

LOCAL FLEXIBILITY MARKET BALANCE SETTLEMENT

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Abstract

Electricity system needs to balance the consumption and generation every moment. Imbalance settlement considers the differences between the allocated and realised volumes of energy of the market participants. Local market, developed in the project DOMINOES will have an effect on the balance settlement since it introduces an additional market place and local market participants trade energy and possibly also flexibility between each other thus interfering the retailer balances. New balance settlement can be handled via smaller BRP units, independent aggregation or multiple retailers. DOMINOES-project proposes two solutions, where balance responsibility is extended to end-user ('full local balance settlement model') or extended to local market level ('light local balance settlement'). Full model proposes the end-user to have responsibility to keep itself in balance. Local market level adds another layer of local balance settlement before the centralised balance settlement. Both approaches are going to be further evaluated in the project validation.

1. Introduction

Electricity system is based on the balance of generation and consumption that need to be equal every moment to keep the frequency at 50 Hz. In order to ensure the balance and incentivize the market participant to keep the system balance, balancing services and balancing markets are developed. Imbalance settlement mechanisms are in place to settle the allocated volumes and final positions of the parties. Imbalance settlement determines the electricity deliveries between the parties operating in the electricity market. Imbalance settlement is based on a hierarchic imbalance settlement model and on chains of open deliveries. Every party who operates in electricity markets must take continuous care of its power balance meaning that balance between consumption/sales and generation/procurement are equal.

In practice, not every party can do it by themselves and they have an open supplier, which balances the power balance of the party. The open supplier supplies its customers with all the electricity they need or balances the differences in production/acquisition and use/supply by supplying the amount of electricity that is lacking or by receiving the surplus during each hour. A party who is responsible for the imbalance is called a balance responsible party (BRP). Imbalance settlement responsible (ISR) is responsible for settlement of differences between the contracted quantities and the realised quantities of energy products for the BRPs in the market area [1]. The model is described in the Figure 1.

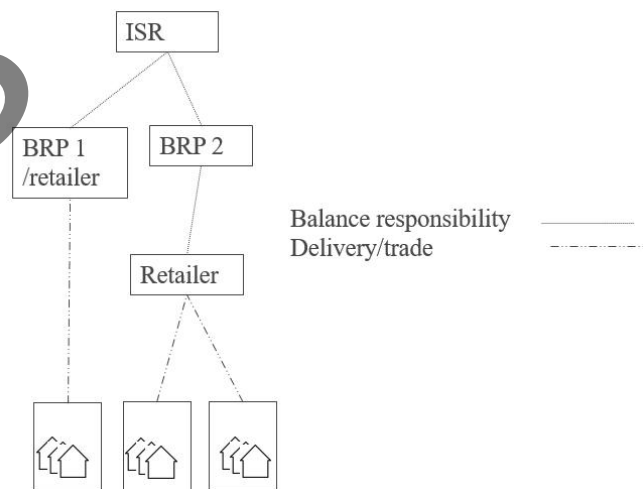


Figure 1. Imbalance settlement model

DOMINOES-project is developing local market solutions that enable new demand response, aggregation, grid management and peer-to-peer trading services. Local markets enable bottom-up flexibility management so that local sharing of resources is possible considering also the value of local flexibility for network management. Local market operates in sequence with the existing open markets so that the interconnections to wholesale energy markets and ancillary services markets are possible (i.e. to enable utilisation of local flexibility in wholesale portfolio optimisation and provision of flexibility services to other stakeholders). Local markets in DOMINOES consider energy

and flexibility products. Main principle is that flexibility is used where it is most highly valued.

Local market operation and flexibility controls change the customer behaviour and in large scale keeping the market party in balance will be more difficult since the customers will act based on an outside input of which balancing party is not aware of. Also customers' peer-to-peer trades and customers' own implicit demand response affect the retailer's balance. Imbalance risks of retailers will increase because of the local markets if these changes in the balancing mechanisms are not taken into account. If a local market operates inside the same balance, the balance settlement works as today. If different balance responsible parties represent the local market participants, new challenges for the balance settlement are occurring.

Developing the balance settlement process suitable for local market should consider the basic principles of the balance settlement (concept of balance responsibility and open supplier), role of the distribution network (local market does not operate behind one metering point) and rights of the customer to choose the retailer and withdraw from the energy community. The definition of the balance settlement has a significant impact on the viability of the proposed market solution.

2. Methodology

This paper will describe how the local market operation effects the balance settlement procedures. Options for implementing the balance settlement in the local market operation are described and their drawbacks and benefits are analysed. Then, alternative solutions proposed for the DOMINOES-project are presented.

3. Balance settlement at local markets in DOMINOES

Based on [2] following possibilities to implement balance responsibility at local markets are considered.

3.1. *Smaller balance responsible parties*

Problem of local markets interfering in the balance settlement could be avoided by creating mechanisms for smaller BRP. This would create more competition and new possibilities for market participation, but the actual balance settlement mechanisms would remain the same. Nowadays the threshold for being a BRP is quite high with all the responsibilities, financial requirements and information system needs. Profitability of small BRP is highly uncertain. Large number of small units creates high needs for information and communication technology (ICT) systems, which will lead into economies of scale and purchasing the ICT infrastructure as a service. Small amount of resources increases variance and there might be difficulties to forecast accurately enough for balance settlement purposes.

With smaller BRPs balance settlement process would work as nowadays and BRP takes care of the balance settlement of its customers as a whole, including the flexibility. If the energy community acts as a BRP it could also take care of the distribution costs and distribute them according the community principles. Model should be incentivized in a way that the community does not focus only in their own benefit but also the benefit of the whole energy system.

3.2. *Independent aggregators*

One solution to address the problems of providing flexibility is the concept of independent aggregation, where a party that is not the BRP of the resource is providing flexibility, and possibly energy, to markets. This solution, however, interferes with the traditional balance settlement process.

There are already now some possibilities for independent aggregators to offer flexibility and it will further promoted in the future regulation. In Finland, independent aggregation is possible in frequency containment reserves (FCR) where the effect of the control in energy balance is very small since the control times are relatively short. BRP needs to be informed however. [3]

Regarding the markets where a flexibility control causes larger differences in balance, rules must be in place. Finnish transmission system operator (TSO) Fingrid has an Aggregation Pilot Project in the Balancing Energy Markets where an independent aggregator has a possibility to participate in the balancing energy market and aggregate resources from multiple balances. This is compensated for the resources' BRPs. [4]

Baseline methodologies can be used to evaluate what would have the consumption been without the activation of the flexibility and thus the impact of activation to the balance. These methodologies are based on the measurement data before and possibly also after the activation. Different methodologies and their suitability to Baltic market are described in [5].

Another issue with the independent aggregator model is how to in a cost-correlated way compensate the harm/financial defeats of the control to balance responsible parties. Compensation mechanisms should be verified by a neutral party like ISR need to have the information to compare the planned consumption/generation and agreed trades. Compensation mechanisms amount to double balance settlement.

Trading must be time bound between existing markets, in order to avoid the situation where the resource could be sold for multiple purposes at the same time. The independent aggregator model is easy for the independent aggregator to start since there are no specific obligations and demands for independent aggregation. There are multiple ways to organize aggregation, one report by the Nordic TSOs studied several of these [6].

3.3. Multiple retailers

One solution to problem caused by the flexibility provision to balance settlement could be tackled by introducing possibility for multiple retailers for one customer. This would mean, that there would be separate retailers for e.g. generation, EV charging or demand response (like electric heating/cooling, air conditioning) and basic electricity consumption at one customer, or some part of these according to customer wishes, and these retailers would be responsible for their own part of the balance settlement chain.

Verifying the supply/flexibility needs measurements (additional register in the electricity meter or separate sub measurement) or some parts of the supply could be verified with improving the load curve processing, fixed deliveries and proportional allocation. Concept of multiple retailers is evaluated for example in [7] and [8].

3.4. Role of measurement

Distribution system operator (DSO) is in the role of providing the physical market platform (network) and has a role in providing the measurements. Role of the measurements is very crucial when talking about balance settlement. Balance settlement is nowadays based on the measurements provided by DSO. DSO measurement contains the net sum of consumption and possibly also small scale generation. Flexibility devices do not have their own approved measurement provided by a neutral market party, like DSO. There might be measurements from the generation units and automation systems, but these are not necessarily approved by BRP. This has to be considered especially in the case of multiple retailers when the distinction between the different supplies has to be made. There is always a possibility for sub measurements but requirements and verification for sub measurements should be defined and commonly agreed. Organizing a separate sub measurement is also a significant cost factor for small distributed resources.

4. Results

The aim in DOMINOES-project is to offer a model, where the distributed resources have increased possibilities to participate in energy markets through increased discoverability, accountability and scalability. The chosen solution is to offer the possibility to manage the energy balances on a more granular level. The benefits are multiple ranging from an accountable baseline for flexibility to energy sharing and the possibility to track the use of energy on the local level. However, there are also challenges due to the increased requirements for information exchange and granularity of generated data such as forecasts.

Based on [2], the identified solutions for implementing balance responsibility locally could be categorized into light (Figure 2) and full (Figure 3) local balance responsibility. Trades with local market (LM) and wholesale market (WM) are presented as well as balance responsibility relationships and provision of settlement information are visualized.

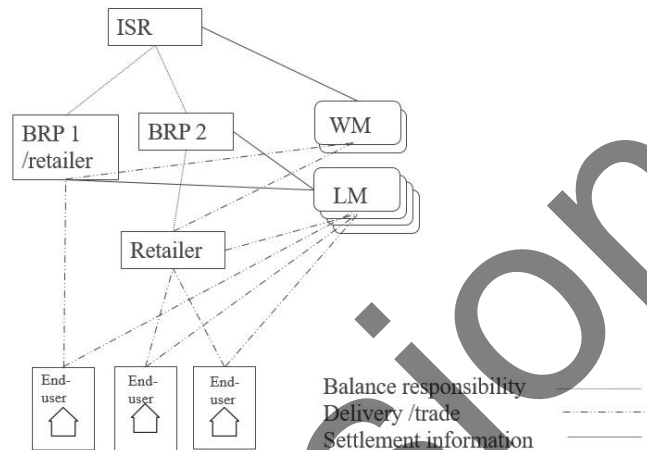


Figure 2. Light local balance settlement

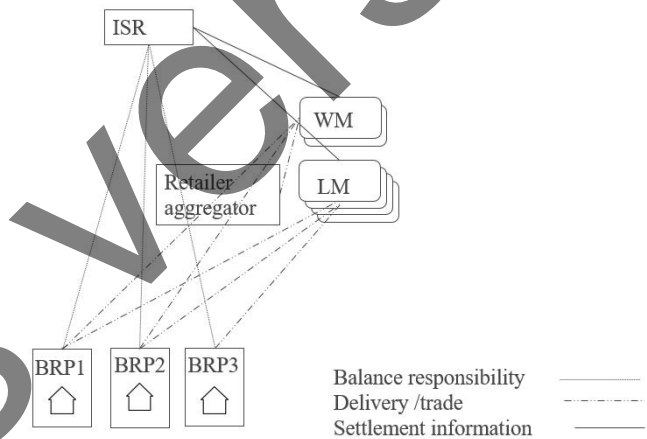


Figure 3. Full local balance settlement

Both of these approaches are considered in developing the DOMINOES local market and in the future validation phase of the project. Light model will be studied in the use case where the retailer operates the local market and energy asset management is used for retailer value (use case 4). Objective of this use case is in the day-ahead energy optimization and minimization the deviations in an intraday timeframe. Full balance settlement model is considered in the use case where local market is operating for the community value (use case 3) where local market participants are encouraged to actively participate to trading locally and to other markets. DOMINOES use cases are described in detail in [9].

4.1. Light balance responsibility

In the light version, the traditional system balance responsibility is maintained and a separate local balance is created (i.e. *light* in the amount of regulatory changes required). It will add an additional layer for balance settlement and thus complicates the settlement procedure but for the ISR local market operation is not visible. In this light model, the balance responsibility is a separate contractual agreement similar to the system balance responsibility but maintained only between the “sub-BRP” (e.g. end-consumer) and its retailer or BRP. The local market coordinates the

changes to the balances of the BRPs on the system level. In the light model, a separate local ISR might be required in order to allocate payments for non-delivery of flexibility to e.g. the DSO. The DSO can also cover some of its participation expenses through excess fees.

4.2. Full balance responsibility

Alternatively, in the full model, the (system) balance responsibility is extended to e.g. level of individual houses and the trades from the local market are directly forwarded to the imbalance settlement responsible (ISR) as well as the bilateral trades or trades with retailer. This increases extensively the amount of parties connected to settlement procedure and the amount of data to settle.

One benefit of this approach is that it does not interfere the structures of balance settlement in general level but it requires redefinition of BRP role and responsibilities and thus new regulation. The proposed model increases the responsibilities of end-user but also incentives for active market participation.

4.3. DSO role

In both of the cases DSO is responsible to providing the measurement data for balance settlement purposes, in the light model DSO reports the data to local market as well from those customers that are involved in local market operation. For the imbalance settlement structure, BRP and in the light model sub-BRP needs the data about the metering points that they are aggregating. Balance settlement information is linked to validation of the trades, but for the flexibility validation purposes the hourly and for some cases even the quarterly measurement data is not enough accurate. Flexibility validation should be further studied.

DSO can be in the local markets also a procurer of flexibility. By procuring flexibility, DSO creates imbalance since DSO is not traditionally a balance responsible party. The imbalance can be handled via compensating the imbalance or by countertrading. Countertrading in the same local market would be viable option in the light model if network structure allows this. In the full model, compensation probably is an easier option unless also DSO becomes a BRP like all the other market participants.

5. Conclusion

Local flexibility market operation affects the balances of the market participants and thus the position of retailers and further BRPs. There are several possibilities to consider the local market operation so that all market participants are treated more equally and effect of local market trading to the balance is considered.

DOMINOES-project proposes two models. In the first one, balances are settled first at local market level (light local balance settlement) and in the second one (full local balance settlement), balance responsibility is extended lower to the

end-user level. The feasibility of the solutions and implications of both approaches to the local and overall market operation are further evaluated in the validation phase of the project and creating a roadmap to real market environments.

6. Acknowledgements

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