions that are mutually beneficial. However, TSOs recognize that current market composition might pose some risk to ensuring fair and non-discriminatory conditions for the parties. As described before in Section 4, TSOs, propose two alternative approaches to mitigate potential unfair advantages.

- **Agr → Sup Settlement Model -** for Aggregators unable to enter into business relationships with BRP/Supplier, there is an option to join the market via direct agreement with TSO. In this case the TSO ensures the energy transfer between respective BRP(s) and aggregator via centralized mechanism at a reference price (e.g. commonly respective day-ahead spot price). In case Aggregators have entered into business relationships with the respective BRPs/Suppliers, energy transfer takes place directly between Aggregator and BRPs/Suppliers.
- **Con → Sup Agreement Model** - aggregators can join the market without an agreement with the respective BRP/Supplier, however aggregators are required to provide the respective BRP/Supplier all the information necessary to ensure that BRP/Supplier is able to identify consumers participating in activation and the amount aggregated from their portfolio to avoid countermeasures in balancing their portfolios and to be able to adjust the terms in agreements with the consumers participating in DR services. Aggregators can also enter into business relationships with BRPs/Suppliers, and in that case energy transfer takes place directly between Aggregator and BRP/Supplier.

6.1.2. Issues to be reviewed in pilots

<table>
<tr><th colspan="2">Agr → Sup Settlement Model</th><th>Con → Sup Agreement Model</th></tr>
<tr><th>Supplier settlement</th><th>Centralized settlement</th><th></th></tr>
<tr><td colspan="2">The profit margins for Aggregator do not facilitate/ allow market development. During the pilot the following should be reviewed via collecting feedback from the participants:
Evaluation of net benefits for each of the parties (i.e. Aggregator, Consumer, BRP, TSO).</td><td rowspan="2">Suppliers overestimate the compensation necessary from the Consumers, which might discourage the consumers to participate in DR. During the pilot the following should be reviewed via collecting feedback from the participants:
Changes in Supplier-Consumers agreement.
Retention of consumers for flexibility.
Evaluation of net benefits for each of the parties (i.e. Aggregator, Consumer, BRP, TSO).</td></tr>
<tr><td>Supplier settlement is not working because the market parties cannot find an agreement. This should be reviewed during the preparation for the pilot via collecting feedback.</td><td>The centralized settlement is cumbersome/ costly process administratively. This should be reviewed during the pilot via collecting feedback.</td></tr>
</table>

Unforeseen demotivators for consumers to join the flexibility market. During the pilot the following should be reviewed via collecting feedback from the participants:

- Aggregators' experience in building the portfolio.
- Main issues consumers are concerned about (that restrict their willingness to join the flexibility market).

6.2 Overview of the pilot studies chosen

6.2.1 Independent aggregation pilot projects in Finland

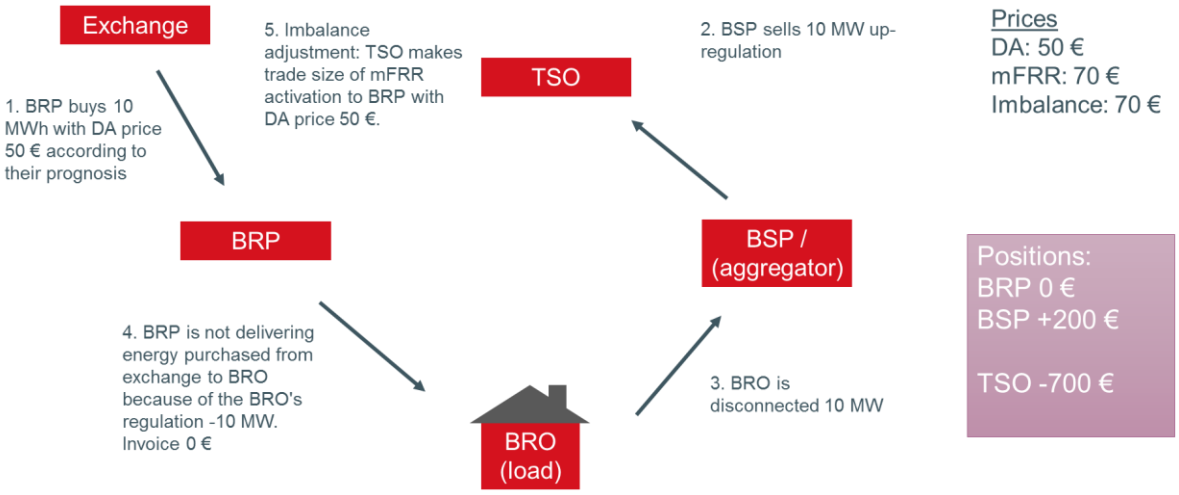
In Finland, piloting aggregation for mFRR market is planned to be commenced during Q4 in 2017. The pilot's duration is going to be one year. The pilot is organized by Fingrid and Aggregators. Originally it was planned to test "No Settlement Model", however after thinking the model more closely it was identified that such a model would result in financial inequality to the BRPs (which would potentially put pressure on the retail prices).

It was decided to test out two different variations of "Central Settlement Model":

1. Aggregator does not have balance responsibility, and non-delivery is penalized monetarily;
2. Aggregator has balance responsibility, and non-delivery is penalized with imbalance.

In both cases the energy transfer between the Aggregator and BRPs is managed by TSO. The reference price for compensation is set at the day ahead market price. The Aggregator receives the difference between the balancing price and the reference price (day ahead price).

Example (Source – Fingrid)



The target of the pilot is to get practical experiences of leaving aggregated bids, registering the sales and handling the imbalances and information exchange between parties, among others. Based on pilot experiences, Fingrid evaluates whether to implement independent aggregator model in balancing and reserve market in general.

6.2.2 Independent aggregation pilot project in Estonia

In Estonia the pilot test for mFRR market is planned to be commenced during Q3/Q4 2017. Originally, Supplier settlement model was considered, however, no reasonable agreement between BRP and the aggregator could be reached. Due to this, the approach was changed and a variation of No Settlement Model was agreed to be tested out with the following principles:

- consumer's BRP gets information of aggregated metering points and total amounts of aggregation within its portfolio;

- consumer's BRP's schedule is adjusted based on the meter data (actual delivery) provided by the Aggregator;
- Aggregator is balance responsible, i.e. under- or over-delivery is penalized with imbalance to the Aggregator's BRP.

The results from the pilot are to provide information on how the data exchange works, how competitive the Aggregator's bids are, how will the BRP-s handle the clients who are participating in the aggregation etc. All the information would serve as a basis for further development decisions.

6.2.3 DR service case studies in Latvia

Latvian TSO is currently working with Riga Technical University to develop a mathematical model to estimate the business case for different types of flexibility providers. The project agreed includes model (tool) testing on real flexibility providers. The pilot cases are planned to take place during Q2-Q3 of 2018.

6.2.4 DR service case studies in Lithuania

Lithuanian TSO together with the main Lithuanian DSO are carrying out a feasibility study on assessing the technical potential of demand side response in Lithuania and establishing technical requirements for providing such services. During the project investigation will be performed by conducting a survey to estimate willingness of market participants to provide potential DR services. Meetings and workshops with the most promising customers and groups of consumers, which can be aggregated, aggregators to be carried out investigating their technical characteristics and technical requirements. This investigation shall provide potential capacities of DR services including cost-benefits analyses for the most promising providers. Final results of the case studies is scheduled to be completed by 2018 Q3.

6.3 Overview of the national initiatives

Dimension	Estonia	Latvia	Lithuania	Finland
Scale of the project	Aggregation pilot study	Case study involving individual DR resource owners	Case study involving individual DR resource owners	Aggregation pilot study
Aggregator needs to have an agreement with	AGR has an agreement with Consumer and TSO	TBA	AGR has agreement with TSO and Consumer	AGR has agreement with TSO and Consumer
AGR balance responsibility	AGR is balance responsible	DR resource owner is balance responsible	Two variations – AGR is balance responsible, AGR is not balance responsible	Two variations – AGR is balance responsible via imbalance or via financial penalty.
Compensation mechanism (market model)	Con → Sup Agreement Model	n/a	n/a	Centralized settlement model
Data exchange requirements	• Same technical requirements as other BPS. • Real time measurements (not required during pilot)	TBA	TBA	• Same technical requirements as other BPS. • Real time measurements • Bid specification includes the balance portfolios be impacted
mfRR product specification	1 MW (can be combined from generation and DR)	TBA	1 MW	Minimum 5 MW (can be combined from generation and DR).
Baseline methodology	No	To be used	N/A	To be used.
Expected start date	Q4 2017	Q2 2018	Q1 2018	Q1 2018

7. Proposed model for energy transfer calculations

Baseline methodology is used to measure curtailments in response to a DR event. During a DR event, actual facility load must be compared to "business as usual" load or what the facility load would have been but for the implemented curtailment measures. "Business as usual" load is estimated using a baseline methodology. The difference between the baseline and actual load constitutes that facility's DR performance. Well-designed baseline methodology enables grid operators and utilities to measure performance of DR resources. A baseline methodology that systematically over-estimates the "business as usual" loads will over-value the contribution of a DR resource to the grid. Conversely, a baseline methodology that underestimates "business as usual" load will under-value the DR resource. A well-designed baseline benefits all stakeholders by aligning the incentives, actions and interests of end-user participants, aggregators, utilities, grid operators and ratepayers. [17]

The most important baseline characteristics that should be taken into account when evaluating suitable baseline methodology **are accuracy, simplicity, integrity and alignment**. The accuracy is important in order to evaluate the DR actually provided, but at the same time methodology should be simple enough for all stakeholders to calculate and understand. The suitable methodology should minimize the availability of data manipulation and also minimize unintended consequences such as inadvertently penalizing real curtailment efforts. [17]

Since the baseline represents a theoretical figure and as such various models with different characteristics can be observed. In total four models where reviewed – two models use only data from the periods before the activation, while the other two uses data from both before and after.

7.1 Methods' descriptions

Four baselines methods were analysed in this paper. "EnerNOC" method was originally presented in 2009 by EnerNOC [17], Inc. "UK model" was adopted from paper by Imperial College London [18]. "Average" and "daily profile" methods were developed by the authors of this paper to check the precision of the models using both "before" and "after" data. Short description and formulas of the methods are presented below:

Method	Short description
EnerNOC	Baseline is equal to the average consumption of 5 corresponding hours with highest consumption within 10 last non-event days. Baseline is adjusted upwards by the average difference between last two hours' actual consumption and their baseline. Formula: $b_t = \frac{c_1 + c_2 + c_3 + c_4 + c_5}{5} + \max[\frac{c_{t-1} - b_{t-1} + c_{t-2} - b_{t-2}}{2}; 0]$
UK model	Baseline is equal to the average consumption of 5 corresponding hours within 5 days with highest daily consumption (out of 10 last non-event days). Baseline is adjusted upwards and downwards by the difference between last two hours' actual consumption and their baseline. Formula: $b_t = \frac{C_1 + C_2 + C_3 + C_4 + C_5}{5} + \frac{C_{t-1} - b_{t-1} + C_{t-2} - b_{t-2}}{2}$
Average	Baseline is equal to the average of consumption one hour before and one hour after the DR event. Formula: $b_t = \frac{c_{t-1} + c_{t+1}}{2}$
Daily profile	Baseline is equal to the consumption within preceding hour multiplied by the fraction of increase/decrease of consumption in the corresponding hours a day before the event. Formula: $b_t = \frac{c_{\mathrm{d},\ t-1} * c_{\mathrm{d}-1,\ t}}{c_{d-1,t-1}}$

b_t −baseline at hour *t*;

c_1 −highest corresponding hourly consumption within 10 last non-event days;

C_1 −highest corresponding hourly consumption in a day with highest daily consumption within 10 last non-event days.

7.2 Model comparison

The analysis of the methods showed that "EnerNOC" model is not the best option for implementation in Baltic States due to its low forecast accuracy and regular baseline overestimation, which puts the aggregator in favorable conditions. "Average" and "Daily profile" methods showed high accuracy results, but did not achieve the performance of the "UK model". Moreover, "Average" method showed high forecast errors in peak/off-peak hours, which are considered to be the most demand response intensive (in theory). As well as it cannot be used for calculus of baseline in case of 2 of more subsequent DR hours. Advantages and disadvantages of the models are summarised in the table:

Method	Advantages	Disadvantages
EnerNOC	• Relatively simple; • Cannot be exploited by aggregator.	• High forecast error; • Regular baseline overestimation (asymmetric error); • Lower forecast accuracy for weekends.
UK model	• Highest forecast accuracy; • Can't be exploited by aggregator; • Symmetric error (no over/underestimation bias).	• Lower forecast accuracy for weekends.
Average	• Simple; • High forecast accuracy.	• Can't be used 2 and more hours in a row; • Doesn't account for peak and off-peak hours; • Can be exploited by aggregator;
Daily profile	• High forecast accuracy; • Can't be exploited by aggregator; • Symmetric error (no over/underestimation bias).	• Requires cyclic consumption pattern;

According to the analysis of 40 random consumption patterns, the most accurate baseline method is the "UK model". The results are summarised in the table:

	EnerNOC	UK model	Average	Daily profile
Average error:	9.6%	2.5%	3.1%	5.2%
Biases:	Baseline overestimation	-	Peak/off-peak errors	-

Although its forecast error is not statistically different from "Average" method, the "UK model" has symmetric forecast error, which is preferable to peak/off-peak forecast errors. In the long-run symmetric forecast error will bring aggregator in equilibrium, as in some DR events its baseline will be underestimated, while in other hours it will be overestimated. *Ceteris paribus*, symmetric under- and overestimation of the baseline will not allow any DR party to malfunction the system, as a result fair economic conditions will be created.

Comparison of baseline methods shows that the best choice for the Baltic States is following the baseline method used in the UK. According to the results, the UK method produces lowest baseline forecast error comparing to other methods. It does not require complex calculations, as well as is simple to use and thus communicate.

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Appendices

Appendix I – mFRR product requirements

Common requirements have been agreed upon for the mFRR product among the Baltic TSOs. The technical parameters are listed as of: 01.09.2017.

Parameter	Baltic standard mFRR product for balancing
Preparation period	Agreed during the phone call (or in Electronic message)
Ramping period	Not more than 15 min
Full activation time	Not more than 15 min
Minimum and maximum quantity	MIN = 1 MW; MAX = no restrictions
Deactivation period	Not more than 15 min
Pricing method	Pay as bid of BSP, marginal pricing in the future
Minimum and maximum price	MIN not determined; MAX = 5000 EUR/MWh
Divisibility	To be defined by BSP (Divisible or Not divisible)
Minimum and maximum duration of delivery period	MIN = 1 min; MAX = 60 min (but not more than until the end of operational hour)
Validity period	60 min
Mode of activation	Manual
Minimum duration between the end of deactivation period and the following activation	Not determined
Settlement volume determination: required start of delivery end time of the order	Block product of between required start of delivery and end time of order
Gate closure of the BSP offers	H-45min

Appendix II - detailed description of the proposals

A. Integrated Aggregators

Integrated market model is very similar to the traditional BSP market model.

Process category and step		Description
Pre-qualification	Joining the market	• For LV – requires AGR registration as both Energy Supplier and AGR. • For EE and LT – requires AGR registration as Energy Supplier.
	Providing DR services to consumers	• Energy supplier –AGR needs to have a BRP. • Energy supplier – AGR needs to have Energy supply agreement before it can provide DR services.
	Joining balancing market	• AGR Needs to sign a balancing agreement with a TSO. • AGR Needs to demonstrate that it has actual DR resources to provide sufficient amount of electricity for the participation in balancing market. • AGR Needs to demonstrate that it is capable to fulfil technical requirements. • AGR Needs to provide TSO with the real-time data required for dispatch operators.
Bid management	Bid submission	• Bids can be submitted no later than 1h before operational hour. • Only standard product bids are accepted. • Bids can include the load from DR and/or generation
	Bid activation	• Bid activation time has to comply with the standard product specification.
	Energy source identification	• No need to identify the energy source after the delivery.
Settlement	DR amount determination	• Delivered volume is considered to be fixed delivery from the AGRs balance area to TSO. It is considered to be always fulfilled. No baseline methodology needed.
	Balance settlement	• AGR receives from TSO balancing price ($P_{balancing}$) for the ordered amount ($DR_{activated}$).
	Imbalance settlement ($BRP_{Consumer}$)	• As $BRP_{Consumer}$ and BRP_{AGR} is the same entity. BRP_{AGR} settles with TSO ($P_{imbalance}$) for the under/over delivery (DR_{imb})
	Imbalance settlement (BRP-AGR)	
	Consumer	• Consumer may receive compensation from AGR.

B. Independent aggregator – Agr → Sup Settlement Model

The basis of this approach is the voluntary agreement between Supplier and Aggregator in regards to the compensation mechanism for already procured energy by supplier (as in Supplier settlement model); however to mitigate the risk of discrimination against Aggregators (or direct/indirect market barriers) centrally regulated entry mechanism (without having an agreement with the Supplier) for Independent aggregator is ensured (based on Central settlement model). In this way the Suppliers and Aggregators are motived to find an agreement which ensures that both parties are at least as well-off as within the Central settlement model.

Process category and step		Description
Pre-qualification	Joining the market	• For LV – requires AGR registration as both Energy Supplier and AGR. • For EE and LT – requires AGR registration as Energy Supplier.
	Providing DR services to consumers	• AGR needs to have a BRP.
	Joining balancing market	• AGR needs to sign a balancing agreement with a TSO. • AGR needs to demonstrate that it has actual DR resources to provide sufficient amount of electricity for the participation in balancing market. • AGR needs to demonstrate that it is capable to fulfil technical requirements • AGR needs to provide a TSO with the real-time data required for dispatch operators.
Bid management	Bid submission	• Bids can be submitted no later than 1h before operational hour. • Only standard product bids are accepted. • Bids can include load from DR and/or generation
	Bid activation	• Bid activation time has to comply with the standard product specification.
	Energy source identification	• Energy source to be identified by the AGR after the delivery to relevant BRP and TSO.
Settlement & Energy transfer (Aggregator-Supplier/BRP)	DR amount determination	• Delivered DR amount is determined according to baseline methodology. $DR_{activated}$ may be different from $DR_{delivered}$.
	Balance settlement	• AGR receives from TSO balancing price ($P_{balancing}$) for the ordered amount ($DR_{activated}$). • AGR compensates $BRP_{consumer}$ at agreed price between the AGR and BRP ($P_{agreement}$) for the amount $DR_{delivered}$.
	Imbalance settlement ($BRP_{Consumer}$)	• TSO imbalance settlement with $BRP_{consumer}$ is not impacted (in addition to BRP imbalance adjustment).
	Imbalance settlement (BRP_{AGR})	• BRP_{AGR} settles with TSO ($P_{imbalance}$) for the under/over delivery (DR_{imb}).
	Consumer	• Consumer may receive compensation from AGR for $DR_{Delivered}$ ($P_{flexibility}$).
Settlement & Energy transfer (Aggregator-TSO-Supplier/BRP)	DR amount determination	• DR amount is determined according to baseline methodology. $DR_{activated}$ may be different from $DR_{delivered}$.
	Balance settlement	• AGR receives from TSO balancing price ($P_{balancing}$) minus reference price ($P_{reference}$) for the full amount of activated bid ($DR_{activated}$). • TSO pays $BRP_{consumer}$ reference price for all MWh delivered from that $BRP_{consumer}$ portfolio ($DR_{delivered}$).
	Imbalance settlement ($BRP_{Consumer}$)	• TSO imbalance settlement with $BRP_{consumer}$ is not impacted. $BRP_{consumer}$ schedule is reduced by $DR_{Delivered.}$.
	(Im)balance settlement (BRP_{AGR})	• BRP_{AGR} settles with TSO ($P_{imbalance}$) for the under/ over delivery (DR_{imb}).

	Netted invoicing	• After the settlement is calculated and settlement report is approved TSO calculates the netted financial positions for $BRP_{consumer}$, AGR, and BRP_{AGR} ○ $BRP_{consumer} = (DR_{delivered} * P_{referene})$ ○ $AGR = (DR_{activated} * P_{balancing}) - (DR_{delivered} * P_{reference})$ ○ $BRP_{AGR} = DR_{imb} * P_{imbalance}$
	Consumer	• Consumer may receive compensation from AGR for $DR_{Delivered}$ ($P_{flexibility}$).

C. Independent aggregator – Con → Sup Agreement Model

The basis of this approach are the voluntary adjustments in the Agreement between Consumer & Supplier. The Aggregator can enter the market without having an agreement with Supplier (as in No settlement model), however, to ensure that the Supplier has full control over its Balance Area the Aggregator is required to provide the data regarding DR activations (including the amount of DR provided and metering points). In such a way the Supplier may adjust the consumption agreement with the Consumers involved in flexibility agreements to ensure that Supplier does not suffer losses. The Consumer can still choose both Supplier and Aggregator to ensure that (s)he receives benefits from participating in the flexibility agreement.

Process category and step		Description
Qualification	Joining the market	• For LV – requires AGR registration as both Energy Supplier and AGR. • For EE and LT – requires AGR registration as Energy Supplier.
	Providing DR services to consumers	• AGR needs to have a BRP.
	Joining balancing market	• AGR Needs to sign balancing agreement with TSO. • AGR Needs to demonstrate that it has actual DR resources to provide sufficient amount of electricity for the participation in balancing market. • AGR Needs to demonstrate that it is capable to fulfil technical requirements. • AGR Needs to provide TSO with the real-time data required for dispatch operators.
Bid management	Bid submission	• Bids can be submitted no later than 1h before operational hour. • Only standard product bids are accepted. • Bids can include load from DR and/or generation
	Bid activation	• Bid activation time has to comply with the standard product specification.
	Energy source identification	• Energy source to be identified after the delivery to relevant BRP and TSO.
Settlement & Energy transfer (Aggregator-Consumer-Supplier/ BRP)	DR amount determination	• Delivered DR amount is determined according to baseline methodology. $DR_{activated}$ may be different from $DR_{delivered}$.
	Balance settlement	• AGR has to receive from TSO balancing price ($P_{balancing}$) for the full amount of activated bid ($DR_{activated}$).
	Imbalance settlement ($BRP_{Consumer}$)	• TSO imbalance settlement with $BRP_{consumer}$ is not impacted. $BRP_{consumer}$ schedule is reduced by $DR_{Delivered}$..
	Imbalance settlement (BRP_{AGR})	• BRP_{AGR} settles with TSO ($P_{imbalance}$) for the under/ over delivery (DR_{imb}).
	Consumer	• $BRP_{consumer}$ may request Consumer to provide compensation for $DR_{Delivred}$ ($P_{?}$). • Consumer may receive compensation from AGR for $DR_{Delivered}$ ($P_{flexibility}$).

Appendix III – Overview of regulations

The 3rd Electricity Directive (2009/72/EC)

Defines the concept of "energy efficiency/demand side management" and acknowledges its positive impact on environment, on security of supply, on reducing primary energy consumption and peak loads:

29. 'energy efficiency/demand-side management' means a global or integrated approach aimed at influencing the amount and timing of electricity consumption in order to reduce primary energy consumption and peak loads by giving precedence to investments in energy efficiency measures, or other measures, such as interruptible supply contracts, over investments to increase generation capacity, if the former are the most effective and economical option, taking into account the positive environmental impact of reduced energy consumption and the security of supply and distribution cost aspects related to it.

Art. 25.7 requires network operators to consider DR and energy efficiency measures when planning system upgrades:

When planning the development of the distribution network, energy efficiency/demand-side management measures or distributed generation that might supplant the need to upgrade or replace electricity capacity shall be considered by the distribution system operator.

Energy Efficiency Directive (2012/27/EU)

Art. 15.4 requires all member states to "ensure the removal of those incentives in transmission and distribution tariffs that are detrimental to the overall efficiency (including energy efficiency) of the generation, transmission, distribution and supply of electricity or those that might hamper participation of Demand Response, in balancing markets and ancillary services procurement".

Art. 15.8 states that "member States shall ensure that national regulatory authorities encourage demand side resources, such as Demand Response, to participate alongside supply in wholesale and retail markets."

Art. 15.8 states that "[…] transmission system operators and distribution system operators, in meeting requirements for balancing and ancillary services, treat demand response providers, including aggregators, in a non-discriminatory manner, on the basis of their technical capabilities."

ANNEX XI. states that "Network regulation and tariffs shall not prevent network operators or energy retailers making available system services for demand response measures, demand management and distributed generation on organised electricity markets, in particular:

(a) the shifting of the load from peak to off-peak times by final customers taking into account the availability of renewable energy, energy from cogeneration and distributed generation;
(b) energy savings from demand response of distributed consumers by energy aggregators;
(c) demand reduction from energy efficiency measures undertaken by energy service providers, including energy service companies;
(d) the connection and dispatch of generation sources at lower voltage levels;
the connection of generation sources from closer location to the consumption; and
(e) the storage of energy."

For the purposes of this provision the term 'organised electricity markets' shall include over-the-counter markets and electricity exchanges for trading energy, capacity, balancing and ancillary services in all timeframes, including forward, day-ahead and intra-day markets.

Regulation 2016/1388 on establishing a Network Code on Demand Connection

This network code among other things lays down the requirements for grid connection for demand units, used by a demand facility or a closed distribution system to provide DR services to relevant system operators and relevant TSOs.

It emphasizes that "Harmonised rules for grid connection for demand facilities and distribution systems should be set out in order to provide a clear legal framework for grid connections, facilitate Union-wide trade in electricity, ensure system security, facilitate the integration of renewable electricity sources, increase competition, and allow more efficient use of the network and resources, for the benefit of consumers".

Art. 1.3 states that the "Regulation also lays down the obligations for ensuring that system operators make appropriate use of the demand facilities' and distribution systems' capabilities in a transparent and non-discriminatory manner to provide a level playing field throughout the Union".

Proposal for Directive on the internal market for electricity (published on 30.11.2016)

Article 13 - Contract with an aggregator

1. Member States shall ensure that, where a final customer wishes to conclude a contract with an aggregator, such engagement shall not require the consent of the final customer's supplier.
2. Member States shall ensure that a final customer wishing to terminate the contract with an aggregator, while respecting contractual conditions, is entitled to such termination within three weeks.
3. Member States shall ensure that final customers terminating a fixed term contract with an aggregator before its maturity are not charged any termination fee that exceeds the direct economic loss to the aggregator, including the cost of any bundled investments or services already provided to the final customer as part of the contract.
4. Member States shall ensure that final customers are entitled to receive all relevant demand response data or data on supplied and sold electricity at least once per year
5. Member States shall ensure that the rights referred to in paragraphs 1, 2, 3 and 4 are granted to final customers in a non-discriminatory manner as regards cost, effort or time.

Article 17 – Demand Response

1. Member States shall ensure that national regulatory authorities encourage final customers, including those offering demand response through aggregators, to participate alongside generators in a non-discriminatory manner in all organised markets.
2. Member States shall ensure that transmission system operators and distribution system operators when procuring ancillary services, treat demand response providers, including independent aggregators, in a non-discriminatory manner, on the basis of their technical capabilities
3. Member States shall ensure that their regulatory framework encourages the participation of aggregators in the retail market and that it contains at least the following elements:
    b. the right for each aggregator to enter the market without consent from other market participants;
    c. transparent rules clearly assigning roles and responsibilities to all market participants;
    d. transparent rules and procedures for data exchange between market participants that ensure easy access to data on equal and non-discriminatory terms while fully protecting commercial data;
    e. aggregators shall not be required to pay compensation to suppliers or generators;
    f. a conflict resolution mechanism between market participants.

1. In order to ensure that balancing costs and benefits induced by aggregators are fairly assigned to market participants, Member States may exceptionally allow compensation payments between aggregators and balancing responsible parties. Such compensation payments must be limited to situations where one market participant induces imbalances to another market participant resulting in a financial cost. Such exceptional compensation payments shall be subject to approval by the national regulatory authorities and monitored by the Agency.
2. Member States shall ensure access to and foster participation of demand response, including through independent aggregators in all organised markets. Member States shall ensure that national regulatory authorities or, where their national legal system so requires, transmission system operators and distribution system operators in close cooperation with demand service providers and final customers define technical modalities for participation of demand response in these markets on the basis of the technical requirements of these markets and the capabilities of demand response. Such specifications shall include the participation of aggregators.

Art. 24.8 sets that the "Member States shall require electricity distribution system operators to assess at least biannually, in cooperation with the operators of district heating or cooling systems in their respective area, the potential of district heating or cooling systems to provide balancing and other system services, including demand response and storing of excess electricity produced from renewable sources and if the use of the identified potential would be more resource- and cost-efficient than alternative solutions".

Proposal for Regulation on the internal market for electricity (published on 30.11.2016)

It is pointed out that the (8) "Core market principles should set out that electricity prices are to be determined through demand and supply. Those prices should signal when electricity is needed, providing market-based incentives for investments into flexibility sources such as flexible generation, interconnection, demand response or storage".

Art. 3.1. "Member States, national regulatory authorities, transmission system operators, distribution system operators, and market operators shall ensure that electricity markets are operated in accordance with the following principles:[..] (f) market rules shall deliver appropriate investment incentives for generation, storage, energy efficiency and demand response to meet market needs and thus ensure security of supply; [..] (i) all generation, storage and demand resources shall participate on equal footing in the market".

Art. 6.3 "Market operators shall be free to develop products and trading opportunities that suit market participants' demand and needs and ensure that all market participants are able to access the market individually or through aggregation. They shall respect the need to accommodate increasing shares of variable generation as well as increased demand responsiveness and the advent of new technologies".

Art. 11.1 "Dispatching of power generation facilities and demand response shall be non-discriminatory and market based unless otherwise provided".

Art.19.5.b "By six months after entry into force of this Regulation, the ENTSO for Electricity shall submit to the Agency a draft methodology for calculating: (b) the "cost of new entry" for generation, or demand response".